

Online Resource I Discover Medicine

Review Title:

Modifiable musculoskeletal factors and their association with shoulder function in adults: A Systematic review of Etiology and Risk.

Journal: Discover Medicine

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Online Resources 1

SoF: a) Isometric and isotonic external and internal rotator strength values reported of the cases.

Study	LOE	Sport	Sample size	Age*	Gender F=female; M= male	Strength Dominant	Strength Non-Dominant	Weight	SMD (95%CI)
Cools et al., 2016. Observational study	3	Handball athletes and healthy controls	N=100	18-25	F=19	Isom ER Position (90/0) 0.91 0.14	Isom ER Position (90/0) 0.94 0.12	11.34 %	-0.23 (-0.60, 0.14)

Study	LOE	Sport	Sample size	Age*	Gender F=female; M= male	Strength Dominant	Strength Non-Dominant	Weight	SMD (95%CI)
		Tennis	N=100	26-33	F=10	ECC ER Position (90/90) 2.1 0.5	ECC ER Position (90/90) 2.0 0.6	21.29 %	0.18 (- 0.19. 0.55)
		Volleyball	100	34-50	F=20	Isom ER Position (90/0) 1.9 0.4	Isom ER Position (90/0) 1.9 0.4	4.69%	0.00 (- 0.58. 0.58)
						ECC ER Position (90/90) 2.5 0.7	ECC ER Position (90/90) 2.3 0.5	21.09 %	0.33 (- 0.05. 0.70)
		Handball		18-25	M=22	Isom ER	Isom ER		

Study	LOE	Sport	Sample size	Age*	Gender F=female; M= male	Strength Dominant	Strength Non-Dominant	Weight	SMD (95%CI)
						Position (90/0) 1.6 0.4	Position (90/0) 1.5 0.4	4.25%	0.25 (- 0.36. 0.85)
						ECC ER Position (90/90) 2.2 0.5	ECC ER Position (90/90) 2.0 0.6	21.29 %	0.18 9- 0.19. 0.55)
		Tennis		26-33	M=11	Isom ER (90/0) 0.91 0.14	ER Position (90/0) 0.94 0.12	11.34 %	-0.23 (- 0.61. 0.15)
						ECC ER Position (90/90) 0.92 0.22	ECC ER Position (90/90) 0.94 0.18	8.01%	-0.10 (- 0.70. 0.51)
		Volleyball		34-50	M=	Isom ER Position (90/0) 0.87	Isom ER Position (90/0) 0.89		

Study	LOE	Sport	Sample size	Age*	Gender F=female; M= male	Strength Dominant	Strength Non-Dominant	Weight	SMD (95%CI)
						0.15	0.19	4.68%	-0.11 (-0.69, 0.46)
						ECC ER Position (90/90) 1.02 0.20	ECC ER Position (90/90) 1.11 0.16	8.53%	-0.49 (-1.07, 0.10)
Dos Santos De Andrade et al., 2010. Observational	3	Handball players female and males	27	23.0-34	27	Ecc ER Position (90/0) 33.7 8.0	ECC ER Position (90/0) 32.2 4.9	5.47%	0.22 (-0.31, 0.76)
Study	LOE		Sample size	Age, Mean/ (SD)	F Sample	Isom ER Position (90/0)	Isom ER Position (90/0)		SMD CL 95%
Riemann et al., 2010 Observational	3	Healthy volunteers	181 180	23.4 4.1 F	91 90	9.9 3.0 17.8 5.2	9.6 4.1 17.8 5.2	18.54 % 18.35 %	0.08 (-0.2, 0.37) 0.00 (-0.29, 0.29)
Peckitt et al., 2019 Observational cohort	3	Cricketers	36	20.-28.0	4	155.0 27.8	147.2 22.5	N/A	N/A

Study	LOE	Sport	Sample size	Age*	Gender F=female; M= male	Strength Dominant	Strength Non-Dominant	Weight	SMD (95%CI)
Forthomme et al., 2018.	3		108	24 4		Ecc ER Position (90/90) 0.63 0.11	Ecc ER Position (90/90) 0.61 0.13	21.94 %	0.17 (- 0.10. 0.43)
Furness et al., 2018 Cohort.	2	Surfacing athletes	13	24.1 6.9	4	Isom ER (90/0) 1.81 0.40	Isom ER Position (90/0) 1.65 0.34	N/A	N/A

F=female; M= male; D= dominant; ND= non-dominant; ecc= eccentric; isom= isometric; ER= external rotation. Age*= years in mean (SD); SD= standard deviation; D= dominant' ND= non-dominant.

Level of Evidence (LOE): OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. <http://www.cebm.net/index.aspx?o=5653> * OCEBM Table of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson

SoF: b) Eccentric external rotator strength of the cases.

Study	LOE	Sample size	Sport	Age*	S	AS	Study			Weight	SMD (95%CI)
							M	S	AS		
McDonough et al., 2014 Cohort	2	20	Rugby league	19.6 (1.77)	8	14	M=20	56.9	62.3	6.53%	0.27
								18.39	19.32		(-0.60. 1.15)
								54.1	64.5	6.47%	0.46
								12.28	25.4		(-0.42. 1.34)
Laudner, 2004 Observational study	3	22	Baseball league	22.9 3.45		11	M=22	-0.60	0.17	6.80%	0.13 (-0.70. 0.97)
								6.16	4.90		
Heck et al., 2021. Cohort	2	15	Gymnasts	20.5 0.9	12	19	F=15	10.2	10.9	7.75%	0.19 (-0.53. 0.92)
								2.9	3.9		
								9.8	10.2		
								2.2	3.5		

Forthomme et al., 2018	3	108	Handball	24 4	51	57	M=108	0.62 0.10	0.63 0.12	11.12%	-0.09 (-0.47. 0.29)
Cross sectional											

S= symptomatic; AS= asymptomatic; ER= external rotators; ER= external rotators; N=Newton, N-M= Newton-meters, iso= isokinetic; ecc= eccentric, Age*= mean in years (SD); SD= standard deviation. Level of Evidence (LOE): OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. <http://www.cebm.net/index.aspx?o=5653> * OCEBM Table of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard, and Mary Hodgkinson.

SoF: c) IR and GIRD of the cases.

Study	LOE	Sample size	Sport	Age*	S	A	IR Position Supine (90/90)	Means (SD) Degrees		Weight %	SMD (95 %CI)
								S	AS		
Lal., B 2017. Prospective	3	36	Cricket professional league.	S= and AS= 23.56 (4.27)	8	23	D	51.30 (9.53)	51.48 (14.91)	8.94 %	-0.01 (0.82. 0.79)

Study	LO E	Samp le size	Sport	Age*	S	A S	IR Positi on Supin e (90/90)	Means (SD) Degrees		Weig ht %	SMD (95 %CI)
								S	AS		
Observatio nal study.							ND	58.11 (12.4 5)	64.09 (13.3 0)	10.50 %	-0.44 (-1.26- 0.37)
Rosa et al., 2019. Cross- sectional study	3	51	Members of the general public	S= 33.5(10. 1) AS= 27.4 (6.6)	2 5	28	IR	57.4 (12.4)	71.4 (14.7)	11.11 %	-1.01 (-1.58. -0.44)
Lubiatows ki et al., 2018. Cross sectional	3	128	Profession al handball Player and asymptom atic control group	S= 25.0 (4.7) AS= 25.0 (1.0)	8 7 5 7 4 9	41 41 41	IR	50.0 (15) 37.0 (12.0) 49.0 (13)	53.0 (13.0) 53.0 (12) 52.0 (14.0)	13.79 % 12.86 % 13.79 %	-0.21 (-0.58. 0.16) -1.32 (-1.76.- 0.88) -0.22

Study	LO E	Samp le size	Sport	Age*	S	A S	IR Positi on Supin e (90/90)	Means (SD) Degrees		Weig ht %	SMD (95 %CI)
								S	AS		
Moreno- Perez et al., 2015 Analytical Cross sectional Study.	3	47	Tennis	S=25.6 (3.0) AS= 27.2 (4.3)	1 9	28	D ND	40.6 (11.6)	49.3 (11.3)	10.71 %	-0.77 (-1.37.- 0.16) -0.92 (-1.53.- 0.30)
Marcondes et al., 2013 Analytical cross- sectional	3	49	Tennis	S= 25.9 (4.1) AS= 26.5 (3.6)	2 7	22	D ND	49.2 (5.6)	58.0 (7.7)	10.50 %	-1.31 (1.93.- 0.69) 0.14 (-0.42. 0.71)
Authors	LO E	Samp le size	Sport	Age*	S	A S	GIRD	S	AS	Weig ht	SMD (95%CI)
								Degrees Means (SD)			

Study	LOE	Sample size	Sport	Age*	S	A	IR Position Supine (90/90°)	Means (SD) Degrees		Weight %	SMD (95%CI)
								S	AS		
Moreno-Perez et al., 2015 Observational cross-sectional	3	47	Tennis professional players.	S=25.6 (3.0) AS=22.2 (4.3)	19	28	GIRD	11.9 (10.5)	13.3 (8.6)	20.20 %	-0.14 (-0.72, 0.44)
Lala, 2017 Prospective observational study	3	36	Professional Cricketers	S and AS=23.56 (4.27)	9	23	GIRD	7.78 (12.70)	12.61 (13.16)	11.42 %	-0.36 (-1.14, 0.41)
Lubiatowski et al., 2018 Cross sectional	3	128	Professional handball players and asymptomatic control	S=25 (4.7) AS=25 (1.0)	36	41	GIRD	6.0 (11) 7 (11) 4 (11)	5 (10) 5 (10) 6 (10)	34.25 % 34.13 %	0.09 (-0.35, 0.54) -0.19 (-0.64, 0.26)

GIRD= glenohumeral internal range of motion deficit; S=symptomatic; AS= asymptomatic; D= dominant; ND= non-dominant. Age*=years in means (SD); S=symptomatic; AS= asymptomatic; GIRD= glenohumeral internal rotation deficit.

Level of Evidence (LOE): OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. <http://www.cebm.net/index.aspx?o=5653> * OCEBM Table of Evidence

SoF: d) ER:IR strength ratios of the cases.

Author	Ratio ER: IR		Isometric	DCR Isotonic	Sport/ Healthy individuals	No Participants	Pre-season	Post season
	D	ND						
Riemann et al., 2010	0.87 (0.21)	0.88 (0.25)	X		Members of the general public	M=181		
Riemann et al., 2010	0.86 (0.37)	0.85 (0.30)	X		Members of the general public	F=181		
Peckitt and McCaig 2019	0.87 (0.21)	0.92 (0.27)	X		Elite cricketers	M=18	X	
Peckitt and McCaig 2019	0.82 (0.17)	0.81 (0.24)	X		Elite cricketers.	M=18		X
Forthomme et al., 2018.	0.73 (0.12)	0.81 (0.13)		X Conn Er/conn IR at 60°/s	Hand ball players	M=108		
Forthomme et al., 2018.	1.20 (0.30)	1.30 (0.35)		X Mixed ratio Ecc ER/Conn IR at 60°/s.	Handball players.	M=108		

Author	Ratio ER: IR		Isometric	DCR Isotonic	Sport/ Healthy individuals	No Participants	Pre-season	Post season
	D	ND						
Author	Asymptomatic	Symptomatic	Isometric	Isotonic	Discipline			
McDonough et al., (L)	1.84 (0.5)	1.71 (0.26)		X	Rugby	M=20		
McDonough et al., 2014(R)	1.97 (0.29)	1.69 (0.44)		X	Rugby	M=20		
Maestroni et al.,	0.9 (0.2)	0.7 (0.2)	X		Members of the general public	67		
Marcondes et al., (D)	0.82 (0.1)	0.74 (0.2)	X		Tennis	49		
Marcondes et al (ND)	0.99 (0.1)	0.98 (0.1)	X		Tennis	49		
Forthomme et al	0.74 (0.12)	0.73 (0.12)		Conn ER at 60°/s X	Handball	108		
Forthomme et al.,	0.79 (0.16)	0.77 (0.13)		Conn ER at 60°/s X	Handball	108		
Forthomme et al.,	1.21 (0.33)	1.19 (0.28)		Conn ER at 60°/s	Handball	108		
Skazalski et al	1.35 (0.18)	1.63 (0.53)		Conn ER at 60°/s	Volleyball	81		

S=symptomatic; AS= asymptomatic; D= dominant; ND= non-dominant. Age*=years in means (SD); S=symptomatic; AS= asymptomatic; GIRD= glenohumeral internal rotation deficit, conn ER=concentric external rotation.

Level of Evidence (LOE): OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. <http://www.cebm.net/index.aspx?o=5653> * OCEBM Table of Evidence

SoF: e) IR; ER; TROM; GIRD; TAMD of the cases.

Authors	IR ROM		GIRD	ER		ERG	TROM	TAMD		Discipline
	D	ND	(ND-D)	D	ND	(ND-D)	D	(ND-D)	ND	
Peckitt et al.,	185.4 (41.9)	172.1 (46.3)	-13.3	155.0 (27.8)	147.2 (22.5)	-7.8	177.8 (13.5)	183.0 (14.4)	5.6	Cricket (Pre-season)
Peckitt et al.,	172.8 (46.3)	169.1 (52.6)	-3.1	139.2 (32.7)	128.8 (27.3)	11.2	197.8 (16.9)	197.0 (10.3)	-0.2	In season)
Lala, 2017	51.30 (9.53)	58.11 (12.45)	7.78 (12.70)	121.60 (18.10)	114 (20)	0 (-6-4)	172.90 (19.65)	178 (26)		Cricket S
Lala, 2017	51.48 (14.91)	64.09 (13.30)	12.61 (13.16)	122.0 (19)	120 (25)	-2 (-16:-8)	173.09 (20.380)	184.91 (19.53)		Cricket AS

Authors	IR ROM		GIRD	ER		ERG	TROM	TAMD		Discipline
	D	ND	(ND-D)	D	ND	(ND-D)	D	(ND-D)	ND	
Marcondes et al., 2013	49.2 (8.6)	65.4 (11.1)	8.8	107.1 (7.7)	90.5 (3.3)	-16.6	156.3	155.9	-0.4	Tennis S
Marcondes et al., 2013	58.0 (7.7)	64.1 (4.8)	6.1	97.3 (4.6)	91.8 (2.9)	-5.5	155.3	155.9	0.6	Tennis AS
Moreno-Perez et al., 2015	40.6 (11.6)	49.3 (11.3)	8.7							Tennis S
Moreno-Perez et al., 2015	51.5 (10.6)	62.6 (11.0)	13.3							Tennis As
Rosa et al., 2019	71.4 (14.7)				102.6 (15.3)			174.0		(AS)
Author	IR	GIRD	ER	ERG	TAM	TAMD	Symptoms	Discipline		
Lubiatowski et al., 2018	50 (15)	6 (11)	88 (21)	3 (11)	138 (32)	4 (14)	Shoulder pain	Handball (S)		
Lubiatowski et al., 2018	53.0 (12.0)	5 (10)	94 (15)	5 (10)	146 (24)	1 (18)	Shoulder pain	Handball (AS)		

Authors	IR ROM		GIRD	ER		ERG	TROM	TAMD	Discipline
	D	ND	(ND-D)	D	ND	(ND-D)	D	(ND-D) ND	
Lubiatowski et al., 2018 S	37 (12)	7 (11)	76 (26)	1 (17)	110 (34)	6 (20)	Internal impingement	Handball (AS)	
Lubiatowski et al., 2018	53 (12)	5 (10)	94 (14)	4 (10)	148 (22)	1 (11)	Internal impingement	Handball (AS)	
Lubiatowski et al., 2018 S	49 (13)	4 (11)	94 (16)	7 (7)	14(26)	-3 (9)	Partial rotator cuff tear	Handball (AS)	
Lubiatowski et al., 2018	52 (14)	6 (10)	9(18)	3 (12)	143 (28)	3 (13)	Partial rotator cuff tear	Handball (AS)	

IR= internal rotation, ER= external rotation, TROM= total range of motion, GIRD= gleno humeral internal rotation deficit, TAMD= total range of motion deficit.

Level of Evidence (LOE): OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. <http://www.cebm.net/index.aspx?o=5653> * OCEBM Table of Evidence

SoF: f) Studies investigating pectoralis minor (PM) muscle of the cases and the controls.

Authors	Sport/ Members of the general public	PML (pectoralis minor muscle length) (Kendall position)	PMI (pectoralis minor muscle index) (Borstad position)	Novel testing position	Symptomatic (S) Asymptomatic (AS) Dominant (D) Non-dominant (ND)	Other variables
Lala, 2017	Cricket	X			S and AS	TROM, ER, GIRD
Olivier et al., 2020	Cricket	X			D and ND	TAROM, ER, GIRD
Olivier et al., 20148	Cricket	X			S and AS	ER, IR, TROM
De Souza, 2019	Swimming				AS	
Bhati et al., 2007	Competitive sportsmen				S	Pectoralis minor entheses
Morais and Cruz, 2016	Overhead athletes				S	Scapula dyskinesis
Grimes et al., 2020	Soc		X		S and AS	Scapula dyskinesis Scapula assistance test (SAT)
Kim et al., 2020	Office workers			X		Shortness of PM
Reeser et al., 2010	Athletes			X		Scapula dyskinesis, GIRD, ER, IR strength
Finley et al., 2017	Soc		X		S and AS	Resting and activated length of PM during arm elevation
Ebaugh et al., 2018	Soc			X	S and AS	Resting and activated length of Pm during scapular plane elevation
Bond, 2016	Soc	X	X		S and AS	Difference between PM Length testing

						and PMI testing. Scapula dyskinesis.
Yeşilyaprak et al., 2016.	Soc		X		S and AS	Upper trapezius length and scapula dyskinesis test (SDT)
Lee et al., 2015	Soc		X		AS	Serratus anterior muscle strength, posterior capsule tightness and scapula dyskinesis
Turgut and Baltaci, 2018	Soc	X			S and AS	Scapula dyskinesis in elevation and posterior capsule tightness.
Navarro-Ledesma et al., 2019	Soc	X			S and AS	Scapula dyskinesis and posterior shoulder tightness And acromio-humeral distance (AHD)
Muhle et al., 2020	Soc		X		S and AS	Strength of lower trapezius
Struyf et al., 2014	Soc		X		S and AS	Intra -and inter -rater reliability
Sebastian et al., 2017	Soc	X			S and AS	Scapula backwards test (SBT)
Harrington et al., 2014	Swimming		X		S and AS and D and ND	IR, ER and joint position test JPS
Rosa et al., 2019	Soc		X		S and AS	Gleno-humeral (GHJ) and ER
Lee et al., 2020	Soc		X		S and AS	Scapular reposition test (SRT) VAS (Pain) and isometric elevation strength

Authors	Sport/ Members of the general public	PML (pectoralis minor muscle length) (Kendall position)	PMI (pectoralis minor muscle index) (Borstad position)	Novel testing position	Symptomatic (S) Asymptomatic (AS) Dominant (D) Non-dominant (ND)	Other variables
Lala, 2017	Cricket	X			S and AS	TROM, ER, GIRD
Olivier et al., 2020	Cricket	X			D and ND	TAROM, ER, GIRD
Olivier et al., 2018	Cricket	X			S and AS	ER, IR, TROM
De Souza, 2019	Swimming				AS	
Bhati et al., 2007	Competitive sportsmen				S	Pectoralis minor enthesi
Morais and Cruz, 2016	Overhead athletes				S	Scapula dyskinesis
Grimes et al., 2020	Soc		X		S and AS	Scapula dyskinesis Scapula assistance test (SAT)
Kim et al., 2020	Office workers			X		Shortness of PM

Reeser et al., 2010	Athletes			X		Scapula dyskinesis, GIRD, ER, IR strength
Finley et al., 2017	Soc		X		S and AS	Resting and activated length of PM during arm elevation
Ebaugh et al., 2018	Soc			X	S and AS	Resting and activated length of Pm during scapular plane elevation
Bond, 2016	Soc	X	X		S and AS	Difference between PM Length testing and PMI testing. Scapula dyskinesis.
Yeşilyaprak et al., 2016.	Soc		X		S and AS	Upper trapezius length and scapula dyskinesis test (SDT)
Lee et al., 2015	Soc		X		AS	Serratus anterior muscle strength, posterior capsule tightness and scapula dyskinesis
Turgut and Baltaci, 2018	Soc	X			S and AS	Scapula dyskinesis in elevation and posterior capsule tightness.
Navarro-Ledesma et al., 2019	Soc	X			S and AS	Scapula dyskinesis and posterior shoulder tightness And acromio-humeral distance (AHD)
Muhle et al., 2020	Soc		X		S and AS	Strength of lower trapezius
Struyf et al., 2014	Soc		X		S and AS	Intra -and inter -rater reliability

Sebastian et al., 2017	Soc	X			S and AS	Scapula backwards test (SBT)
Harrington et al., 2014	Swimming		X		S and AS and D and ND	IR, ER and joint position test JPS
Rosa et al., 2019	Soc		X		S and AS	Gleno-humeral (GHJ) and ER
Lee et al., 2020	Soc		X		S and AS	Scapular reposition test (SRT) VAS (Pain) and isometric elevation strength

AS=asymptomatic, S= symptomatic. Level of Evidence (LOE): OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. <http://www.cebm.net/index.aspx?o=5653> * OCEBM Table of Evidence