

## Additional Data File 2 – Summary Tables of Current Evidence for Risk Factors for Hip OA

TABLE 1: XRAY AND PREDICTION OF HIP OA									
AP - anteroposterior, OA = osteoarthritis, FAI = femoracetabular impingement, K&L - Kellgren-Lawrence radiographic scale of OA, THA - total hip arthroplasty									
STUDY FINDINGS	OVERVIEW	STUDY POPULATION	LEVEL OF EVIDENCE (CEBM 2009)					REFERENCE	
			1	2	3	4	5		
Hip morphology characteristics of FAI or mild dysplasia is predictive of OA development at 19 years follow-up	Longitudinal cohort study. AP radiographs compared at year 2 and year 20. CAM deformity defined by $\alpha$ angle $>65^\circ$ on AP pelvic radiograph was associated with a 2.7 fold increased risk of OA (95% CI 1.63-4.33, $p<0.001$ ). Dysplasia as identified by measurement of lateral centre edge angle was an independent predictor of OA development.	n=466, 100% women, age not provided.		2				Thomas, G. E., et al. (2012). "The association between hip morphology and 19-year risk of osteoarthritis in the hip." Osteoarthritis and Cartilage 20: S23-S24.	
Osteoarthritis developed in 17.7% of patients with evidence of FAI. 82.3% of patients did not develop OA.	Retrospective long-term outcome study. Looked for radiographic evidence of FAI in asymptomatic contralateral hips of patients who had undergone surgery for unilateral hip disease (varied diagnoses including DDH, OA, trauma). Follow-up radiographs were examined to look for OA. <u>(No further information about type of hip surgery performed or patient activity levels post-operatively in short-term or long-term)</u>	n=96, (M=31, F=65), mean age 49.3yrs (16-65), mean follow-up time 18.5yrs (10-40yrs)		2				Hartofilakidis, G., et al. (2011). "An examination of the association between different morphotypes of femoroacetabular impingement in asymptomatic subjects and the development of osteoarthritis of the hip." J Bone Joint Surg Br 93(5): 580-586.	

<p>Cam type deformity was strongly associated with end stage OA. OR for a severe cam type deformity (<math>\alpha</math> angle <math>&gt; 83^\circ</math>) was high (10.88, 95% CI 5.21 22.69, <math>p &lt; 0.001</math>). No association was found between a pincer deformity and the development of end stage OA. The risk of THR if cam type deformity with <math>\alpha</math>- angle <math>&gt; 83^\circ</math> and <math>&gt; 60^\circ</math> was 23.3% and 9.6% respectively. No relation was found between any impingement parameter and the development of early OA.</p>	<p>A random subset of 865 from the CHECK cohort had standardized anteroposterior radiographs (AP) taken at both baseline and 5 years follow up. AP pelvic radiographs of sufficient quality were obtained in 723 subjects at baseline and in 770 subjects at the 5 years follow up. At baseline, 75% of the hips had no signs of OA (K&amp;L1/40) whereas 25% had doubtful OA (K&amp;L1/41). The shape of the proximal femur and acetabulum on the AP radiographs was assessed using statistical shape modelling (SSM).</p>	<p>n= 865, F= 682 (mean age 55.8), M= 183 (mean age 56.4).</p>		2				<p>Agricola, R., et al. (2012). "Cam-type deformities strongly predict total hip replacement within 5 years in those with early symptomatic OA: a prospective cohort study (check)." <i>Osteoarthritis and Cartilage</i> 20: S203.</p>
<p>Hip geometry has a moderate ability to predict HOA in participants with and without initial signs of osteoarthritis (OA), similar to and largely independent of the predictive value of clinical risk factors.</p>	<p>Results: The included individuals comprised 575 females and 148 males (mean age 55.9 <math>\pm</math> 5.2 years). At baseline, 8% fulfilled the ACR criteria, 76% had no radiographic hip OA [Kellgren &amp; Lawrence (K&amp;L) 1/4 0] and 24% had doubtful OA (K&amp;L 1/4 1). At follow-up, 147 hips (10.4%) fulfilled the ACR criteria and 35 hips (2.5%) had received THR. Five shape variants (modes) at baseline associated significantly with THR within 5 years. When combined in one GEE model, these shape variants resulted in a predictive power indicated by an area under the curve of 0.81. No shape variants associated with the presence of clinical OA at follow-up.</p>	<p>n=688 participants with no KL radiographic osteoarthritis score Randomly selected from the Rotterdam study cohort of 7983 people. Age <math>&gt;55</math> yrs. Men and women.</p>		2				<p>Castano-Betancourt, M. C., et al. (2013). "The contribution of hip geometry to the prediction of hip osteoarthritis." <i>Osteoarthritis Cartilage</i> <b>21</b>(10): 1530-1536.</p>

The data suggest that playing ice hockey at an elite level during childhood is associated with an increased risk for cam-type deformity and hip pain after physeal closure.	77 elite-level male ice hockey players were evaluated with a questionnaire, clinical examination, and MRI. Hip pain, internal rotation and $\alpha$ -angles were assessed. The $\alpha$ -angles were significantly higher in athletes with closed physes versus open physes. Symptomatic athletes had significantly higher $\alpha$ -angles compared with asymptomatic athletes. Internal rotation was significantly decreased in symptomatic compared with asymptomatic athletes. Higher $\alpha$ -angles in the anterosuperior quadrant were significantly associated with decreased internal rotation.	n=77 elite male hockey players. Mean age= 16.5 yrs (range, 9-36 yrs); 15 of 77 (19.5%) athletes had a history of hip pain and a positive impingement test finding.			3		Siebenrock, K. A., et al. (2013). "Prevalence of cam-type deformity and hip pain in elite ice hockey players before and after the end of growth." <i>Am J Sports Med</i> 41(10): 2308-2313.
Cam-type deformities were recognizable and present from the age of 13 years and were more prevalent in soccer players than in their nonathletic peers.	Cross-sectional study of adolescent footballers and asymptomatic controls using AP pelvic and frog-leg lateral hip radiographs. $\alpha$ angle > 60° used to define cam-type deformity. A cam-type deformity tended to be more prevalent in soccer players (26%) than in controls (17%, p=0.31). In 13% of soccer players a prominence was visible on radiographs (youngest - 13yrs). The anterosuperior flattening (56% vs18%, P=0.0001) and prominence (13% vs. 0%, p<0.03) were more prevalent in soccer players than controls.	n= 89 elite pre-professional soccer players, n= 92 controls. Age 12-19 years.			3		Agricola, R., et al. (2012). "The development of Cam-type deformity in adolescent and young male soccer players." <i>Am J Sports Med</i> 40(5): 1099-1106.
Patients with CAM-type FAI and an $\alpha$ -angle of >65° are at increased risk of substantial cartilage damage. Conversely, pincer-type FAI seemed to have a decreased risk.	Data collected on patients undergoing joint-preservation surgery for CAM-type FAI. Alpha angle greater than 65° had increased risk of Beck Type 3 or greater cartilage damage (OR 4, 95% CI 1.26-12.71, p=0.02)	n=167 (129 male, 38 female). Mean age 38yrs (17-59).			3		Beaule, P. E., et al. (2012). "Can the alpha angle assessment of cam impingement predict acetabular cartilage delamination?" <i>Clin Orthop Relat Res</i> 470(12): 3361-3367.
A deep acetabular socket and pistol grip deformity were associated with increased risk of OA	Cross-sectional cohort study studying AP pelvic radiographs. Prevalence of pistol grip deformity was 19.6% for males and 5.2% for females. The risk ratio for OA associated with a deep acetabular socket (coxa profunda and/or protusio acetabuli) was 2.4 (95% CI 2-2.9) and associated with pistol grip deformity was 2.2 (95% CI 1.7-2.8).	n=3620 (1332 male, 2288 women). Mean age 62 (male), 65 (female)			3		Gosvig, K. K., et al. (2010). "Prevalence of malformations of the hip joint and their relationship to sex, groin pain, and risk of osteoarthritis: a population-based survey." <i>J Bone Joint Surg Am</i> 92(5): 1162-1169.

The risk of OA increases as femoral head diameter, neck length, outer shaft diameter, inner shaft diameter and pelvic width decrease and as sourcil angle increase, whereas both extremes of neck shaft angle confer risk. Prospective studies are required to confirm these findings.	Nested case-control study. Unaffected hips of hip OA cases were compared to the same side hips of controls. Assumption made that the unaffected hip values in cases reflect the original measures on the affected side prior to development of OA. Standardized antero-posterior radiographs of pelvis were used to measure 10 morphological features. The ICC for intra-observer reliability for all the measurements was >0.84. In controls all morphological measures were symmetrical between right and left (ICC ranged from 0.80-0.95).	n=566 hips with unilateral OA, n=1108 controls from GOAL database.			3		Abdulrahim, H., et al. (2012). "Morphological measures of femur and pelvis on plain radiographs as risk for hip osteoarthritis." <i>Osteoarthritis and Cartilage</i> 20.
Hips with presumably idiopathic OA had more abnormalities at the femoral head-neck junction than did the control hips without OA	Measurement of $\alpha$ -angle in idiopathic OA hips and control hips. The $\alpha$ -angle was measured on Dunn view at 45 degrees flexion. Abnormal $\alpha$ -angle defined as >50°. 82% of OA hips had $\alpha$ -angles >50° (mean 66.4°, range 28°-108) vs. 30% of controls (mean 48.1°, 34°-68°).	n = 72 hips with idiopathic OA, n = 56 controls. Mean age 70 (60-84).			3		Barros, H. J., et al. (2010). "Femoral head-neck junction deformity is related to osteoarthritis of the hip." <i>Clin Orthop Relat Res</i> 468(7): 1920-1925.
Male sex, older age, Tonnis OA grade and alpha angle >50° on frog lateral radiograph were independently associated with increase risk of grade 3 or 4 acetabular chondromalacia (p<0.001). Pincer FAI and acetabular dysplasia not significantly associated.	Retrospective exam of radiographs on patients who had arthroscopy following 3 month history of hip pain not responding to conservative management	n=355 hips (338 patients). Average age 36.8yrs (15-68yrs)			3		Nepple, J. J., et al. (2011). "Clinical and radiographic predictors of intra-articular hip disease in arthroscopy." <i>Am J Sports Med</i> 39(2): 296-303.
Patients with THA had a higher prevalence of cam deformity than did their respective controls (median $\alpha$ -angle 88° versus 46°in controls.)	Nested case-control from a longitudinal cohort study of 1003 women (Chingford Study). Between year 8 and year 20, 22 THA procedures were performed for OA on study participants. Hip morphology of these participants as well as 100 randomly selected controls were analysed. An alpha angle of more than 65° was associated with a 6.0 fold increased risk of THA (95% CI 2.04- 17.59, p<0.001).	n=22 who had THA, n=100 controls.			3		Thomas, G. E., et al. (2012). "The association between hip morphology and end-stage osteoarthritis at 12-year follow up." <i>Osteoarthritis and Cartilage</i> 20: S204.

60% (81/135) patients undergoing THA were classified as having an abnormal femoral head-neck-junction.	A consecutive series of 135 total hip arthroplasties were performed in patients aged less or equal to 60 years because of end-stage osteoarthritis. The pelvic-views and the corresponding Dunn-view of these patients were screened for "pistol-grip-deformity" by measuring head-ratio on pelvic-views and the $\alpha$ -angle on Dunn-views. An $\alpha$ -angle greater than 51° and/or a head-ratio greater than 1.16 were considered as pathological.	n=135 consecutive THA, patients <60yrs,				4	Ipach, I., et al. (2013). "The prevalence of acetabular anomalies associated with pistol-grip-deformity in osteoarthritic hips." <u>Orthop Traumatol Surg Res</u> <b>99</b> (1): 37-45.
Hips with presumably idiopathic OA had more abnormalities at the femoral head-neck junction than control hips without OA and may relate to risk of OA developing	Observational case-control study. Measured $\alpha$ angle on Dunn View radiograph. 82% vs. 30% controls had abnormal $\alpha$ angles (using a definition of abnormal $\alpha$ angle >50°)	n= 72 hips (controls = 56), mean age 70yrs (range 60-74),				4	Barros, H. J., et al. (2010). "Femoral head-neck junction deformity is related to osteoarthritis of the hip." <u>Clin Orthop Relat Res</u> <b>468</b> (7): 1920-1925.
Hip pain in young patients significantly correlated with radiograph findings of : increase in $\alpha$ angle on all views (p<0.0001), presence of a bump (CAM deformity) on the femoral head-neck transition (p<0.0001) on AP view. AP and Dunn 45° views were considered best for assessment of CAM deformity.	Comparative radiographic investigation of FAI in young patients with and without hip pain. All patients had an AP hip, Lequesne false profile view, Dunn view, Dunn view with 45° of flexion and a Ducroquet view. .	n=122 with groin pain (52% women), n=100 asymptomatic. (58% women). Age 20-50yrs.				4	Miguel, O. F., et al. (2012). "A comparative radiographic investigation of femoroacetabular impingement in young patients with and without hip pain." <u>Clinics</u> <b>67</b> (5): 463-467.
Cam lesions were present in 68% (51/75) of men (76.5% [39/51] bilateral involvement) and 50% (10/20) of women (90% [9/10] bilateral involvement). Pincer lesions were present in 26.7% (20/75) of men and 10% (2/20) of women.	Observational study. Retrospective assessment of AP pelvis and frog-leg lateral radiographs of 95 elite male and female soccer players to determine the prevalence of hip abnormalities. Athletes with a history of hip or groin injuries. In total, 72% (54/75) of male and 50% (10/20) of female players demonstrated some evidence of radiographic hip abnormality. Abnormal $\alpha$ -angle defined as $\geq 55^\circ$ . The average male alpha angle overall was 65.6° . Cam-positive hips averaged 70.7° . The average female alpha angle overall was 52.9° , with cam-positive hips averaging 60.8° .	n=95 elite soccer player. Male (n=75_ and female (n=20).				4	Gerhardt, M. B., et al. (2012). "The prevalence of radiographic hip abnormalities in elite soccer players." <u>Am J Sports Med</u> <b>40</b> (3): 584-588.

Definite FAI was present in 36 % of subjects who had THR for hip OA below the age of 55yrs.	Retrospective prevalence study. Prevalence of FAI detected radiographically in a cohort that underwent THR for primary hip OA. 82 cases were randomly selected from 470 identified THR cases. Two radiologists independently assessed the retrospective preoperative radiographs (AP pelvis and lateral).	n=82 patients who underwent THR at young age <55 yrs				4	Lung, R., et al. (2012). "The prevalence of radiographic femoroacetabular impingement in younger individuals undergoing total hip replacement for osteoarthritis." <u>Clin Rheumatol</u> <b>31</b> (8): 1239-1242.
---	---	--	--	--	--	---	--

**TABLE 2: MRI AND PREDICTION OF HIP OA**

**cam** - short for camshaft (a reflection of shape of femoral head/neck junction), **CI** - confidence interval, **OR** - odds ratio, **dGEMRIC** - delayed gadolinium enhanced MRI of cartilage, **1.5T/3T** = 1.5 or 3 Tesla (unit of magnetic field strength), **FAI** – femoroacetabular impingement, **p** = rho (correlation coefficient)

STUDY FINDING	OVERVIEW	STUDY POPULATION	LEVEL OF EVIDENCE (CEBM 2009)					REFERENCE
			1	2	3	4	5	
The presence of a cam-type deformity is associated with MRI-detected hip damage in asymptomatic young men. cam-type deformity present in 24%. In the hips with cam-type deformity the odds ratio(OR) for labral lesions was 2.77 (95% CI 1.31,5.87), the OR for labral avulsions was 2.24 (95%CI 1.17, 4.28), the OR for impingement pits was 2.91 (95% CI 1.43, 5.93). Large majority of the damage identified occurred anterosuperiorly (91% cam-type deformities, 77% labral tears)	Cross-sectional population based study using the Sumiswald cohort of asymptomatic young men. Recent hip pain >3/5 on Likert scale excluded. Random selection of cohort invited for MRI exam.	n=244, average age 19.9yrs				4		Reichenbach, S., et al. (2011). "Association between cam-type deformities and magnetic resonance imaging-detected structural hip damage: a cross-sectional study in young men." <u>Arthritis Rheum</u> <b>63</b> (12): 4023-4030.
High-resolution 3D dGEMRIC at 3T has potential for assessing acetabular and femoral cartilage. They found significant differences in mean T1Gd values between symptomatic and asymptomatic hips.	Case-control MRI study using three-dimensional delayed gadolinium-enhanced MRI at 3T to identify cartilage abnormalities in symptomatic hips compared to asymptomatic controls.	n=40 symptomatic hips (18 male), n=31 asymptomatic hips (12 male). Mean age 32.8yrs (18-57) Hip symptoms = 35 FAI, 3 dysplasia, 2 coxa magna.			3			Zilkens, C., et al. (2012). "Three-dimensional delayed gadolinium-enhanced magnetic resonance imaging of hip joint cartilage at 3T: a prospective controlled study." <u>Eur J Radiol</u> <b>81</b> (11): 3420-3425.

Gradient-echo dGEMRIC's ability to identify cartilage degeneration was validated against histological analyses. The mean T1Gd values decreased significantly with increasing cartilage degeneration ( $p<0.001$ ).	Histologically controlled <i>in vitro</i> validation study of gradient echo 3D dGEMRIC. The dGEMRIC index (T1Gd relaxation time in milliseconds) reflects the uptake of gadolinium within cartilage and is inversely proportional to the tissue glycosaminoglycan (GAG) content.	n=21 femoral head specimens (7 male, 14 female) from THR operations. Mean age 60.9 (37.6 - 77.3)				4	Zilkens, C., et al. (2013). "Validity of gradient-echo three-dimensional delayed gadolinium-enhanced magnetic resonance imaging of hip joint cartilage: a histologically controlled study." <u>Eur J Radiol</u> <b>82</b> (2): e81-86.
Feasibility study of the use of MRI T2* mapping in patients with clinical FAI suggests that it could be a useful MRI biomarker for early cartilage degeneration in FAI. However larger studies required with attention to timing of the mapping during the protocol (increased T2 values as protocol progressed presumed due to unloading of joint).	22 patients with clinical FAI and Tönnis grade $\leq 1$ on AP radiograph. T2* mapping at 3T performed in both groups.	n=22 symptomatic hips (13 male, 9 female), mean age 28.1, n=35 asymptomatic controls				4	Apprich, S., et al. (2012). "Evaluation of articular cartilage in patients with femoroacetabular impingement (FAI) using T2* mapping at different time points at 3.0 Tesla MRI: a feasibility study." <u>Skeletal Radiol</u> <b>41</b> (8): 987-995.
d-GEMRIC index was significantly different between mild, moderate and severe dysplasia and might be a sensitive measure of early osteoarthritis, but further studies needed to determine whether can predict disease progression in different clinical scenarios.	dGEMRIC index correlated with pain ( $rs=-0.5$ , $p<0.0001$ ) and with lateral centre-edge angle ( $rs=0.52$ , $p<0.001$ ). dGEMRIC index was significantly different ( $p<0.0001$ ) among three groups of severity of hip disease.	n= 68 dysplastic hips, mean age 30yrs (11-47),				4	Kim, Y. J., et al. (2003). "Assessment of early osteoarthritis in hip dysplasia with delayed gadolinium-enhanced magnetic resonance imaging of cartilage." <u>J Bone Joint Surg Am</u> <b>85-a</b> (10): 1987-1992.
Moderate correlation seen between WOMAC pain score and cartilage damage on MRI. For DDH $p=0.457$ ( $p=0.049$ ). For FAI $p= 0.528$ ( $p=0.014$ ).	Retrospective study of hip pain patients with DDH or FAI who underwent MRI. 40 of 71 consecutive patients met the inclusion criteria (having WOMAC pain score, MRI and dGEMRIC, Tönnis OA grade 0 or 1).	n=40, mean age 28.6yrs (range 13-52yrs). FAI = 21 hips (9 male, 12 female), DDH = 19 hips (0 male, 19 female).				4	Stelzeneder, D., et al. (2012). "Patterns of joint damage seen on MRI in early hip osteoarthritis due to structural hip deformities." <u>Osteoarthritis Cartilage</u> <b>20</b> (7): 661-669.



Study found that radial dGEMRIC able to assess cartilage damage in the entire hip including the anterior-superior quadrant of the acetabulum. It found that DDH and CAM type FAI have different T1 distribution of cartilage damage.	DDH and FAI cohorts consist of 20 consecutive cases each. The Western Ontario and McMaster Universities (WOMAC) index for pain was assessed in all patients at the time of MRI and was mean 6.6 ± 5.1 range 0-20.	n=40 (20 DDH, 20 FAI). Mean age = 28.1yrs (range 13-52). The Tönnis grade was 0 in 21, 1 in 17, and 2 in 2 cases, respectively.				4	Domayer, S. E., et al. (2010). "Radial dGEMRIC in developmental dysplasia of the hip and in femoroacetabular impingement: preliminary results." <u>Osteoarthritis Cartilage</u> <b>18</b> (11): 1421-1428.
Pattern of zonal T1 variations appears to exist that is unique to different sub-groups of FAI. In cam-types this was located in the anterosuperior portion. In pincer-types the changes were found in a generalized circumferential distribution.	Preliminary study assessing cartilage damage in FAI using standard MRI and dGEMRIC.	n = 26 symptomatic FAI, controls = 10.				4	Bittersohl, B., et al. (2009). "Cartilage damage in femoroacetabular impingement (FAI): preliminary results on comparison of standard diagnostic vs. delayed gadolinium-enhanced magnetic resonance imaging of cartilage (dGEMRIC)." <u>Osteoarthritis Cartilage</u> <b>17</b> (10): 1297-1306.
Magnetic resonance images of asymptomatic participants revealed abnormalities in 73% of hips, with labral tears being identified in 69% of the joints. A strong correlation was seen between participant age and early markers of cartilage degeneration such as cartilage defects and subchondral cysts.	Forty-five volunteers with no history of hip pain, symptoms, injury, or surgery underwent an MRI scan with a Siemens 3.0-tesla scanner. All MRI scans were reviewed by 3 fellowship-trained musculoskeletal radiologists. The scans were mixed randomly with 19 scans from symptomatic patients to blind the radiologists to the possibility of patient symptoms. An abnormal finding was considered positive when 2 of 3 radiologists agreed on its presence.	n = 45, 60% men, average age 37.8yrs (range 15-66yrs).				3	Register, B., et al. (2012). "Prevalence of abnormal hip findings in asymptomatic participants: a prospective, blinded study." <u>Am J Sports Med</u> <b>40</b> (12): 2720-2724.

**TABLE 3: MR ARTHROGRAM AND PREDICTION OF HIP OA**

**OA** – osteoarthritis, **CAM** - short for camshaft (a reflection of shape of femoral head/neck junction), **OR** - odds ratio, **dGEMRIC** - delayed gadolinium enhanced MRI of cartilage, **1.5T/3T** = 1.5 or 3 Tesla (unit of magnetic field strength), **FAI** - femoracetabular impingement, **Mra or MRA** = magnetic resonance arthrogram, **PPV** = positive predictive value, **NPV** = negative predictive value.

STUDY FINDING	OVERVIEW	STUDY POPULATION	LEVEL OF EVIDENCE (CEBM 2009)					REFERENCE
			1	2	3	4	5	
Labral tears and cartilage loss are common in patients with mechanical symptoms in the hip (prevalence 66% and 76% respectively). There was a significant correlation between the grade of cartilage abnormality and the grade of labral tear, (r=0.29; P< or =0.01).	Case series of 100 patients undergoing MR arthrography for mechanical hip symptoms (clicking, locking, sharp pain, giving way)	n=100 patients with mechanical symptoms, women=76, men=24, mean age 39 yrs (range 17-76)				4		Neumann, G., et al. (2007). "Prevalence of labral tears and cartilage loss in patients with mechanical symptoms of the hip: evaluation using MR arthrography." <u>Osteoarthritis Cartilage</u> <b>15</b> (8): 909-917.
Indirect-MRa can be considered a valid method of assessing endoarticular damage related to FAI, in comparison to d-MRa.	To assess the effectiveness of indirect MRa in the detection of chondral and labral lesions related to FAI compared with standard MRI and direct-MRa. There was good agreement between i-MRa and d-MRa in detection of chondral lesions, labral damage and early osteoarthritic changes.	n = 21 hips (17 patients) with clinical FAI				4		Pozzi, G., et al. (2009). "Femoro-acetabular impingement: can indirect MR arthrography be considered a valid method to detect endoarticular damage? A preliminary study." <u>Hip Int</u> <b>19</b> (4): 386-391.

<p>The diagnostic test accuracy for the detection of hip joint cartilage lesions is currently superior for MRI compared with MRA. MRI indicated a pooled sensitivity of 0.59 (95 % CI: 0.49-0.70) and specificity of 0.94 (95 % CI: 0.90-0.97). MRA pooled sensitivity was 0.62 (95 % CI: 0.57-0.66) and specificity was 0.86 (95 % CI: 0.83-0.89). There were insufficient data to perform meta-analysis for MDCT or CTA protocols.</p>	<p>A review of the published and unpublished literature databases was performed to identify all studies reporting the diagnostic test accuracy (sensitivity/specificity) of MRI, MRA or MDCT for the assessment of adults with chondral (cartilage) lesions of the hip with surgical comparison (arthroscopic or open) as the reference test.</p>	<p>18 studies. 648 hips from 637 patients.</p>			3		<p>Smith, T. O., et al. (2013). "The diagnostic test accuracy of magnetic resonance imaging, magnetic resonance arthrography and computer tomography in the detection of chondral lesions of the hip." <u>Eur J Orthop Surg Traumatol</u> <b>23</b>(3): 335-344.</p>
<p>The diagnostic accuracy of MRA in detecting labral tears was as follows: sensitivity 81%, specificity 51% and accuracy 58%. For chondral wear: sensitivity 17%, specificity 100%, and accuracy 55%.</p>	<p>Study aim was to assess the diagnostic accuracy of MRA in detecting labral tears and chondral wear in compared to arthroscopy. . All patients underwent pre-operative MRA and then subsequent hip arthroscopy.</p>	<p>n = 69 hips with symptomatic FAI</p>			4		<p>Banks, D. B., et al. (2012). "Magnetic resonance arthrography for labral tears and chondral wear in femoroacetabular impingement." <u>Hip Int</u> <b>22</b>(4): 387-390.</p>
<p>MRA better at detecting cam-type deformities, os acetabuli and labral tears than the diagnosis of cartilage abnormalities in the hip. The sensitivity, specificity, PPV and NPV in the presence of reported cam-type deformity or an os acetabuli were 100%. In the presence of cartilage lesions of the femoral head, the values were 46, 81, 55 and 73%, respectively. For labral tears, the values were 91, 86, 97 and 67%. In the presence of acetabular cartilage injuries, the values were 69, 88, 78 and 81%, respectively. .</p>	<p>The purpose of this study was to assess the diagnostic correlation between MRA and findings at arthroscopic and open surgery. MRA reports of 41 hips with symptomatic FAI were reviewed and compared with subsequent intraoperative findings. Each case was assessed for the presence of a cam deformity, a cartilage lesion of the femoral head, an os acetabuli, an injury to the labrum and injury to the acetabular cartilage.</p>	<p>n = 41 with symptomatic FAI</p>			4		<p>Aprato, A., et al. (2013). "Magnetic resonance arthrography for femoroacetabular impingement surgery: is it reliable?" <u>J Orthop Traumatol</u> <b>14</b>(3): 201-206.</p>

**TABLE 4 - CT SCAN AND PREDICTION OF HIP OA**

CT - computed tomography, HCTA - helical computed tomography arthrogram, KL = Kellgren Lawrence radiographic scale, MSK = musculoskeletal.

STUDY FINDINGS	OVERVIEW	STUDY POPULATION	LEVEL OF EVIDENCE (CEBM 2009)					REFERENCE
			1	2	3	4	5	
In patients with hip pain and normal radiographs, helical computed tomography arthrograms (HCTA) can show evidence of developing osteoarthritis with cartilage lesions	Retrospective review of abnormal CHTA in mechanical hip pain with normal AP and oblique radiographs	n=18 (14 women, 4 men), Mean age 47.8 (18-62 yrs)				4		Alvarez, C., et al. (2005). "Contribution of helical computed tomography to the evaluation of early hip osteoarthritis: a study in 18 patients." <u>Joint Bone Spine</u> 72(6): 578-584.
Isotropic high-resolution CT arthrography is accurate at simultaneously identifying labral tears (sensitivity 997%, spec 87%, accuracy 92%) and cartilage disorder of the acetabulum (sensitivity 88%, spec 87%, accuracy 92%).	Retrospective study of ability of CT arthrography to identifying labral tears and articular cartilage damage (gold-standard: findings at arthroscopy).	n=41 hips (27 women, 2 men) with hip dysplasia, symptomatic hip pain and pre- or early osteoarthritis. Age 33 (12-58)				4		Nishii, T., et al. (2007). "Disorders of acetabular labrum and articular cartilage in hip dysplasia: evaluation using isotropic high-resolutonal CT arthrography with sequential radial reformation." <u>Osteoarthritis Cartilage</u> 15(3): 251-257.
CT arthrography used to identify early cartilage damage associated with labral tears. A lowered lateral-medial (LM) ratio of cartilage thickness in the anterosuperior region was associated with more extensive labral tears.	Retrospective observational study of dysplastic hips using isotropic, high resolution CT arthrography. No control group.	n=31 hips (26 women). Inclusion if KL grade 0 (21 hips) or grade 1 (11 hips).				4		Tamura, S., et al. (2012). "Three-dimensional patterns of early acetabular cartilage damage in hip dysplasia; a high-resolutonal CT arthrography study." <u>Osteoarthritis Cartilage</u> 20(7): 646-652.

**TABLE 5: PATIENT REPORTED OUTCOME MEASURES AND PREDICTION OF HIP OA**

PROM (PATIENT REPORTED OUTCOME MEASURE)	SUMMARY	VALIDATED FOR OA?	VALIDATED FOR HIP PAIN IN YOUNG, ACTIVE POPULATION?	VALIDATED AS PREDICTIVE TOOL FOR OA FOLLOWING SPORT-RELATED INJURY?	REFERENCE
<b>OA</b> -osteoarthritis, <b>ADL</b> - activity of daily living, <b>QOL</b> - quality of life.					
<b>WOMAC</b> (Western Ontario and McMaster Universities Arthritis Index)	Validated for measurement of symptoms and disability in hip OA and knee OA. 24 questions: pain (5), disability (17) and joint stiffness (2).	Y	N	N	Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW.(1988). Validation study of WOMAC: A health status instrument for measuring clinically important patient relevant outcomes following total hip or knee arthroplasty in osteoarthritis. J Orthop Rheum 1988;1:95–108.
<b>HOOS</b> (Hip Disability and Osteoarthritis Outcome Score)	Validated for measurement of hip disability with or without OA in middle-aged and older patients. 40 questions: symptoms (3), stiffness (2), pain (10), ADLs (17), sport and recreational activity (4), QOL (4).	Y	N	N	Klassbo, M. (2003). "Hip disability and osteoarthritis outcome score. An extension of the Western Ontario and McMaster Universities Osteoarthritis Index." Scandinavian Journal of Rheumatology 32(1): 46-51.
<b>OHS</b> (Oxford Hip Score)	Validated as an outcome measure following total hip replacement. 12 questions.	Y	N	N	Dawson J, Fitzpatrick R, Carr A, Murray D (1996). Questionnaire on the perceptions of patients about total hip replacement. J Bone Joint Surg Br. 1996 Mar;78(2):185-90. Link
<b>HAGOS</b> (The Copenhagen Hip and Groin Outcome Score)	Validated for measurement of symptoms and QOL in young to middle-aged, active patients with hip and/or groin pain. 37 questions: symptoms (5), stiffness (2), pain (10), ADL (5), function (8), physical activity (2), QOL (5)	N	Y	N	Thorborg, K., P. Holmich, R. Christensen, J. Petersen and E. M. Roos (2011). "The Copenhagen Hip and Groin Outcome Score (HAGOS): development and validation according to the COSMIN checklist." Br J Sports Med 45(6): 478-491.

PROM (PATIENT REPORTED OUTCOME MEASURE)	SUMMARY	VALIDATED FOR OA?	VALIDATED FOR HIP PAIN IN YOUNG, ACTIVE POPULATION?	VALIDATED AS PREDICTIVE TOOL FOR OA FOLLOWING SPORT-RELATED INJURY?	REFERENCE
<b>OA</b> -osteoarthritis, <b>ADL</b> - activity of daily living, <b>QOL</b> - quality of life.					
<b>i-HOT 33</b> (international Hip Outcome Tool)	Validated for measurement of health-related quality of life in young, active patients (18-60yrs, Tegner activity level $\geq 4$ ) with hip pathologies such as FAI or articular cartilage degeneration. 33 questions: symptoms and functional limitations (16), sports and recreational activities (6), job related concerns (4), social, emotional and lifestyle concerns (7).	N	Y	N	Mohtadi, N. G., D. R. Griffin, M. E. et al (2012). "The Development and validation of a self-administered quality-of-life outcome measure for young, active patients with symptomatic hip disease: the International Hip Outcome Tool (iHOT-33)." <i>Arthroscopy</i> <b>28</b> (5): 595-605; quiz 606-510 e591.
<b>i-HOT 12</b> (international Hip Outcome Tool)	Shorter version of i-HOT33. Validated against i-HOT33 for measurement of health-related quality of life in young, active patients (18-60yrs, Tegner activity level $\geq 4$ ) with hip disorders. 12 questions.	N	Y	N	Griffin, D. R., N. Parsons, N. G. Mohtadi and M. R. Safran (2012). "A short version of the International Hip Outcome Tool (iHOT-12) for use in routine clinical practice." <i>Arthroscopy</i> <b>28</b> (5): 611-616; quiz 616-618.

**TABLE 6 - BLOOD TESTS AND PREDICTION OF HIP OA**

**uCTX-II** = urinary crosslinking telopeptides of collagen types I and II, **sHA** = hyaluronan, **OA** = osteoarthritis.

STUDY FINDING	OVERVIEW	STUDY POPULATION	LEVEL OF EVIDENCE (CEBM 2009)					REFERENCE
			1	2	3	4	5	
<p>Paper concludes that uCTX-II and sHA are potential predictors of structural progression of hip OA.</p> <p>The results showed patients in whom uCTX-II and sHA were in the upper tertile had a relative risk of progression of 3.73 (95% CI 2.48 to 5.61) compared with patients with markers in the two lower tertiles.</p>	<p>ECHODIAH cohort. 3-year multicentre trial. The following information was collected at entry: demographics, characteristics of hip OA, and 10 markers: N-propeptides of collagen types I and III, cartilage oligomeric matrix protein, YKL-40, hyaluronan (sHA), matrix metalloproteinases-1 and -3, C reactive protein, C-terminal crosslinking telopeptides of collagen types I and II (uCTX-II). Radiographs were obtained at entry and every year. Structural progression was defined as a joint space decrease &gt;0.5 mm or requirement for total hip replacement.</p>	n = 333		2				<p>Mazieres, B., et al. (2006). "Molecular markers of cartilage breakdown and synovitis at baseline as predictors of structural progression of hip osteoarthritis. The ECHODIAH Cohort." <u>Ann Rheum Dis</u> <b>65</b>(3): 354-359.</p>

Note: further studies regarding potential biomarkers exist using knee osteoarthritis as outcome

**TABLE 7: HISTORY AND PREDICTION OF HIP OA**

STUDY FINDING	OVERVIEW	STUDY POPULATION	LEVEL OF EVIDENCE (CEBM 2009)					REFERENCE
			1	2	3	4	5	
OCCUPATION								
There is an association between long-term exposure to heavy lifting and risk of hip OA. Long-term exposure to standing at work might also increase the risk of hip OA.	Systematic review of epidemiological studies on workload or occupation and osteoarthritis of the hip were identified through database and bibliography searches. Study results were too heterogeneous to develop pooled risk estimates by specific work activities.	30 studies.		2				Sulsky, S. I., et al. (2012). "Epidemiological evidence for work load as a risk factor for osteoarthritis of the hip: a systematic review." <u>PLoS One</u> 7(2): e31521.
Joint injury, obesity, and occupational activity are associated with an increased risk of knee and hip OA.	Systematic review to identify risk factors for osteoarthritis of the knee, hip, and ankle, including joint injury, sport, physical activity, overweight/obesity, and occupational activity, in all age groups.	43 studies		2				Richmond, S. A., R. K. Fukuchi, A. Ezzat, K. Schneider, G. Schneider and C. A. Emery (2013). "Are joint injury, sport activity, physical activity, obesity, or occupational activities predictors for osteoarthritis? A systematic review." <u>J Orthop Sports Phys Ther</u> 43(8): 515-B519.
FAMILY HISTORY - OA								
After adjustment for confounders that cause secondary morphological change, individuals with an hereditary predisposition to end-stage hip OA had a higher prevalence of morphological abnormalities associated with hip OA	'Sibkids' (see study population) had an odds ratio of 2.1 (95%CI 1.3-3.5) for cam deformity. There were no differences in the prevalence of dysplasia or pincer deformities. In both groups, hips with cam deformities or dysplasia were more likely to have clinical features than normal hips (OR 4.46 (1.8- 11.3), and 4.40 (1.4-14.3) respectively). "	n =123 'sibkids' ( individuals from families in which two female siblings in the previous generation had undergone total hip arthroplasty for idiopathic end-stage OA). Controls = 80 spouses.			3			Pollard, T. C., R. N. Batra, A. Judge, B. Watkins, E. G. McNally, H. S. Gill, G. E. Thomas, S. Glyn-Jones, N. K. Arden and A. J. Carr (2013). "The hereditary predisposition to hip osteoarthritis and its association with abnormal joint morphology." <u>Osteoarthritis Cartilage</u> 21(2): 314-321.



OA at five joint sites including the hip were heritable. Genetic influences were strongly correlated among joints in the hand; however, there was little evidence of common genetic pathways to account for the co-occurrence of OA at the hand, hip and knee.	<p>Study to identify whether a shared genetic influence accounts for the occurrence of OA at different skeletal sites.</p> <p>Methods. Multivariate modelling of data on prevalent radiographic OA at the hand (DIP, PIP and CMC joints), hip and knee joints assessed in 992 monozygotic and dizygotic female twin participants from the Twins UK Registry.</p>	n = 992 monozygotic and dizygotic female twins			3			Macgregor, A. J., Q. Li, T. D. Spector and F. M. Williams (2009). "The genetic influence on radiographic osteoarthritis is site specific at the hand, hip and knee." <i>Rheumatology (Oxford)</i> 48(3): 277-280.
<b>PMH HIP PROBLEMS</b>								
Joint injury, obesity, and occupational activity are associated with an increased risk of knee and hip OA.	Systematic review to identify risk factors for osteoarthritis of the knee, hip, and ankle, including joint injury, sport, physical activity, overweight/obesity, and occupational activity, in all age groups.	43 studies		2				Richmond, S. A., R. K. Fukuchi, A. Ezzat, K. Schneider, G. Schneider and C. A. Emery (2013). "Are joint injury, sport activity, physical activity, obesity, or occupational activities predictors for osteoarthritis? A systematic review." <i>J Orthop Sports Phys Ther</i> 43(8): 515-B519.
Hip dysplasia is associated with the development of hip osteoarthritis in men and women.	Cross-sectional survey. Hip dysplasia (HD) prevalence ranged from 5.4–12.8% depending on the radiographic index applied. Logistic regression analyses showed hip dysplasia to be significantly associated with hip OA prevalence in women (P<0.001 for right hips and P=0.004 for left hips) and men ( P<0.001 in right hips and P = 0.001 in left hips).	2232 women and 1336 men (age range 20–91yr)		2				Jacobsen, S. and S. Sonne-Holm (2005). "Hip dysplasia: a significant risk factor for the development of hip osteoarthritis. A cross-sectional survey." <i>Rheumatology (Oxford)</i> 44(2): 211-218.
Patients with Perthes Disease have an increased risk of having THA compared with a gender- and age-matched control group.	Copenhagen City Heart Study: the Osteoarthritis Sub- study. 167 patients with Perthes Disease treated with a Thomas splint.	167 patients with LCPD treated with a Thomas splint. Gender- and age- matched control subjects			3			Froberg, L., F. Christensen, N. W. Pedersen and S. Overgaard (2011). "The need for total hip arthroplasty in Perthes disease: a long-term study." <i>Clinical orthopaedics and related research</i> 469(4): 1134-1140.

A history of hip injury was a predictor of increased incidence of hip OA.	Baseline (1991-1997) and first follow up (1999-2005) data from Johnston County Osteoarthritis Project participants. The incidence of 4 hip OA-related outcomes ranged from 0.3 to 5.5% each year. For each outcome, older age, being female, and having a history of hip injury were all predictors of increased incidence.	n=1,423; aged > 45 years.						Do, B. T., L. Murphy, C. G. Helmick, K. E. Barbour, Y. J. Cheng and J. M. Jordan (2011). "Incidence of hip symptoms and radiographic and symptomatic hip osteoarthritis in African Americans and Caucasians: The Johnston county osteoarthritis project." <i>Arthritis and Rheumatism</i> <b>63</b> (10 SUPPL. 1).
Previous hip injury and the presence of Heberden's nodes were independent risk factors for hip osteoarthritis among men and women. Hip injury was more closely related to unilateral as compared with bilateral disease.	Population-based case-control study looking at individual risk factors for OA. The study was performed in two English health districts (Portsmouth and North Staffordshire) from 1993 to 1995. Questionnaire administered at interview and a short physical examination. Previous hip injury (OR = 4.3, 95% CI 2.2-8.4), and the presence of Heberden's nodes (OR = 1.6, 95% CI 1.2-2.2) were identified as risk factors.	A total of 611 patients (210 men and 401 women) listed for hip replacement because of osteoarthritis over an 18-month period were compared with an equal number of controls selected from the general population and individually matched for age, sex, and family practitioner.			3			Cooper, C., H. Inskip, P. Croft, L. Campbell, G. Smith, M. McLaren and D. Coggon (1998). "Individual risk factors for hip osteoarthritis: obesity, hip injury, and physical activity." <i>Am J Epidemiol</i> 147(6): 516-522.
<b>SPORTING PARTICIPATION - LOAD, TYPE etc.</b>								
Inconclusive results for risk of developing hip OA with respect to levels of physical activity or sport specificity <u>in individuals who do not suffer an injury.</u>	Systematic review to identify risk factors for osteoarthritis of the knee, hip, and ankle, including joint injury, sport, physical activity, overweight/obesity, and occupational activity, in all age groups.	43 studies			2			Richmond, S. A., R. K. Fukuchi, A. Ezzat, K. Schneider, G. Schneider and C. A. Emery (2013). "Are joint injury, sport activity, physical activity, obesity, or occupational activities predictors for osteoarthritis? A systematic review." <i>J Orthop Sports Phys Ther</i> <b>43</b> (8): 515-B519.

There is moderate evidence for a positive association between sporting activities and the occurrence of hip OA.	Systematic review of the influence of sporting activities on the development of OA of the hip	22 articles met selection criteria (1 cohort and 21 case-controlled).		2				Lievensen, A. M., et al. (2003). "Influence of sporting activities on the development of osteoarthritis of the hip: a systematic review." <i>Arthritis Rheum</i> <b>49</b> (2): 228-236.
Weight-bearing sports activity in women is associated with a 2-3 fold increased risk of radiologic OA (particularly the presence of osteophytes) of the knees and hips. The risk was similar in ex-elite athletes and in a subgroup from the general population who reported long-term sports activity, suggesting that duration rather than frequency of training is important.	A retrospective cohort study to estimate the risk of osteoarthritis (OA) of the hip and knee due to long-term weight-bearing sports activity in ex-elite athletes and the general population. A retrospective cohort study was conducted of	81 female ex-elite athletes (67 middle- and long-distance runners, and 14 tennis players), currently ages 40-65. 977 age-matched female controls.		2				Spector, T. D., P. A. Harris, D. J. Hart, F. M. Cicuttini, D. Nandra, J. Etherington, R. L. Wolman and D. V. Doyle (1996). "Risk of osteoarthritis associated with long-term weight-bearing sports: A radiologic survey of the hips and knees in female ex-athletes and population controls." <i>Arthritis and Rheumatism</i> <b>39</b> (6): 988-995.
Increasing levels of total physical activity are positively associated with the risk of primary knee but not hip replacement due to OA. <u>Note:</u> no differentiation made between weight-bearing and non-weight-bearing activity and activity levels measured only once at baseline.	Cohort study to estimate prospectively any association between measures of physical activity and the risk of either primary knee or hip replacement due to osteoarthritis. A total physical activity level was computed, incorporating both intensity and frequency for different forms of physical activity obtained by questionnaire at baseline attendance (1990-1994). Primary knee and hip replacement for OA during 2001-2005 was determined by linking the cohort records to the National Joint Replacement Registry.	n =39,023.		2				Wang, Y., J. A. Simpson, A. E. Wluka, A. J. Teichtahl, D. R. English, G. G. Giles, S. Graves and F. M. Cicuttini (2011). "Is physical activity a risk factor for primary knee or hip replacement due to osteoarthritis? A prospective cohort study." <i>Journal of Rheumatology</i> <b>38</b> (2): 350-357.
The risk of hip OA was doubled (OR, 2.0; 95% CI, 1.5-2.8) and hip arthroplasty was 2.5 times higher (OR, 2.5; 95% CI, 1.6-3.7) in former athletes than in controls.	Case-control study looking at the prevalence of OA and arthroplasty of the hip and knee in former male elite athletes compared to controls. Higher risk found in former impact athletes.	n = 709 male retired elite athletes. Median age 70 (range 50-93). N = 1368 matched controls.			3			Tveit, M., et al. (2012). "Former male elite athletes have a higher prevalence of osteoarthritis and arthroplasty in the hip and knee than expected." <i>Am J Sports Med</i> <b>40</b> (3): 527-533.

Significantly higher prevalence of OA in ex-footballers compared to controls. The ex-professional footballers with OA of the hip had not sustained any recognised hip injury nor had undergone previous hip surgery.	The managers of league and premierhip football clubs in England and Wales were selected as a study group for the pilot investigation. Questionnaire. OA in 9/68 (13%) ex-professionals vs. 2/136 (1.4%) of controls. 6/9 ex-players with OA had undergone THR.	n= 68 ex-professional footballers. Mean age =44 years (range 32–59), mean playing career length was 16 years (5–25), and the mean number of appearances was 474. n=136 age and sex-matched controls.			3		Shepard, G. B., AJ ; Ryan, WG (2003). "Ex-professional association footballers have an increased prevalence of osteoarthritis of the hip compared with age matched controls despite not having sustained notable hip injuries." <u>British Journal Of Sports Medicine</u> 37(1): 80-81.
Increased prevalence of hip OA in ex-footballers. 14% of elite ex-football players had hip OA compared to 4.2% of age-matched controls and non-elite players.	Case-control study.	n=286 male former football players. Mean age = 55yrs. Age-matched control group.			3		Lindberg, H., H. Roos and P. Gardsell (1993). "Prevalence of coxarthrosis in former soccer players: 286 players compared with matched controls." <u>Acta Orthopaedica Scandinavica</u> 64(2): 165-167.
4% of ex-football players developed OA left hip at an average age of 42.4yrs, 1.7% developed OA of right hip at an average age of 43.7yrs..	Observational study via questionnaire.	n=185 former football players registered with the English Professional Footballers' Association. Mean age - 47.6 (20-84)				4	Drawer, S. and C. W. Fuller (2001). "Propensity for osteoarthritis and lower limb joint pain in retired professional soccer players... including commentary by Waddington I." <u>British Journal of Sports Medicine</u> 35(6): 402-409.
Men with high exposure to sports of all kinds had a relative risk to develop osteoarthritis of the hip of 4.5 compared to those with low exposure. Track and field sports and racket sports seemed to be the most hazardous to the hip join	Case-control study to investigate if participation in sports increases the risk of developing osteoarthritis of the hip, .	n =233 men < 49yrs who had recently had total hip replacement for idiopathic OA 302 controls.			3		Vingard, E., L. Alfredsson, I. Goldie and C. Hogstedt (1993). "Sports and osteoarthritis of the hip: an epidemiologic study." <u>American Journal of Sports Medicine</u> 21(2): 195-201.

Vigorous sporting activity during the growth years is associated with an increased risk of having a cam-type deformity develop. This study suggests that a cam-type abnormality in athletes is a consequence of an alteration of the growth plate rather than reactive bone formation.	Case-control comparative analysis of young (age range, 9-22 years) male elite basketball athletes with age-matched non-athletes, substratified by whether they had open or closed physes. Measurement of epiphyseal extension on radial-sequence MRI cuts throughout the cranial hemisphere from 9 o'clock (posterior) to 3 o'clock (anterior). Epiphyseal extension was correlated to alpha angle measurements at the same points. Epiphyseal extension was increased in all positions in the athletes compared with the control group.	n = 37 elite basketball players + 38 controls			3		Siebenrock, K. A., I. Kaschka, L. Frauchiger, S. Werlen and J. M. Schwab (2013). "Prevalence of cam-type deformity and hip pain in elite ice hockey players before and after the end of growth." <u>Am J Sports Med</u> <b>41</b> (10): 2308-2313.
The most frequent intra-articular hip diagnoses in ice-hockey players are hip labral tear (69.1%), followed by hip osteoarthritis (13.8%), hip loose body (6.3%), and hip femoroacetabular impingement (5.3%).	A database containing the injury surveillance of National Hockey League (NHL) players from the years 2006 to 2010 was used to identify athletes who had sustained a hip or groin injury.	n=980 hip/groin pain of which n=94 intra-articular injuries.			4		Epstein, D. M., M. McHugh, M. Yorio and B. Neri (2013). "Intra-articular hip injuries in national hockey league players: a descriptive epidemiological study." <u>The American journal of sports medicine</u> <b>41</b> (2): 343-348.
The risk of developing premature hip OA seems high for retired handball players and significantly greater than for the general population. 60% of the handball players were diagnosed with OA in at least one of the hip joints compared with 13% of the control subjects.	Case-control study. A questionnaire yielded personal details, loading patterns during physical activity, and previous lower limb joint injury. Bilateral radiographs were analysed to diagnose and classify hip OA. Passive hip ROM was measured bilaterally with a goniometer. Passive ROM measured in the handball players was significantly lower for hip flexion and medial rotation and higher for abduction, extension, and lateral rotation than the control values. The handball players with OA reported less pain in the hip joints during daily activities than the control subjects with OA.	n= 20 former elite handball players, n= 39 control subjects were collected. A questionnaire yielded personal details, loading patterns during physical activity, and previous lower limb joint injury. Bilateral radiographs were analysed to diagnose and classify hip OA. Passive hip ROM was measured bilaterally with a goniometer.			3		L'Hermette, M., G. Polle, C. Tourny-Chollet and F. Dujardin (2006). "Hip passive range of motion and frequency of radiographic hip osteoarthritis in former elite handball players... including commentary by Klassbo M." <u>British Journal of Sports Medicine</u> <b>40</b> (1): 45-50.

89% (8/9) of former elite water polo players had $\alpha$ angle $\geq 60^\circ$ consistent with the presence of cam lesion morphology in one or both hips. All five players with a reported history of “hip” or “groin” pain had MR evidence of cam lesion morphology	Small case-series looking at ex-elite level water polo players. Examined with 3T MRI.	n =9 former male high performance Water Polo players (4 asymptomatic, 5 with self-reported hip or groin pain). Average age= 30, 16+5 years playing history.				4		Melville, P., C. Engstrom, D. Bailey and S. Daley (2012). "Femoroacetabular impingement in former high performance male Water Polo players." <u>Journal of Science and Medicine in Sport</u> <b>15</b> : S243.
AGE								
Increased incidence of hip OA with age.	Epidemiological study using US Defence Medical Epidemiology Database (DMED). Poisson regression used to estimate the rate of hip OA per 100,000 person-years by sex, race, age, rank, and service (unadjusted rates). The highest incidence rate was seen in the > 40 years age group with an incidence rate of 140 per 100,000 person-years. The adjusted rate ratio for the >40 years age group compared with the 20 years age group was 22.21 (95% CI 17.54 –28.14).	A total of 4,262 cases of hip OA were documented in population at risk of 12,096,304 person-years.		2				Scher, D. L., P. J. Belmont, Jr., S. Mountcastle and B. D. Owens (2009). "The incidence of primary hip osteoarthritis in active duty US military service members." <u>Arthritis Rheum</u> <b>61</b> (4): 468-475.
Increasing age was associated with the development of hip OA in women.	Cross-sectional survey. Hip OA prevalence was 1.0–2.5% in subjects <60 yr of age and 4.4–5.3% in subjects >60 yr of age. Logistic regression analyses showed age (P<0.001) to be significantly associated with hip OA prevalence in women.	2232 women and 1336 men (age range 20–91yr)				4		Jacobsen, S. and S. Sonne-Holm (2005). "Hip dysplasia: a significant risk factor for the development of hip osteoarthritis. A cross-sectional survey." <u>Rheumatology (Oxford)</u> <b>44</b> (2): 211-218.
Older age was a predictor of increased incidence of hip OA.	Baseline (1991-1997) and first follow up (1999-2005) data from Johnston County Osteoarthritis Project participants. The incidence of 4 hip OA-related outcomes ranged from 0.3 to 5.5% each year. For each outcome, older age, being female, and having a history of hip injury were all predictors of increased incidence.	n=1,423; aged > 45 years.				3		Do, B. T., L. Murphy, C. G. Helmick, K. E. Barbour, Y. J. Cheng and J. M. Jordan (2011). "Incidence of hip symptoms and radiographic and symptomatic hip osteoarthritis in African Americans and Caucasians: The Johnston county osteoarthritis project." <u>Arthritis and Rheumatism</u> <b>63</b> (10 SUPPL. 1).
GENDER								

Increased incidence of hip OA in women compared to men in all age groups.	Epidemiological study using US Defence Medical Epidemiology Database (DMED). Poisson regression used to estimate the rate of hip OA per 100,000 person-years by sex, race, age, rank, and service. Women - 54/ 100,000 person-yrs; men 32/ 100,000 person-yrs. Women had a significantly increased adjusted incidence rate ratio for hip OA of 1.87 (95% confidence interval [95% CI] 1.73–2.01) compared to men.	A total of 4,262 cases of hip OA were documented in population at risk of 12,096,304 person-years.		2				Scher, D. L., P. J. Belmont, Jr., S. Mountcastle and B. D. Owens (2009). "The incidence of primary hip osteoarthritis in active duty US military service members." <i>Arthritis Rheum</i> 61(4): 468-475.
Female sex was a predictor of increased incidence of hip OA.	Baseline (1991-1997) and first follow up (1999-2005) data from Johnston County Osteoarthritis Project participants. The incidence of 4 hip OA-related outcomes ranged from 0.3 to 5.5% each year. For each outcome, older age, being female, and having a history of hip injury were all predictors of increased incidence.	n=1,423; aged > 45 years.		2				Do, B. T., L. Murphy, C. G. Helmick, K. E. Barbour, Y. J. Cheng and J. M. Jordan (2011). "Incidence of hip symptoms and radiographic and symptomatic hip osteoarthritis in African Americans and Caucasians: The Johnston county osteoarthritis project." <i>Arthritis and Rheumatism</i> 63(10 SUPPL. 1).
<b>PAIN</b>								
Painful hips had a statistically significant higher mean alpha angle than asymptomatic hips (69.9 degrees vs. 63.1 degrees, $p < 0.001$ ). Hips with an alpha angle of more than 60 degrees had an odds ratio of being painful of 2.59 (95% confidence interval 1.32 to 5.08, $p = 0.006$ ) compared with those with an alpha angle of less than 60 degrees .	Study to determine the prevalence of bilateral deformity in patients with symptomatic cam-type femoroacetabular impingement as well as the presence of associated acetabular abnormalities and hip pain. Bilateral cam-type deformity was present in 88 patients (77.8%) while only 23 of those (26.1%) had bilateral hip pain.	n = 113 patients (M=82, F=31) with a symptomatic cam-impingement deformity of at least one hip. Age <55 years. Mean age 37.9 (16-55). At least one anteroposterior and lateral pelvic radiograph available. All patients with dysplasia and/or arthritis were excluded.		3				Allen, D., P. E. Beaulé, O. Ramadan and S. Doucette (2009). "Prevalence of associated deformities and hip pain in patients with cam-type femoroacetabular impingement." <i>Journal of Bone &amp; Joint Surgery, British Volume</i> 91(5): 589-595.

<p>Hip pain with combined clinical examination tools is predictive of osteoarthritis with increasing predictive power with increasing number of positive clinical findings.</p>	<p>Preliminary study to determine clinical prediction tool for accurately predicting osteoarthritis of the hip. The 5 variables that emerged from the subsequent logistic regression analysis were used to form the preliminary clinical prediction rule: (1) self-reported squatting as an aggravating factor; (2) active hip flexion causing lateral hip pain; (3) scour test with adduction causing lateral hip or groin pain; (4) active hip extension causing pain; and (5) passive internal rotation of less than or equal to 25°. If at least 4 of 5 variables were present, the positive Likelihood Ratio was equal to 24.3 (95% confidence interval: 4.4-142.1), increasing the probability of hip OA to 91%.</p>	<p>n=72 patients with unilateral pain in hip, groin or buttock. F=40 female, M=32. Mean age 56.8yrs. 29% had radiographic evidence of OA.</p>				3		<p>Sutlive, T. G., H. P. Lopez, D. E. Schnitker, S. E. Yawn, R. J. Halle, L. T. Mansfield, R. E. Boyles and J. D. Childs (2008). "Development of a clinical prediction rule for diagnosing hip osteoarthritis in individuals with unilateral hip pain." <u>J Orthop Sports Phys Ther</u> <b>38</b>(9): 542-550.</p>
---	--	---	--	--	--	---	--	---



**TABLE 8: EXAMINATION AND PREDICTION OF HIP OA**

**BMI** - body mass index, **FAI** - femoroacetabular impingement, **HR** - hazard ratio, **LLI** - lower limb inequality, **OA** - osteoarthritis,

STUDY FINDING	OVERVIEW	STUDY POPULATION	LEVEL OF EVIDENCE (CEBM 2009)					REFERENCE
			1	2	3	4	5	
BODY MASS INDEX (BMI)								
BMI at early and middle adulthood is a risk factor for hip OA. Hazard ratio per 5 kg/m(2) = 1.29 [95% Confidence intervals 1.21- 1.37)]	At baseline interview participants were asked to recall their weight at age 18-21 years and had their middle age height and weight measured. Total knee and hip replacement for OA between 2001 and 2009 was determined by linking the cohort records to the Australian Orthopaedic Association National Joint Replacement Registry.	n = 38,149 (Melbourne Collaborative Cohort Study). Mean age 54.9yrs.		2				Wang, Y., et al. (2013). "Body weight at early and middle adulthood, weight gain and persistent overweight from early adulthood are predictors of the risk of total knee and hip replacement for osteoarthritis." <u>Rheumatology (Oxford)</u> <b>52</b> (6): 1033-1041.
Joint injury, obesity, and occupational activity are associated with an increased risk of knee and hip OA.	Systematic review to identify risk factors for osteoarthritis of the knee, hip, and ankle, including joint injury, sport, physical activity, overweight/obesity, and occupational activity, in all age groups.	43 studies		2				Richmond, S. A., R. K. Fukuchi, A. Ezzat, K. Schneider, G. Schneider and C. A. Emery (2013). "Are joint injury, sport activity, physical activity, obesity, or occupational activities predictors for osteoarthritis? A systematic review." <u>J Orthop Sports Phys Ther</u> <b>43</b> (8): 515-B519.

Obesity (odds ratio (OR) = 1.7, 95% confidence interval (CI) 1.3-2.4; highest vs. lowest third of body mass index independent risk factors for hip osteoarthritis among men and women.	The authors explored individual risk factors for hip osteoarthritis in a population-based case-control study. The study was performed in two English health districts (Portsmouth and North Staffordshire) from 1993 to 1995. Information about suspected risk factors was obtained by a questionnaire administered at interview and a short physical examination. .	A total of 611 patients (210 men and 401 women) listed for hip replacement because of osteoarthritis over an 18-month period were compared with an equal number of controls selected from the general population and individually matched for age, sex, and family practitioner.		3			Cooper, C., H. Inskip, P. Croft, L. Campbell, G. Smith, M. McLaren and D. Coggon (1998). "Individual risk factors for hip osteoarthritis: obesity, hip injury, and physical activity." <u>Am J Epidemiol</u> 147(6): 516-522.
Greater weight and BMI at age 18-21 years and middle age, weight gain and persistent overweight during this time were associated with an increased risk of total knee and hip replacement in later life. (Associations were stronger for knee OA than hip OA).	A cohort study to examine the relationships between weight at early and middle adulthood and adult weight gain and the risk of total knee and hip replacement for OA. Melbourne Collaborative Cohort Study were asked to recall their weight at age 18-21 years and had their middle age height and weight measured. Total knee and hip replacement for OA between 2001 and 2009 was determined by linking the cohort records to the Australian Orthopaedic Association National Joint Replacement Registry. Hip results: Middle-age weight hazard ratio (HR) per 5 kg = 1.11 (1.09, 1.14), and BMI hazard ratio per 5 kg/m(2)= 1.29 (1.21, 1.37)] and adult weight gain hazard ratio per 5 kg 1.10 (1.07, 1.13)	n =38,149. Mean age 54.9yrs.		2			Wang, Y., A. E. Wluka, J. A. Simpson, G. G. Giles, S. E. Graves, R. N. de Steiger and F. M. Cicuttini (2013). "Body weight at early and middle adulthood, weight gain and persistent overweight from early adulthood are predictors of the risk of total knee and hip replacement for osteoarthritis." <u>Rheumatology (Oxford)</u> 52(6): 1033-1041.
Increasing BMI is associated with a higher risk of hip osteoarthritis. Adjusted hazard ratio (HR) for hip OA with increasing BMI were; overweight HR= 1.46 (1.39-1.52); obese HR= 1.75 (1.66-1.83);morbidly obese HR= 1.93 (1.82-2.05).	Cohort study using computerized medical records from the SIDIAP Database to identify those aged 40 years or older with an incident diagnosis of hip OA. SIDIAP contains the anonymised medical records of >3,100 GPs in Catalonia (North-East Spain) with information on an 80% of the total population.	n = 12, 567 patients with hip OA.		2			Prieto-Alhambra, D., A. Pages-Castella, M. K. Javaid, A. Judge, C. Cooper, N. K. Arden and A. Diez-Perez (2012). "Incidence of knee, hip, and hand clinical osteoarthritis: A population-based cohort study." <u>Arthritis and Rheumatism</u> 64: S397-S398.

A high BMI was significantly associated with knee OA and hand OA, but not with hip OA.	Norwegian study on musculoskeletal pain in both 1994 and 2004. When adjusting for age, gender, work status and leisure time activities, a high BMI (> 30) was significantly associated with knee OA (OR 2.81; 95%CI 1.32–5.96), and hand OA (OR 2.59; 1.08–6.19), but not with hip OA (OR 1.11; 0.41–2.97).	A total of n =1675. age at start of study = 24–76 yrs. No OA at start of study. The main outcome measure was OA diagnosis at follow-up based on self-report. Obesity was defined by a body mass index (BMI) of 30 and above. NOTE: Both diagnosis of OA and BMI estimation was based on self-report.		2			Grotle, M., K. B. Hagen, B. Natvig, F. A. Dahl and T. K. Kvien (2008). "Obesity and osteoarthritis in knee, hip and/or hand: an epidemiological study in the general population with 10 years follow-up." <u>BMC Musculoskelet Disord</u> 9: 132.
<b>HIP RANGE OF MOVEMENT (ROM)</b>							
Internal rotation was significantly reduces in symptomatic and asymptomatic patients with radiological FAI compared to healthy controls.	The range of internal rotation on impingement testing was found to average 27.9° in the healthy control group compared with 21.1° in the asymptomatic control group with radiographic features specific to FAI (P < .001) and 12.3° in the patient group (P < .001). Cam size, acetabular coverage, and femoral version appeared to be predictive variables for the range of internal rotation. Seventy-five percent of variance between patients could be attributed to the combined effect of these 3 variables (R = .86).	n= 30 patients (10 per subgroup). All male, 18-35 yrs.			3		Audenaert, E. A., I. Peeters, L. Vigneron, N. Baelde and C. Pattyn (2012). "Hip morphological characteristics and range of internal rotation in femoroacetabular impingement." <u>Am J Sports Med</u> 40(6): 1329-1336.
Restriction in range of movement was predictive of the presence of OA in new presenters to primary care with hip pain	New hip pain attenders with radiographic OA had restricted movement at the hip compared with those without radiographic change. Restriction in internal rotation was the most predictive and flexion the least predictive of radiographic OA.	n =195 patients with hip pain presenting to general practice, median age = 63yrs, female = 68%.			3		Birrell, F., P. Croft, C. Cooper, G. Hosie, G. Macfarlane and A. Silman (2001). "Predicting radiographic hip osteoarthritis from range of movement." <u>Rheumatology</u> 40(5): 506-512.

Internal rotation correlated to radiographic (but not necessarily symptomatic) cam FAI. Authors suggest that football players with diminished internal rotation in whom hip pain develops should be evaluated for underlying cam FAI abnormalities.	The objective of this study was to determine whether physical examinations (flexion–abduction–external rotation [FABER], impingement, range-of-motion profiles) could be used to detect the bony abnormalities of femoroacetabular impingement (FAI) in an athletic population. Although 95% of the hips had at least 1 radiographic sign of FAI, pain was reported in only 8.5% and 2.3% during the impingement and FABER tests, respectively.	n = 65 collegiate football players.				4	Kapron, A. L., A. E. Anderson, C. L. Peters, L. G. Phillips, G. J. Stoddard, D. J. Petron, R. Toth and S. K. Aoki (2012). "Hip internal rotation is correlated to radiographic findings of cam femoroacetabular impingement in collegiate football players." <u>Arthroscopy - Journal of Arthroscopic and Related Surgery</u> <b>28</b> (11): 1661-1670.
Reduced internal rotation in professional footballers compared to controls. The authors suggest this may be an indication of early degenerative change.	Case-control observational study. Bilateral measurements of passive hip internal rotation (IR), external rotation (ER), flexion, abduction and extension were made together with Faber's test and the hip quadrant test. Footballers had significantly less IR and Faber's range and significantly higher abduction than their respective controls ( $p < 0.001$ ). Senior footballers also had significantly reduced IR ( $p < 0.05$ ) and Faber's ( $p < 0.001$ ) than the youth team. A higher proportion of senior footballers had positive hip quadrants (45% of all hips) compared to all other groups. No significant difference in hip ROM was found between dominant and non-dominant legs.	40 asymptomatic male professional footballers: 20 youth (age 16-18) and 20 senior team (>19yrs) and 40 matched control subjects.				3	Manning, C. and Z. Hudson (2009). "Comparison of hip joint range of motion in professional youth and senior team footballers with age-matched controls: An indication of early degenerative change?" <u>Physical Therapy in Sport</u> <b>10</b> (1): 25-29.
<b>IMPINGEMENT TESTS</b>							
35 of 480 (7.3%) healthy men and 32 of 672 (4.8%) healthy women had positive impingement tests.	Population based study looking at prevalence of FAI in healthy young adults. Correlated with activity levels, history of hip symptoms and radiographic findings. Positive impingement tests were associated with history of hip pain in women and in high activity levels and radiographic CAM lesions in men.	n = 1152 healthy young adults. Men =480, women =672. Ages 18 to 20 years old. Part of the follow-up of the population- based '1989 Bergen Birth Cohort'				4	Laborie, L. B., T. G. Lehmann, I. O. Engesaeter, L. B. Engesaeter and K. Rosendahl (2013). "Is a positive femoroacetabular impingement test a common finding in healthy young adults?" <u>Clin Orthop Relat Res</u> <b>471</b> (7): 2267-2277.

Impingement test(FADIR) had best diagnostic ability to diagnose labral tears clinically. (sensitivity 59%, spec 100%, PPV - 100%, NPV - 13%)	Testing diagnostic validity of impingement test (FADIR test - hip flexion, adduction, internal rotation), FABER test (hip flexion, abduction, external rotation), resisted straight leg raise test and ultrasound compared to MR arthrography for identifying labral tears.	n = 18 hips, male = 2, female = 16. Median age 43 (range 32-56yrs)				4	Troelsen, A., et al. (2009). "What is the role of clinical tests and ultrasound in acetabular labral tear diagnostics?" <u>Acta Orthopaedica</u> <b>80</b> (3): 314-319.
The most sensitive clinical test) for detecting intra-articular hip pathology were flexion abduction external rotation (FABER) test and the internal rotation over pressure (IROP) manoeuver	Diagnostic study looking at four clinical tests for detecting intra-articular pathology: FABER, internal rotation over-pressure, Stinchfield manoeuvre, Scour manoeuvre. Study group were patients undergoing hip injection for suspected pathology. Indications for injections were: OA (64%), FAI For the FABER test, sensitivity was 0.82 (95% CI 0.57-0.96); sensitivity for the IROP manoeuvre was 0.91 (95% CI 0.68-0.99). The most specific test was the Stinchfield manoeuver, with specificity at 0.32 (95% CI 0.14-0.55). FABER and IROP had the highest positive predictive value, with 0.46 (95% CI 0.28-0.65) and 0.47 (95% CI 0.29-0.64), respectively. IROP had the highest negative predictive value at 0.71 (95% CI 0.25-0.98). NOTE: There was no comparison with a control group without suspected intra-articular pathology.	n = 50 (male =20, female =30). Average age = 60.2yrs.				4	Maslowski, E., W. Sullivan, J. Forster Harwood, P. Gonzalez, M. Kaufman, A. Vidal and V. Akuthota (2010). "The diagnostic validity of hip provocation manoeuvres to detect intra-articular hip pathology." <u>PM R</u> <b>2</b> (3): 174-181.
The maximal squat test was found to have marginal incremental diagnostic ability for CAM-type FAI. The authors conclude that its utility in the diagnostic evaluation of FAI remains limited.	Pilot study to determine relationship between maximal squat test and FAI. Maximal squat test was compared to MRI and MRA findings of CAM-type FAI deformity. The sensitivity and specificity of the maximal squat test were 75 % (56.6-88.5 %) and 41 % (27.0-56.8 %), respectively, for CAM-type FAI deformity. The positive and negative likelihood ratios were modest at 1.3 (0.9-1.7) and 0.6 (0.3-1.2), respectively. This means that a 30 % pre-test probability is improved to 36 % following a positive squat test and reduced to 20 % with a negative squat test.	n= 76 consecutive patients with pre-arthritis hip pain, recruited from an outpatient clinic at McMaster University.				4	Ayeni, O., R. Chu, B. Hetaimish, L. Nur, N. Simunovic, F. Farrokhyar, A. Bedi and M. Bhandari (2013). "A painful squat test provides limited diagnostic utility in CAM-type femoroacetabular impingement." <u>Knee Surg Sports Traumatol Arthrosc.</u>

The impingement test had the best diagnostic ability to identify labral tears with a sensitivity of 59% and a specificity of 100%.	Small study comparing clinical diagnostic tests for labral tears( impingement test, FABER test, resisted straight leg raise test) with MRA findings. Acetabular labral tears were identified in 17 of the 18 hip joints on MR arthrograms. Impingement tests were positive in 10 of 17 confirmed cases. NOTE: population all had dysplasia of the hip, unclear whether patients were symptomatic or asymptomatic prior to study.	n = 18 patients. Women = 16, men =2. Median age =43yrs. All had had previous periacetabular osteotomies due to symptomatic, acetabular dysplasia. All hips showed no or only slight signs of osteoarthritis (Tönnis grade 0–1).				4	Troelsen, A., I. Mechlenburg, J. Gelineck, L. Bolvig, S. Jacobsen and K. Søballe (2009). "What is the role of clinical tests and ultrasound in acetabular labral tear diagnostics?" <u>Acta Orthopaedica</u> <b>80</b> (3): 314-319.
<b>BIOMECHANICS</b>							
Varus knee, valgus knee, and toe-in/out angles were <b>not</b> significantly associated with increased risk of isolated hip OA. Adjustments for age, sex, and BMI did not alter these findings	Participants in the Genetics of Osteoarthritis and Lifestyle case-control database were sent a questionnaire containing line-drawing instruments for self-reported knee and foot alignment at ages 20–29 years. Respondents were categorized as having straight, valgus, or varus knee, and straight, toe-in, or toe-out feet.	n=1901 (n = 672 with hip OA), 50% women, mean age 67.4.				3	McWilliams, D. F., S. Doherty, R. A. Maciewicz, K. R. Muir, W. Zhang and M. Doherty (2010). "Self-reported knee and foot alignments in early adult life and risk of osteoarthritis." <u>Arthritis Care and Research</u> <b>62</b> (4): 489-495.
<b>LEG LENGTH INEQUALITY (LLI)</b>							
LLI was moderately associated with chronic knee symptoms and less strongly associated with hip symptoms.	Cross-sectional study examining the association of limb length inequality (LLI) with chronic joint symptoms at the hip and knee in a large, community-based sample, adjusting for the presence of radiographic osteoarthritis (OA) and other confounders. . Participants with LLI were more likely than those without LLI to have knee symptoms (56.8% vs. 43.0%, P < 0.001), and hip symptoms (49.5% vs. 40.0%, P = 0.09). In adjusted models, knee symptoms were significantly associated with presence of LLI (adjusted odds ratio [aOR] = 1.41, 95% confidence interval, [95% CI] 1.02-1.97), but the relationship between hip symptoms and LLI (aOR = 1.20, 95% CI 0.87-1.67) was not statistically significant.	n = 3007 patients with hip symptoms, n = 206 patients with LLI ≥2c m.				4	Golightly, Y. M., K. D. Allen, C. G. Helmick, J. B. Renner and J. M. Jordan (2009). "Symptoms of the knee and hip in individuals with and without limb length inequality." <u>Osteoarthritis and Cartilage</u> <b>17</b> (5): 596-600.

LLI was associated with radiographic knee OA but not hip OA.	This study examined the relationship of limb length inequality (LLI) with radiographic hip and knee osteoarthritis (OA) in a large, community-based sample. Methods: The total study group comprised 926 participants with radiographic knee OA, 796 with radiographic hip OA, and 210 (6.6%) with LLI >=2 cm. . In multiple logistic regression models, knee OA was significantly associated with presence of LLI but there was no significant relationship between hip OA and LLI (aOR = 1.20, 95% CI 0.86-1.67).	n = 796 radiographic hip OA, n = 926 radiographic knee OA, n = 210 with LLI ≥2cm.				4	Golightly, Y. M., K. D. Allen, J. B. Renner, C. G. Helmick, A. Salazar and J. M. Jordan (2007). "Relationship of limb length inequality with radiographic knee and hip osteoarthritis." <u>Osteoarthritis and Cartilage</u> <b>15</b> (7): 824-829.
<b>LOWER LIMB MUSCLE STRENGTH/SYMMETRY/FLEXIBILITY</b>							
Patients with symptomatic FAI presented muscle weakness for all hip muscle groups, except for internal rotators and extensors.	Small case-control study comparing hip muscle strength between patients with symptomatic FAI and healthy controls.FAI patients had significantly lower MVC strength than controls for hip adduction, flexion, external rotation and abduction. Tensor fascia lata EMG activity was significantly lower in FAI patients compared with controls (P < 0.048), while rectus femoris EMG activity did not differ significantly between the two groups (P< 0.056).	n=22 FAI patients n = 22 controls matched for gender, age, and body mass.				4	Casartelli, N. C., N. A. Maffiuletti, J. F. Item-Glatthorn, S. Staehli, M. Bizzini, F. M. Impellizzeri and M. Leunig (2011). "Hip muscle weakness in patients with symptomatic femoroacetabular impingement." <u>Osteoarthritis Cartilage</u> <b>19</b> (7): 816-821.
Strength was significantly reduced on the injured side compared to the non-injured side of patients with a hip labral tear.	Small case-control study to investigate hip flexor muscle size and strength in patients with hip labral pathology compared to control subjects. All participants underwent examination of their lumbo-pelvic region with magnetic resonance imaging. Muscle cross- sectional area of the iliopsoas, sartorius, tensor fascia latae and rectus femoris muscles on both sides were measured and added together to give hip flexor muscle size. Hip flexion strength was measured on both sides by a hand-held dynamometer.	n =12 participants (8 females, 4 males), aged 20–53 years, with a unilateral acetabular labral tear. n=12 control participants matched for age and gender.				4	Mendis, D., S. Wilson, D. Hayes, M. Watts and J. Hides (2011). "Hip flexor muscle strength but not size is reduced in patients with hip labral tears." <u>Journal of Science and Medicine in Sport</u> <b>14</b> , Supplement 1(0): e19.
<b>LUMBAR SPINE ASSESSMENT</b>							

Low back pain predicted subsequent OA-related pain and disability in those with hip disease, but not knee disease.	Study of a population-based cohort of Ontario residents who were 55 years or older and reported symptomatic hip/knee OA at baseline (between 1996 and 1998). The sample was followed-up between 2000 and 2001. Multivariable linear regression was used to model the association between baseline back pain and pain and disability (Western Ontario and McMaster Universities Osteoarthritis Index scores) at follow-up while controlling for confounders.	n=983, mean age=71.7 years, and 72.3% were female. Mean BMI at baseline=29.1 kg/m <sup>2</sup> .			3		Stupar, M., P. Côté, M. R. French and G. A. Hawker (2010). "The association between low back pain and osteoarthritis of the hip and knee: a population-based cohort study." <u>Journal of Manipulative &amp; Physiological Therapeutics</u> <b>33</b> (5): 349-355.
--	---	--	--	--	---	--	---