Radiographic osteoarthritis and obesity

Abdurhman S. Al-Arfaj, FRCPC, MRCP(UK).

ABSTRACT

Objective: To determine the association between obesity and radiographic osteoarthritis (OA) of the knee and generalized OA.

Methods: A cross-sectional survey of patients attending 14 primary clinics for a variety of medical complaints was conducted. They were consented, interviewed, examined and radiographed for the presence of knee and generalized OA. The association between OA and weight was then assessed. This study was carried out in 14 primary care clinics in North Riyadh, Kingdom of Saudi Arabia, between September 1998 through to March 1999.

Results: Two hundred and nineteen patients (118 males, 101 females) completed the study and their results were analyzed. We found a strong association between excess weight and knee OA in females [overall ratio (OR) 3.28 (95% confidence intervals (CI), 2.07-5.36)] and a weaker link with knee OA in males [OR 1.88 (95% CI, 1.24-2.92)]. Generalized OA was found to be associated with obesity in females only [OR 1.93 (95% CI, 1.09-3.43)]. Reporting of joint symptoms in patients with radiographic knee OA was also associated with obesity (P=0.0001).

Conclusion: Excess weight is strongly associated with knee OA in females and symptoms of joint pain in all OA patients, with a weaker but still significant link with male knee OA and generalized OA in females.

Keywords: Osteoarthritis, obesity.

Saudi Med J 2002; Vol. 23 (8): 938-942

Osteoarthritis (OA) in general and osteoarthritis of the knee, in particular, affects more people than any other arthritic condition.[1] Although generally it is a disease of the elderly, our recent local survey showed it to be very common in both males (53.3%) and females (60.9%) and affecting the relatively young individuals.[2] This will increase its already considerable socio-economic impact.[3] Once developed, our armaments against the disease are limited, leading us to look at factors, which may predispose to its occurrence. Obesity is one such factor that have been studied.[4-7] Obesity is very common in the Saudi population and have been reported to be higher than that found in the United States of America (USA), Europe and Australia.[8] This widespread problem of excess weight may have contributed to the Kingdom of Saudi Arabia (KSA) having one of the highest prevalences of knee OA in the world.[2] The relationship between OA and obesity has been proposed to be operative through local, mechanical, hormonal and systemic factors.[9-12]

In this study, we looked at the relationship between radiographic knee OA, generalized OA and body weight in the Saudi population.

Methods.   Through a cross-sectional survey, we examined radiographs of knees, and hands (antero-posterior and lateral) of 219 patients (118 males, 101 females) attending 14 primary care clinics in North Riyadh, Kingdom of Saudi Arabia, over a 7 month period, for a variety of medical conditions. The patients were interviewed, formally consented, examined and radiographed. Their body mass index (BMI) was calculated (weight in kg divided by square height in meters). We also noted their age,

sex, serum cholesterol, triglycerides, and uric acid. Their radiographs were read for the presence of osteoarthritis using the Kellgren-Lawrence grading system[13] (grade 0-normal, grade one-minute osteophytes of doubtful significance, grade 2-definite osteophytes, grade 3-moderate narrowing of joint space, grade 4-greatly reduced joint space and subchondral bone sclerosis). Those individuals having grade 2 or more were considered as having osteoarthritis. Generalized OA was defined here as having both OA of knees and hands. The patients' data were then analyzed for the presence of OA knees or generalized OA. Patients' weights were divided into 3 groups: ideal body weight (BMI < 25 kg/m², overweight (BMI between 25 and <30 kg/m²) and obese (BMI >30 kg/m²). The BMI of patients were also sorted into tertiles and those in the highest 2nd, 3rd tertiles were compared to those in the lowest first tertile (reference group) for the presence of osteoarthritis of knees and generalized OA. The association between OA knees, generalized OA and BMI was carried out using odds ratio which was adjusted for sex, age, serum cholesterol, triglyceride and uric acid using stratification analysis according to the Mantel-Haenszel method. The association between OA and incremental increase in BMI was carried out using multiple regression analysis using SPSS 9.0 computer package (SPSS Inc., Chicago, Illinois, USA).

Results. Two hundred and nineteen patients (118 males, 101 females) had their x-ray of knees, hands and BMI analyzed. The total group means age was 48.82 ± 15.62 years, the males mean age was 51.54 ± 16.64 while the females mean age was 45.67 ± 13.78. There were 113 (51.6%) cases of knee OA (57 males and 56 females) and 57 (26%) cases of generalized OA (37 males and 20 females). The mean age of those without OA is 40.09 ± 14.36 (males 42.04 ± 15.71, females 37.87 ± 12.47). The mean age of those with knee OA was 57.05 ± 12.07 years, (males 60.35 ± 12.22, females 53.02 ± 10.83) while those of generalized OA had an average age of 59.30 ± 12.74 (males 62 ± 11.54, females 51.56 ± 11.99). The mean BMI of the whole group was 28.71 ± 6.36 (males 26.95 ± 5.44, females 30.75 ± 6.76). Mean BMI of all patients with knee OA was 30.30 ± 6.43, (males 28.01 ± 5.68, and females 32.99 ± 6.26) while mean BMI of patients without knee OA was 26.99 ± 5.84 (males 25.82 ± 4.98, females 28.36 ± 6.50). Mean BMI of all patients with generalized OA was 29.5 ± 5.84 (males 27.91 ± 5.54, females 31.74 ± 5.51) while mean BMI of patients without generalized OA was 28.31 ± 6.58 (**Table 1**). Mean BMI of patient complaining of joint pains was 29.19 ± 6.55, while those who did not complain of joint pain had a mean BMI of 26.65 ± 5.03. Among patients with radiographic knee OA, the mean BMI

Table 1 - Mean body mass index of males/females in relation to knee and generalized osteoarthritis.

OA site	Mean BMI of patients without OA	Mean BMI of patients with OA	P value
All group			
Knee OA	26.99 ± 5.84 n=106	30.30 ± 6.43 n=113	0.0001*
Generalized OA	28.31 ± 6.58 n=162	29.51 ± 5.84 n=57	0.2245
Females			
OA knees	28.36 ± 6.50 n= 45	32.99 ± 6.26 n=56	0.0004*
Generalized OA	30.49 ± 7.16 n=81	31.74 ± 5.51 n=20	0.468
Males			
OA knees	25.82 ± 4.98 n=61	28.01 ± 5.68 n=57	0.0276*
Generalized OA	26.64 ± 6.83 n=81	27.41 ± 5.54 n=37	0.549

BMI - body mass index, OA - osteoarthritis
n - number, * - significant

Table 2 - Knee osteoarthritis and generalized osteoarthritis in relation to body mass index tertiles.

BMI Tertiles	OA knees		Generalized OA	
	Present n	Absent n	Present n	Absent n
Females n=101				
First tertile (<27.56)	12	23	6	29
2nd tertile (27.56-33.24)	12	15	5	28
3rd tertile (>33.24)	26	7	9	24
Total	**50**	**45**	**20**	**81**
Males n=118				
First tertile (<23.88)	14	25	9	30
2nd tertile (23.88-28.40)	21	19	14	26
3rd tertile >28.40	22	17	14	25
Total	**57**	**61**	**37**	**81**
Grand Total	**113**	**106**	**57**	**162**

BMI - body mass index, n - number

of those with joint pain was 30.56 ± 6.6 while that of non-complainers was 27.91 ± 3.4. Body mass index tertiles of males, females and the number of cases of knee OA corresponding to each is illustrated in **Table 2**, which also shows the BMI tertiles of males, females and the corresponding number of cases of generalized OA.

Table 3 shows the allocation of patients to categories of ideal body weight (BMI <25 kg/m²), overweight (BMI 25 to less than 30 kg/m²), and obese (BMI ≥30 kg/m²) and their relationship to the

Table 3 - The relationship between weight categories and osteoarthritis (knee generalized and symptoms).

Patients	Normal (Ideal) Weight (BMI <25 kg/m^2) n (%)	Overweight (BMI 25 to <30 kg/m^2) n (%)	Obese (>30 kg/m^2) n (%)
All patients without knee OA n=106	43 (40.6)	33 (31.1) (P=0.39)	30 (28.3) (P=0.2725)
All patients with knee OA n=113	23 (20.4)	37 (32.7) (P=0.07)	53 (46.9) (P=0.0004*)
Females without knee OA n=45	13 (28.9)	17 (37.8) (P=0.46)	15 (33.3) (P=0.709)
Females with knee OA n=56	5 (8.9)	13 (23.2) (P=0.056*)	38 (67.8) (P=<0.00001*)
Males with knee OA n=57	18 (31.6)	24 (42.1) (P=0.35)	15 (26.3) (P=0.6002)
All patients with generalized OA n=57	16 (28.1)	20 (35.1) (P=0.507)	21 (36.8) (P=0.4157)
Females with generalized OA n=20	2 (10)	7 (35) (P=0.089)	11 (55) (P=0.0075*)
Males with generalized OA n=37	14 (37.9)	13 (35.1) (P=0.8431)	10 (27) (P=0.4118)
Joint pain (all patients) n=177	47 (26.6)	57 (32.2) (P=0.3313)	73 (41.2) (P=0.017*)
Joint pain (knee OA patients) n=102	20 (19.6)	31 (30.4) (P=0.1217)	51 (50) (P=0.0001*)
Joint pain (female) patients n=85	14 (16.5)	24 (28.2) (P=0.105)	47 (55.3) (P=<0.000001*)
Joint pain in males n 92	33 (35.9)	33 (35.9) (P= 0.999)	26 (28.3)

n - number, OA - osteoarthritis, BMI - body mass index, * P significant (<0.05) compared to patients with ideal weight

presence or absence of knee and generalized OA and joint pains. It shows that obesity was associated with knee OA in all patients (P=0.0004), knee OA in females (P=0.00001), generalized OA in females (P=0.0075), joint pain in all patients (P=0.017), joint pain in all knee OA patients (P=0.0001), and strongly with joint pain in females (P<0.000001).

Table 4 shows the crude and adjusted (OR) for males and females in the different BMI tertiles. From the table, the association between obesity and OA knee is seen to be strongest for females in the 3rd tertile of weight (OR 7.77, 95% CI 2.29- 27.57) (P=00013) which when adjusted for age, serum cholesterol, triglycerides, and uric acid came down to OR 3.28 (95% CI 2.07–5.36) P=0.00000021. The crude OR for the 2nd female BMI tertile and the 2nd and 3rd male BMI tertiles were above unity but did not reach the same significance level. The latter values however after adjustment for the other factor were significant implying confounding by these factors. However, even after adjustment for age, uric

acid, cholesterol and triglycerides, the association between OA knee and overweight was still stronger in females. As for the relationship between generalized OA and weight, the crude OR in both female and male subsets was not significant (95% CI including unity in its range and P values > 0.05). When adjusted for the other factors, an association between generalized OA and obesity was only seen in females in the 3rd BMI tertile (OR=1.93, CI 1.09-3.43, P=0.022). This association, however, remains much less than seen between OA knees and obesity.

Incremental rise in BMI was also associated with an increased risk for the development of knee OA [crude OR 1.089 (95% CI, 1.04-1.14)] and adjusted OR 1.19 (95% CI, 1.05-1.19).

Pattern of knee OA involvement in the heaviest BMI tertiles in males showed: Tricompartment OA involvement in 16 out of 24 (66.67%), patello femoral compartment alone in 3 out of 24 (12.5%), tibio femoral alone in 3 out of 24 (12.5%), and tibial osteophytosis alone in 2 out of 24 (8.3%), while the

Table 4 - Risk of knee osteoarthritis and generalized osteoarthritis in males and females in relation to body mass index tertiles presented as odd ratio (OR) and 95% confidence intervals.

Variable	Knee osteoarthritis		Generalized osteoarthritis	
	Odds ratio	P value	Odds ratio	P value
Female BMI tertiles (Crude OR)				
1	1.00 (Reference)	-	1.00 (Reference)	-
2	2.37 (0.78 - 7.31)	0.08	0.86 (0.2 - 3.73)	0.825
3	7.77 (2.29 -27.57)	0.00013	1.75 (0.48 - 6.59)	0.34
(Adjusted OR)**				
1	1.00 (Reference)	-	1.00 (Reference)	-
2	2.18 (1.39 - 3.47)*	0.00061	1.00 (0.54 - 1.84)	0.89
3	3.28 (2.07 - 5.36)*	0.00000021	1.93 (1.09 - 3.43)*	0.022
Males BMI tertiles (Crude OR)				
1	1.00 (Reference)	-	1.00 (Reference)	-
2	1.97 (0.73 - 5.39)	0.137	1.79 (0.6 - 5.43)	0.24
2	2.31 (0.85 - 6.38)	0.069	1.87 (0.62 - 5.67)	0.21
(Adjusted OR)**				
1	1.00 (References)	-	1.00 (Reference)	-
2	1.56 (1.02 - 2.39)*	0.038	1.55 (0.98 - 2.48)	0.065
3	1.88 (1.24 - 2.92)*	0.0029	1.58 (0.99 - 2.56)	0.055
* - significant, ** - Adjusted for age, sex, uric acid, serum cholesterol, serum triglycerides BMI - body mass index, OR - odds ratio				

pattern of knee OA in the heaviest females were: Tricompartment OA in 14 out of 24 (58.33%), tibio femoral alone in 3 out of 24 (12.5%), femoral tibial alone in 4 out of 24 (16.67%) and tibial alone in 3 out of 24 (17.5%).

Discussion. Osteoarthritis of the knees is very common in KSA.[2] Obesity, which is a known risk factor for the development of knee OA, is also prevalent.[8,14] Our study showed a strong association between radiographic knee OA and obesity in females (adjusted OR 3.28, 95% CI, 2.07-5.36). This is consistent with previous studies from the USA and Europe.[4-7] In males, the association between bodyweight and knee OA was also present although less marked (adjusted OR 1.88, 95% CI, 1.24-2.92). This difference in the risk for the development of OA knees in relation to body weight in males and females was noted previously.[4,6,15] This may be explained by the higher prevalence of obesity among women in general as borne by our results (**Table 1**). On the other hand, body weight was not found to be a risk factor in the development of generalized OA in males, and was only a weak risk factor for the development of generalized OA in the heaviest female tertile after adjustment for the other factors (adjusted OR 1.93, 95% CI, 1.09-3.43). This is in agreement with the finding of Hart and Spector.[7] Others found an association between body weight and hand osteoarthritis in males but not in females.[6] Studying 809 patients with knee or hip joint replacements for OA, Sturmer et al,[10] found an association between body weight and OA knees but none with either hip or generalized OA. However, a number of studies found an association between obesity and hands OA in females and not males.[7,16-18] Overweight was also associated with more symptoms of joint pain in the whole group (mean BMI of 29.19 ± 6.55) in those with pain compared to 26.65 ± 5.03 in those without joint pain. A similar trend of more joints symptoms with increased body weight was also observed among those with radiographically proven knee OA (mean BMI of 30.56 ± 6.6 in those with knee OA versus mean BMI of 27.91 ± 3.4 in those without). These were emphasized again by the results shown in **Table 3** using t-test, which illustrated the significant association between obesity (BMI ≥ 30 kg/m^{2}) and knee OA in the whole group, but particularly in females. It also showed the influence of obesity on symptoms of OA. This association between obesity and reporting of joint pain and the improvement in symptoms of OA upon weight reduction has been reported previously.[19-22] The pattern of involvement of knee OA in association with obesity which favor tricompartmental OA is consistent with previous reports.[23] This would support the mechanical role of obesity in initiating and propagating OA of the knee and the development of disabling knee OA.[22] Whether obesity plays a mechanical or a systemic role in the development of OA is still being debated.[7,9-12,24] However, most agree that combating obesity and reducing excess weight is to be advocated for the prevention and treatment of OA and should be attempted at a young age.

In conclusion, OA of the knee in general and generalized OA in females is seen to be associated with obesity in this sample of Saudi patients. One method of prevention and treatment of this very common disease in this community is in educating the publics regarding the important benefits of fighting obesity. Obesity in KSA is a recent phenomenon, rising to the surface with the new acquired affluence and sedentary life. This is more so in the case of women. However, knowing the morbidity associated with this, steps should be taken to educate the public about the consequences of obesity not least OA.

References

1. Cooper C. Osteoarthritis and related disorders. In: Klippel J, Dieppe P, editors. 2nd ed. Rheumatology. London (UK): Mosby; 1988. p. 8.2.1-8.
2. Al-Arfaj A, Al-Boukai A. Prevalence of radiographic knee osteoarthritis in Saudi Arabia. *Clin Rheumatol* 2002; 21: 121-123.
3. Lozanda C, Altman R. Management of osteoarthritis. In: Koopman W, editor. Arthritis and Allied Conditions. Baltimore (MD): Williams & Wilkins; 1997. p. 2013-2025.
4. Felson D, Anderson H, Naimark A, Walker A, Meenan R. Obesity and knee osteoarthritis. *Ann Int Med* 1988; 109: 18-24.
5. Davis M, Ettinger W, Neuhaus J. The role of metabolic factors and blood pressure in the association of obesity with osteoarthritis of the knee. *J Rheumatol* 1988; 15: 1827-1832.
6. Bagge E, Bjelle A, Eden S, Svanborg A. Factors associated with radiographic osteoarthritis: Results from the population study of 70-year old people in Götenborg. *J Rheumatol* 1991; 18: 1218-1222.
7. Hart D, Spector T. The relationship of obesity, fat distribution and osteoarthritis in women in the general population: The Chingford Study. *J Rheumatol* 1993; 20: 331-335.
8. El-Hazmi MA, Warsy AS. Prevalence of obesity in the Saudi population. *Annals of Saudi Medicine* 1997; 17: 302-306.
9. Hochberg MC, Lethbridge-Cejku M, Scot WW Jr, Reichle R, Plato CC, Tobin JD. The association of body weight, body fatness and body fat distribution with osteoarthritis of the knee: data from the Baltimore longitudinal study of aging. *J Rheumatol* 1995; 22: 488-493.
10. Sturmer T, Gunther KP, Brenner H. Obesity, overweight and patterns of osteoarthritis: The ulnar osteoarthritis study. *J Clin Epidemiol* 2000; 53: 307-313.
11. Hart D, Doyle D, Spector T. Association between metabolic factors and knee osteoarthritis in Women: The Chingford Study. *J Rheumatol* 1995; 22: 1118-1123.
12. Sandmark H, Hogstedt C, Lewold S, Vingard E. Osteoarthritis of the knee in men and women in association with overweight, smoking, and hormonal therapy. *Ann Rheum Dis* 1999; 8: 151-155.
13. Kellgren JK, Lawrence JS. Radiological assessment of osteoarthritis. *Ann Rheum Dis* 1957; 15: 494-501.
14. Al-Shammari SA, Khoja TA, Al-Maatouq MA, Al-Nuaim LA. High prevalence of clinical obesity among Saudi females: A prospective, cross-sectional study in the Riyadh region. *J Top Med Hyg* 1994; 97: 183-188.
15. Davis M, Ettinger W, Neuhaus J, Hauck W. Sex differences in osteoarthritis of the knee: The role of obesity. *Am J Epidemiol* 1988; 127: 1019-1030.
16. Acheson RM, Collart AB. New Haven survey of joint diseases: Relationship between some systemic characteristics and osteoarthritis in a general population. *Ann Rheum Dis* 1975; 34: 379.
17. Van Saase JLC, Vandenbrouke JP, Van Romunde LK, Valkenburg HA. Osteoarthritis and obesity in the general population: A relationship calling for an explanation. *J Rheumatol* 1988; 15: 1152-1158.
18. Hochberg MC, Lethbridge-Cejku M, Plato CC, Wigley FM, Tobin JD. Factors associated with osteoarthritis of hand in males: Data from the Baltimore Longitudinal Study of aging. *Am J Epidemiol* 1991; 134: 1121-1127.
19. Charles ST, Getz M, Pedersen NL, Dahlberg L. Genetic and behavioral risk factors for self-reported joint pain among a population-based sample of Swedish twins. *Health Psychol* 1999; 18: 644-654.
20. Al-Shammari S, Khoja T, Alballa S, Kremlin M. Obesity and clinical osteoarthritis of the knee in primary health care, Riyadh, Saudi Arabia. *Med Sci Res* 1995; 23: 255-256.
21. Felson DT, Zhang Y, Anthony JM, Naimark A, Anderson JJ. Weight loss reduces the risk for symptomatic knee osteoarthritis in women: The Framingham study. *Ann Intern Med* 1992; 116: 535-539.
22. Manninen P, Rishimaki H, Heliovaara M, Makela P. Overweight, gender and knee osteoarthritis. *Int J Obes Relat Metab Disord* 1996; 20: 595-597.
23. McAlindon T, Zhang Y, Hannan M, Naimark A, Weissman B, Castelli W, Felson D. Are risk factors for patellofemoral and tibiofemoral knee osteoarthritis different? *J Rheumatol* 1996; 23: 332-337.
24. Aspden RM, Scheven BA, Hutchinson JD. Osteoarthritis as a systemic disorder including stromal cell differentiation and lipid metabolism. *Lancet* 2001; 357: 118-20.