Supplementary File: Modifiable Risk Factors for Patellar Tendinopathy in Athletes

a)

(((((patellar tendon OR patella tendon OR patella tendinopathy OR patellar tendinopathy OR patella tendinosis OR patellar tendinosis OR patella tendinitis OR patellar tendinitis OR patella apicitis OR patellar apicitis OR patella tenosynovitis OR patellar tenosynovitis OR jumper's knee))))

AND ((risk factor OR relative risk OR odds OR probability OR prevalence OR odds ratio)))

NOT ("ACL"[Title/Abstract] OR "anterior cruciate ligament"[Title/Abstract] OR "graft"[Title/Abstract] OR"arthroplasty"[Title] OR "prosthetic"[Title] OR "fracture"[Title]) AND (Humans[Mesh])

b)

(patellar tendon OR patella tendon OR patella tendinopathy OR patellar tendinopathy OR patella tendinosis OR patellar tendinosis OR patella tendinitis OR patellar tendinitis OR patella apicitis OR patellar apicitis OR patella tenosynovitis OR patellar tenosynovitis OR jumper's knee)

AND

(risk factor OR relative risk OR odds OR probability OR prevalence OR odds ratio)

NOT

("ACL" OR "anterior cruciate ligament" OR graft OR arthroplasty OR prosthetic OR fracture*)

Human limit Applied

c)

(patellar tendon OR patella tendon OR patella tendinopathy OR patellar tendinopathy OR patella tendinosis OR patellar tendinosis OR patella tendinitis OR patellar tendinitis OR patella apicitis OR patellar apicitis OR patella tenosynovitis OR patellar tenosynovitis OR jumper's knee)

AND

(risk factor OR relative risk OR odds OR probability OR prevalence OR odds ratio)

NOT

("ACL" OR "anterior cruciate ligament" OR graft OR arthroplasty OR prosthetic OR fracture*)

NOT

(Dog* or Rats OR canine*)

d)

(ALL((patellar tendon OR patella tendon OR patella tendinopathy OR patellar tendinopathy OR patella tendinosis OR patellar tendinosis OR patella tendinitis OR patellar tendinitis OR patella apicitis OR patellar apicitis OR patella tenosynovitis OR patellar tenosynovitis OR jumper's knee OR (patella* AND tendinopath*))) AND (TITLE-ABS-KEY((risk factor*))OR TITLE-ABS-KEY(relative risk* OR odds OR probability OR prevalence OR odds ratio*))) AND NOT TITLE-ABS("ACL" OR "anterior cruciate ligament" OR graft OR arthroplasty OR prosthetic OR fracture*) AND NOT TITLE-ABS(Dog* OR rats OR canine*)

Supplementary Figure 1. Search strategies utilized for a) PubMed, b) CINAHL, c) Web of Science and d) SCOPUS.

Supplementary Table 1. Cohen's Kappa values for inter-rater agreement of record screening and quality assessment.

Screening or Assessment Stage	Cohen's Kappa (κ)
Title Screening	0.904
Abstract Screening	0.491
Full-Text Screening	0.701
Quality Assessment	0.744

Supplementary Table 2. Characteristics of included studies.

Study	Potential Risk Factors Investigated	Diagnostic Criteria	Sample Size (Injured/Uninjured)	Sport and Competition Level	Mean Age (SD) (Years)*	Sex (Male/Female)
Prospective Studies						
Backman et al. (2011)♦[25]	BMI, BW, Ankle dorsiflexion ROM, Activity volume, Sport-specific training volume	1) History of activity related anterior knee pain. 2) Distinct palpation tenderness corresponding to painful area. 3) Knee pain provoked by single-legged decline squat	75 (12/63)	Basketball players competing at the national elite level.	17.8 (1.6)	38/37
de Vries et al. (2015)♦[24]	BMI, BW, Activity volume, Other sports training volume, Playing surface, Occupational classification, Occupational demands	1) Indicated pain at the inferior pole of the patella on a self-administered pain map. 2) And/or physician or physical therapist had diagnosed the knee problem as patellar tendinopathy.	385 (51/334)	Basketball and volleyball players competing at the elite (regional or national) or non-elite level.	28.3 (4.5)	142/243
Hagglund et al. (2011)♦[27]	BW, Activity and playing volume, Training/match exposure ratio, Playing surface	Diagnosis based on clinical examination by the team medical staff but no specific diagnostic criteria provided.	2229 (137/2,092)	Soccer players competing at the professional level.	UCL: 25.7 (4.5); SWE: 24.8 (4.7); ART: 25.0 (4.8)	All male
Visnes and Bahr (2013)♦[29]	BW, Waist circumference, Skinfold measurements, Volleyball sets per week, Beach volleyball training volume, Strength training volume, Jump training volume, Other training volume	1) History of pain in the quadriceps or patellar tendons at their patellar insertion in connection with training or competition. 2) Tenderness to palpation corresponding to the painful area.	141 (28/113)	Volleyball players competing at the elite level.	16.8 (0.8)	69/72
Visnes et al. (2013)[26]	CMJ height, Standing jump height	1) History of pain in the quadriceps or patellar tendons at their patellar insertion in connection with training or competition. 2) Tenderness to palpation corresponding to the painful area.	150 (28/122)	Volleyball players competing at the elite level.	16.7 (0.8)	68/82

Witvrouw et al. (2001)♦[28]	BW, Posterior thigh flexibility, Quadriceps flexibility, Peak normalized isokinetic knee extension torque (60, 180 and 240 deg/sec), Peak normalized isokinetic knee flexion torque (60, 180, and 240 deg/sec)	1) 2) 3)	Characteristic history of pain in the quadriceps or patellar tendons or their patellar or tibial insertions Tenderness to palpation corresponding to the painful area. Presence of a hypoechoic nodular lesion in the patellar tendon on ultrasound imaging.	138 (19/119)	Students entering an undergraduate program in physical education with 12-14 hours a week of mandatory participation in swimming, track and field, gymnastics, soccer, basketball, volleyball, jazz dance, handball and judo.	18.8 (Range: 17-21)	99/39
Cross-sectional Studies							
Bisseling et al. (2007)♦[38]	BW	1) 2) 3)	Pain during single-leg decline squat Palpation tenderness localized to the proximal patellar tendon or insertion of the quadriceps tendon VISA-A score < 80 points	17 (8/9)	Volleyball players competing in the elite, first, second or third division.	Case: 24.1 (3.3); Control: 23.6 (2.5)	All male
Bode et al. (2007)[45]	BW, Playing surface, Footwear type, Insole use, Activity volume	No specific diagnostic criteria provided.		119 (13/106)	Soccer players competing at the elite level.	15.94 (2.24)	All male
Cassel et al. (2015)♦[39]	BW, Activity volume	1) 2)	Positive anamnesis of tendon pain Tendon pain on palpation	760 (42/718)	Athletes enrolled in an elite sport school. Athletes participated in boxing, canoeing, cycling, gymnastics, handball, horse riding, judo, modern pentathlon, rowing, shooting, soccer, swimming, track and field, volleyball, wrestling, recreational sports and weight bearing sports.	13.0 (1.9)	442/318
Crossley et al. (2007)♦[30]	BMI, BW, Peak knee extension torque, Posterior thigh flexibility, Calf muscle endurance, Ankle dorsiflexion ROM, Hop for distance, Six-meter hop test	1) 2) 3) 4) 5)	Knee pain with either jumping/landing, running or changing directions Pain on palpation of the patellar tendon VISA-P < 80 points Symptoms sufficient to affect exercise and activity for at least 6 months Confirmed hypoechoic lesion within the patellar tendon on ultrasonography	58 (27/31)	Adults participating in competitive basketball, netball, volleyball, soccer or tennis at least once per week.	Unilateral Patellar Tendinopathy: 26 (7); Bilateral Patellar Tendinopathy: 28 (8); Controls: 24 (6)	39/19

Dauty et al. (2007)♦[40]	BW, Bilateral hamstring and quadriceps peak torque ratios (60, 180, and 240 deg/sec), Bilateral hamstring and quadriceps fatigue ratios	No specific diagnostic criteria provided.	57 (15/42)	Basketball players competing at the elite level.	Case: 25.6 (5); Control: 24.9 (4)	All male
Ferretti et al. (1984)♦[8]	Playing surface, Activity volume	Clinical diagnosis made by authors, or coach or trainer who was trained and supervised by the primary author during an instructional course. No specific diagnostic criteria provided.	407 (93/314)	Volleyball players from various divisions of the Italian Championship.	Descriptive statistics not stated. 26 athletes < 15, 208 athletes between 15 and 19, 140 athletes between 20 and 25, 33 athletes > 25	Case: 74/19 Control: Not stated
Groot et al. (2016)♦[31]	BMI, Activity volume	1) Current symptoms of knee pain in the patellar tendon or its patellar or tibial insertion in connection with training and competitive sports in one knee. 2) Symptoms for over three months. 3) VISA-P score < 80 points	44 (22/22)	Recreational athletes	Cases: 27 (10); Controls: 24 (3)	23/21
Krauss et al. (2007)♦[51]	Running on asphalt, Peak and normalized peak knee extension and flexion concentric and eccentric isokinetic torque (60 deg/sec), Concentric hamstring-quadriceps quotient, Knee flexion and extension eccentric endurance quotient	Presence of at least one of the following: 1) Pain at the tendon while running, mostly at the inferior pole of the patella. 2) Pain after exercise 3) Pain generated by contracting the quadriceps muscle 4) Well localized tenderness to the inferior pole of the patella	46 (20/26)	Recreational runners	Cases: 37.6 (8.9); Controls: 39.9 (5.7)	All female
Kujala et al. (1986)♦[41]	BW, Knee extension ROM, Peak knee flexion and extension isometric torque	1) Maximal tenderness on palpation exactly at the lower pole of the patella 2) Symptoms at the same point during exertion	40 (20/20)	Elite and recreational athletes participating in volleyball, long-distance running or orienteering.	Case: 27.4 (6.4); Control: 27.6 (6.0)	All male

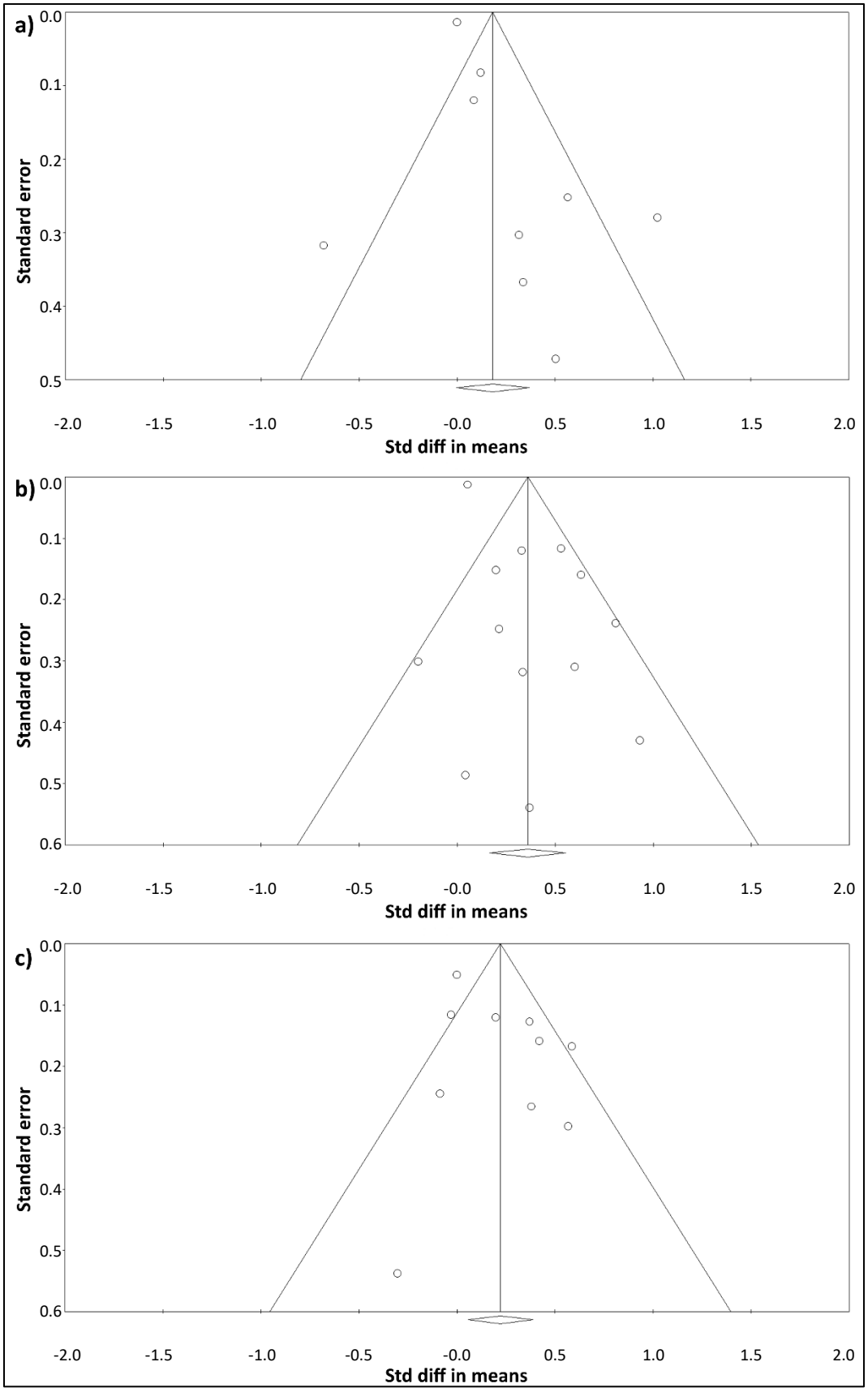
Lian et al. (1996)♦[48]	BW, Standing jump height (No load, 20-kg load, ½ BW load) and work (No load), CMJ height and work, 15-second rebound test work	1) History of pain in the quadriceps or patellar tendons or their patellar or tibial insertions in connection with volleyball play 2) Tenderness to palpation corresponding to the painful area	24 (12/12)	Volleyball players participating in the 1st and 2nd division of the Norwegian Volleyball Federation League.	Case: 23.7 (3.0); Control: 24.8 (4.6)	All male
Lian et al. (2003)♦[42]	BW, Activity volume, Sport specific training volume, Weight training volume, Jump training volume, Stretching habits, Standing jump height (No load, 20-kg load, ½ BW load, 1 BW load) and average work, force and velocity (1/2 and 1 BW load), CMJ height and work, Drop CMJ height and work, 15-second rebound test average work, Jump test composite score	1) History of pain localized to the lower patellar pole or insertion of the quadriceps tendon in connection with volleyball play 2) Distinct palpation tenderness corresponding to the painful area	44 (24/20)	Volleyball players competing at the elite level.	Case: 22.4 (2.5); Control: 22.0 (4.0)	All male
Lian et al. (2005)♦[2]	BW, Activity volume, Weight training volume, Jump training volume	1) History of pain localized to the lower patellar pole or insertion of the quadriceps tendon in connection with athletic activity 2) Distinct palpation tenderness corresponding to the painful area	613 (87/526)	Athletes competing at the national level in soccer, team handball, volleyball, basketball, athletics, ice hockey, wrestling, orienteering or cycling	Mean age ranged from 22.1 to 26.8, depending on sport	506/107
Longo et al. (2011)♦[43]	BW, Impact profile of sport	1) Local tenderness to palpation at the inferior pole of the patella or in the main body of the tendon with the knee fully extended and the quadriceps relaxed 2) Decreased or eliminated tenderness to palpation when the knee was flexed to 90 degress	174 (81/93)	Track and field athletes competing at the elite level.	53.8 (11.4)	103/71
Malliaras et al. (2006)♦[46]	Ankle dorsiflexion ROM, Sit-and-reach flexibility, Ankle plantarflexion endurance, Activity volume, CMJ height	1) Pain elicited during a single-leg decline squat test 2) Tendon abnormality on ultrasound imaging.	140 (53/87) tendons	Volleyball players participating in the Victorian State League competition in Australia.	Right Tendons: 25.8 (4.9); Left Tendons: 26.1 (5.4)	124/66 tendons

Morton et al. (2017)♦[32]	BMI, Activity volume	Self-report of diagnosis by a medical professional with a positive clinical history and clinical examination, with pain localized to the inferior pole.	825 (193/632)	Recreational to professional athletes competing in volleyball, running, gym exercise, racket sports, basketball, walking/hiking, soccer, cycling, dance/gymnastics/ice skating, field sports, or other sports.	Case: 30.7 (10.8); Control: 30.3 (10.8)	365/460
Rio et al. (2016)♦[33]	BMI, Peak knee extension isometric torque, Corticospinal excitability of the quadriceps	1) Pain localized to the inferior pole of the patella during jumping and landing activities. 2) Pain elicited during the single-leg decline squat test.	19 (11/8)	Basketball and volleyball players competing at the sub-elite level.	Median (Range): Case: 26 (18-37); Control: 26 (18-37)	Case: 10/1; Control: 7/1
Rosen et al. (2015)♦[49]	Vertical jump height	1) Pain only in the patellar tendon 2) Self-reported pain within the tendon during loading tasks such as jumping and squatting, during the previous 3 months. 3) VISA-P score <80 points	60 (30/30)	Recreational athletes. Primary sport participation not stated.	Case: 21.3 (3.2); Control: 21.5 (3.0)	Case: 15/15; Control: 15/15
Scattone Silva et al. (2016)♦[44]	BW, Ankle dorsiflexion ROM, Posterior thigh flexibility, Quadriceps flexibility, Activity volume, Peak ankle plantarflexion isometric torque, Peak knee extension isometric torque, Peak hip extension isometric torque	1) Pain localized to the patellar tendon of insidious onset, confirmed by palpation. 2) Current symptoms in the patellar tendon during tendon-loading task for at least three months	14 (7/7)	Volleyball, basketball and handball players competing at the college or professional level.	Case: 22.86 (5.43); Control: 21.00 (2.83)	All male
Siegmund et al. (2008)♦[50]	CMJ or running lay-up height	1) Diagnosis of bilateral or unilateral jumper's knee by a physician or athletic trainer 2) Point tenderness over the inferior pole of the patella on physical examination	24 (12/12)	Basketball players competing at the recreational, high school, collegiate or professional level.	Not stated. Athletes had to be between the ages of 18 and 29 for inclusion.	All male

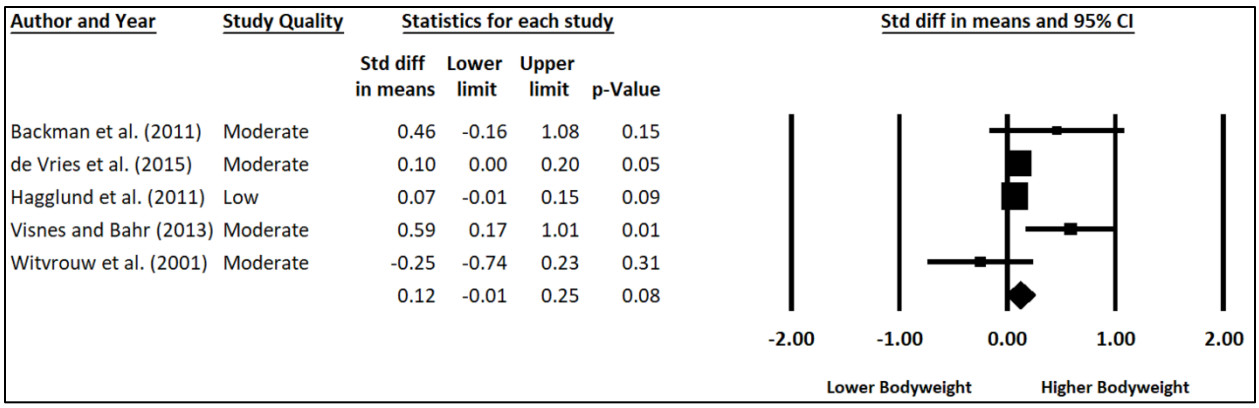
Torres et al. (2016)♦[34]	BW	1) History of training-related and or competition-related pain in the patellar tendon or its insertions 2) Symptoms persisting for more than three months 3) Palpation pain and/or tenderness of the patellar tendon 4) VISA-P score < 80 points		42 (21/21)	Basketball and volleyball players. Competition level not stated.	Case: 24.5 (3.6); Control: 25.7 (2.9)	Case: 13/8; Control: 13/8
van der Worp et al. (2011)[52]	Occupational category, Occupational demands	1) Self-reported diagnosis of patellar tendinopathy by a physician or physical therapist OR 2) Pain at the inferior pole of the patella indicated on a self-administered pain map.		1505 (268/1237)	Basketball and volleyball players. Competition level not stated.	27.3 (4.1)	690/815
van der Worp et al. (2012)♦[35]	BW, Waist circumference, Hip circumference, Activity volume, Playing surface	1) Self-reported diagnosis of patellar tendinopathy by a physician or physical therapist OR 2) Pain at the inferior pole of the patella indicated on a self-administered pain map.		2224 (414/1810)	Basketball and volleyball players. Competition level not stated.	25.4 (4.7)	1006/1218
van Wilgen et al. (2013)♦[36]	BMI	1) History of knee pain in the proximal patellar tendon related to exercise. 2) Palpation pain at the proximal patellar tendon. 3) Symptoms present for at least 6 months. 4) VISA-P score < 80 points.		32 (12/20)	Athletes participating in basketball, soccer, volleyball, squash or rowing. Competition level not stated.	Case: 23.3 (3.6); Control: 24.7 (5.3)	All male

Zhang et al. (2016)♦[37]	BMI, BW	1) Pain in the inferior pole of patella or the proximal part of the patellar tendon. 2) Pain aggravation during single leg squatting and jumping 3) Pain duration >3 months. 4) Maximum intensity of pain in the previous week >3 on the visual analog scale. 5) VISA-P score < 80 points 6) Thickening of proximal part of patellar tendon with area of hypoechoic signal on ultrasound imaging.	66 (36/30)	Volleyball and basketball players. Competition level not stated.	Case: 22.8 (4.2); Control: 23.5 (4.6)	All male
Zwerver et al. (2011)♦[3]	BMI, BW, Activity volume	1) Typical history of gradually developed, activity-related anterior knee pain. 2) A circumscript most painful spot, point out in a diagram of the knee, at the upper or lower pole of the patella, in the patellar tendon, or at its tibial insertions. AND/OR 3) Diagnosis of patellar tendinopathy by a physician or physical therapist.	891 (76/815)	Basketball, volleyball, handball, korfball, soccer, field hockey, or track and field athletes competing at the club and recreational level.	Case: 22.8 (3.1); Control: 24.1 (4.8)	502/389

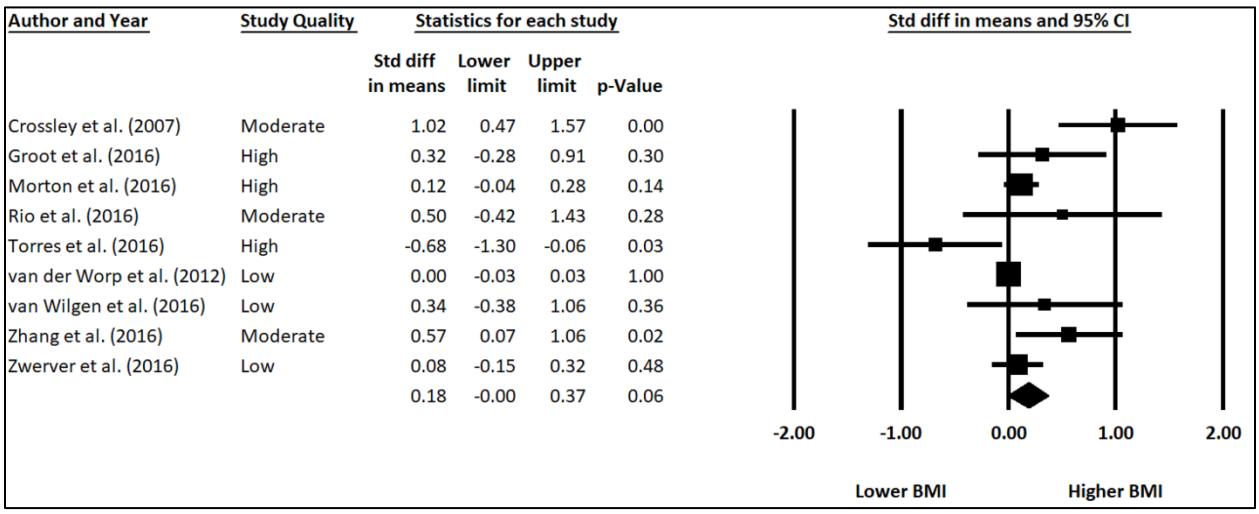
BMI = Body mass index, BW = Bodyweight, ROM = Range-of-motion, UCL = Union of European Football Associations (UEFA) Champions League, SWE = Swedish First League, ART = Artificial Turf Cohort, CMJ = Counter-movement jump. *If a single value is reported, it represents the pooled age for all participants. ♦Study included in quantitative synthesis (meta-analysis).



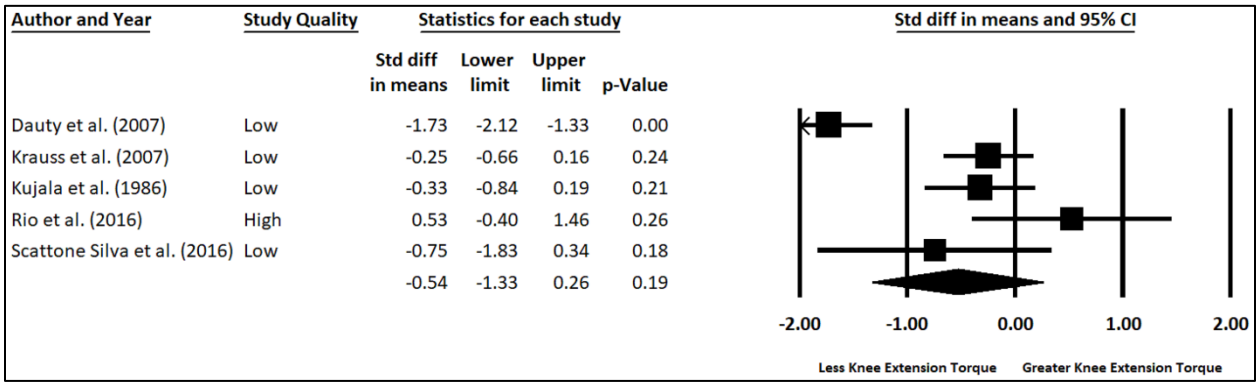
Supplementary Figure 2. Funnel plots for a) BMI, b) bodyweight, and c) activity volume for cross-sectional studies.



Supplementary Figure 3. Standardized mean difference (Cohen's d) with 95% CI for bodyweight as potential modifiable risk factor.



Supplementary Figure 4. Standardized mean difference (Cohen's d) with 95% CI for BMI as an associated modifiable factor.



Supplementary Figure 5. Standardized mean difference (Cohen's d) with 95% CI for knee extension torque production as an associated modifiable factor.