Prevalence of Symptomatic Knee, Hand, and Hip Osteoarthritis in Greece. The ESORDIG Study

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ABSTRACT. ***Objective.*** To assess the prevalence of symptomatic knee, hand, and hip osteoarthritis (OA) in the general adult population of Greece.

Methods. This cross-sectional population based study was conducted on the total adult population of 7 communities (8547 subjects) and on 2100 out of 5686 randomly selected subjects in an additional 2 communities. Sixteen rheumatologists visited the target population at their homes; an interview based on a standardized questionnaire was conducted and clinical evaluation and laboratory investigations were done, when necessary. ACR classification criteria were used for diagnosing symptomatic OA.

Results. Of the final target population of 10,647 subjects, 8740 (82.1%) participated in the study. The age and sex adjusted prevalence of symptomatic knee, hand, and hip OA was 6.0% (95% CI 5.6–6.4), 2% (1.8–2.2), and 0.9% (0.7–1.1), respectively. Symptomatic knee, hand, and hip OA prevalence was significantly higher among women than men and increased significantly with age. Symptomatic knee OA was significantly more common in the rural compared to urban and suburban populations. Logistic regression analysis showed a significant association of female sex and age ≥ 50 years with all sites of OA, of obesity with knee and hip OA, and of a low level of education with knee OA.

Conclusion. Symptomatic knee, hand, and hip OA is common in the general adult population of Greece, showing a female preponderance and a prevalence increasing with age. Female sex and age are risk factors for all sites of OA, obesity for knee and hip OA, and a low level of education for knee OA. (J Rheumatol 2006;33:2507–14)

Key Indexing Terms:
PREVALENCE OSTEOARTHRITIS KNEE HAND HIP EPIDEMIOLOGY

Osteoarthritis (OA) is a complex, slowly-evolving multifactorial disorder that affects many different joints, particularly those of knee, hand, hip, and spine; it represents the most common rheumatic joint disorder and one of the most common causes of disability in the general population[1-3]. The clinical features of OA include pain or aching and stiffness of the affected joints, while lower limb OA is associated with significant physical disability and a high level of utilization of healthcare services[4]. The radiographic findings of OA include joint space narrowing, bony sclerosis, and osteophytosis. Population based studies have shown a significant discordance between symptomatic OA (defined as pain or aching on most days plus radiographic findings of the symptomatic joint) and radiographically defined OA[5,6]. It has been found, for example, that only half of patients with radiographic knee OA reported knee pain[5].

The prevalence of radiographically defined knee, hand, and hip OA has been studied extensively[7-10], especially in subjects aged ≥ 65 years, since OA has been considered to be a disease of the elderly. While a few population based studies have examined the prevalence of symptomatic knee, hand, and hip OA in the elderly[1,11-16], very few studies of all age groups of general adult populations exist[17,18]. In Greece, epidemiological studies on the prevalence of OA, symptomatic or not, in the general population, do not exist. Therefore, this part of a cross-sectional, population based epidemiological study of rheumatic diseases in Greece (the ESORDIG study)[2] aimed at assessing the prevalence of symptomatic knee, hand, and hip OA in the urban, suburban, and rural, general adult populations of Greece.

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MATERIALS AND METHODS

Study population and subject evaluation. Details on the ESORDIG study design, study population, subject recruitment, and evaluation, as well as quality control, have been reported[2]. The ESORDIG study was conducted from March 1996 to April 1999 on the total adult population (aged ≥ 19 years) in 2 urban, one suburban, and 4 rural areas located in northern, central, and southern mainland Greece (8547 subjects), as well as on 2100 out of 5686 randomly selected adult subjects in one additional rural and one suburban community. In the latter areas, every second and third household from a randomly chosen starting point, respectively, was selected (systematic sampling; Figure 1); this was done for practical reasons since there were only 2 investigators available for the suburban and one for the rural area. In Greece, an area is considered urban if its population is more than 10,000 inhabitants, suburban if between 2000 and 10,000, and rural if less than 2000 inhabitants. The study was conducted by 16 rheumatologists who visited the target population at their homes. Each visit involved an interview with each participant and was based on a standardized questionnaire aimed at obtaining a variety of information on sociodemographic characteristics and medical history, as well as on a specific standardized questionnaire aimed at identifying all subjects with symptomatic OA. The latter questionnaire consisted of the following 3 questions: Have you ever had: (1) pain, aching or stiffness, not due to trauma, in any of your knees, hands or hips? (2) Pain or difficulty in walking or going up and down stairs? (3) Any problem in your knees, hands or hips? As shown in a pilot study of 40 patients with known symptomatic OA prior to the start of the ESORDIG study, the screening questionnaire was equally sensitive, at the 100% level, in detecting cases of symptomatic knee OA as well as symptomatic hip and hand OA. All subjects who responded positively to any of the above 3 questions of the specific questionnaire were subsequently evaluated (medical history, clinical examination, and assessment of available radiographs and laboratory tests) during the same home visit by the same rheumatologists who conducted the interview.

When previous radiographs were not available, an anteroposterior radiograph of both knees, with the knee joints fully extended and in a weight-bearing position, and a weight-bearing skyline view, or a supine anteroposterior pelvis radiograph were performed on subjects reporting knee or hip symptoms, respectively. These radiographs were performed within the next few days at the rheumatological centers at which the participating rheumatologists were working or collaborating. All radiographs were read by the rheumatologists conducting the study. However, in rare instances of questionable radiographic findings, the final radiographic assessment was done in cooperation with 3 of the participating rheumatologists. Diagnosis of symptomatic knee, hand, and hip OA was made on the basis of the American College of Rheumatology criteria[19-21].

Quality control. Prior to the start of the ESORDIG study, all participating rheumatologists attended a training course that covered the study protocol, how to conduct the interview, the assessment of musculoskeletal symptoms, and standardizing the use of the OA classification criteria, including the knee, hand or hip radiograph reading. The interexaminer and intraexaminer variations in diagnosing symptomatic OA, and the effect of nonselection and random selection of suburban and rural populations on the study results, were tested in a logistic regression model: the dependent variable was the diagnosis of symptomatic OA and the independent variables were the examiner for the whole period of the study, the examiner for each year of the study, and the selected/nonselected populations. As described[2], we telephoned a random sample of nonresponders (one out of 6 persons who refused to participate in the study) in the 2 urban areas (a total of 60 subjects) and a home visit was arranged. A short questionnaire covering sociodemographic characteristics, medical history, previous rheumatic disease diagnosis (including symptomatic OA), and the reasons for non-participation in the study was completed.

Protocol approval. The study was conducted according to the Declarations of Helsinki and informed consent was obtained from all participants. The protocol was approved by the appropriate committees of the Ministry of Health and the Central Union of Municipalities and Communities of Greece.

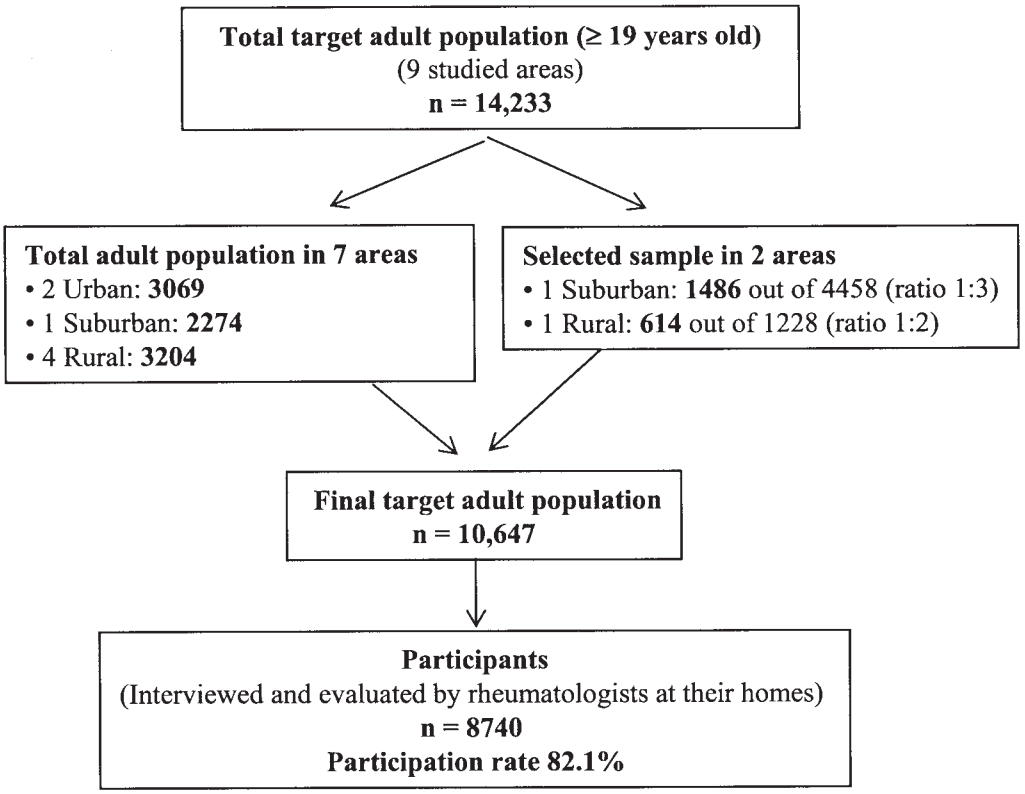

Figure 1. The study design.

Statistical analysis. All analyses were conducted using SPSS v.12.0 for Windows. The population that participated was weighted in terms of sex and age to the total adult population of the studied areas. This was done via the appropriate SPSS procedure using a poststratification weighted coefficient calculated on the basis of sex and age distribution in each area of both the total adult population and the participant study population. The chi-square test was used to compare prevalence and a probability value of $p < 0.05$ was considered significant; 95% confidence intervals (95% CI) were given where relevant. A variety of factors (Table 1) shown by the chi-square test to be associated with symptomatic OA in the study population were included in a multiple logistic regression model for further analysis and for controlling potential confounders. Socioeconomic status was defined as low or high, based on the level of education and the occupation of the family breadwinner.

RESULTS

Of the final target population of 10,647 subjects, 8740 (4269 men and 4471 women) participated in the study (participation rate 82.1%; Figure 1). Thirty-one percent of participants were residents in urban, 34% in suburban, and 35% in rural areas; the age range was 19–99 years, mean 46.95 years (SD ± 17.74). In the age groups 60–69 and ≥ 70 years, there were significantly more people in the rural compared to the urban and suburban areas ($p < 0.0005$ for all comparisons)). Thus, the mean age (± SD) of the rural population (49.64 ± 18.28 yrs) was significantly higher than that of urban (44.65 ± 17.03 yrs) or suburban dwellers (46.30 ± 17.45 yrs) ($p < 0.0005$ for both comparisons). However, the study population was representative of the general adult population of Greece — using Pearson correlation coefficients, we found significant similarities in the age distributions, for men and women separately, between the study participants and the total target population of the study ($r = 0.85$, $p < 0.0005$, and $r = 0.84$, $p < 0.0005$, respectively), between the study participants and the total adult population of Greece ($r = 0.85$, $p < 0.0005$ for both sexes), and between the total target adult population of the study and the total adult population of Greece ($r = 0.99$, $p < 0.0005$ for both sexes). Analogous similarities were found even when the data were analyzed separately for urban, suburban, and rural populations[2]. Logistic regression showed that there was neither significant interexaminer or intraexaminer variation in diagnosing symptomatic OA nor any effect of nonselection and random selection of suburban and rural populations on the results. Analysis of data from the random sample of nonresponders showed no significant differences from responders with respect to age, sex, and prevalence of symptomatic knee, hand and hip OA, or with respect to the prevalence of other rheumatic diseases, as reported[2].

Table 1. Sociodemographic factors that might be associated with the prevalence of OA.

Factors	Definitions
Sex	Male/female
Age	≥ 50 years
Residence	Urban, suburban, rural
Body mass index (BMI)	Obesity: BMI ≥ 30 kg/m^2 Non-obesity: BMI < 30 kg/m^2
Alcohol consumption (daily)	None Modest: up to 0.5 l of wine or 2 beers Moderate: > 0.5 to 1l of wine or 3–4 beers Heavy: > 1l of wine or > 4 beers
Level of education	Low: ≤ 12 years of school High: > 12 years (college or university)
Occupation	Manual: Unskilled blue-collar workers, such as farmers, fishermen, herdsmen, skilled manual workers Nonmanual: Skilled nonmanual workers, clerks, white-collar workers, small business owners, artists, university graduates (junior and senior public/private sector employees, freelance workers), business people
Having ever smoked cigarettes	Smoking cigarettes currently and/or in the past

		Occupation	Level of Education
Socioeconomic status	Low:	Unskilled blue-collar workers, such as farmers, fisherman, herdsmen, junior white-collar workers in the private and public sectors	≤ 12 years of school
	High:	Professionals in the private/public sector, managers, directors, freelance workers, senior white-collar workers	> 12 years (college or university)

Prevalence of symptomatic OA. Symptomatic knee, hand, and hip OA was diagnosed in 547, 171, and 80 subjects, respectively. Thus the prevalence of symptomatic knee, hand, and hip OA among the study participants (8740 subjects) was 6.3% (95% CI 5.8–6.8), 2% (95% CI 1.7–2.3), and 0.9% (95% CI 0.7–1.1), while in the total target adult population the age and sex adjusted prevalence of symptomatic knee, hand, and hip OA was 6.0% (95% CI 5.6–6.4), 2% (95% CI 1.8–2.2), and 0.9% (95% CI 0.7–1.1), respectively (Table 2). Symptomatic knee OA was significantly more common in the rural compared to the urban and suburban populations, and in the suburban compared to the urban populations (Table 2). However, there was no significant difference in the prevalence of symptomatic hand and hip OA among the 3 population subgroups. There was also no significant difference in the prevalence of symptomatic knee, hand, and hip OA among the northern, central, and southern areas of the country we studied, nor between the selected and nonselected populations.

Symptomatic knee, hand, and hip OA was significantly more common among women compared to men in the total target population, with a ratio of 2.7:1, 5.7:1, and 5:1, respectively, as well as in the 3 subpopulations (Table 2).

Symptomatic knee, hand, and hip OA was rare under the age of 45 years, while its prevalence in the total target population increased significantly with age up to and including the group aged 75–79 years ($p < 0.0005$ for all sites of OA); in the last age group (≥ 80 yrs) we found a decrease in the prevalence rate, which was not statistically significant (Table 3). More specifically, in subjects aged 50, 60, and ≥ 65 years, the

Table 2. Age and sex adjusted prevalence (%) of symptomatic knee, hand, and hip OA in the total target adult population.

	Urban			Suburban			Rural			Total		
	M	F	All	M	F	All	M	F	All	M	F	All
Knee OA	2.6	6.8‡	4.7*†	3.2	8.3‡	5.8*†	3.6	10.6‡	7.0*	3.2	8.7‡	6.0
Hand OA	0.5	2.8‡	1.7	0.8	3.4‡	2.1	0.3	3.8‡	2.0	0.6	3.4‡	2.0
Hip OA	0.3	1.4§	0.9	0.2	1.7‡	1.0	0.5	1.2§	0.8	0.3	1.5‡	0.9

* Significantly higher prevalence among rural than urban ($p < 0.0005$) and suburban populations ($p < 0.014$). † Significantly higher prevalence among suburban than urban populations ($p < 0.025$). ‡ Significantly higher prevalence among women than men ($p < 0.0005$). § Significantly higher prevalence among women than men ($p < 0.011$).

Table 3. Age and sex adjusted prevalence of symptomatic knee, hand, and hip OA in the total target adult population by age group.

		Knee OA, %			Hand OA, %			Hip OA, %		
Age, yrs	Subjects, n	M	F	All	M	F	All	M	F	All
19–44	6957	0.5	0.2	0.3		0.1	0.1	0.1	0.1	0.1
45–49	1294	1.2	2.4	1.8		2.0	1.0		1.1	0.5
50–54	1298	2.2	7.0	4.6	0.2	6.8	3.5	0.3	1.1	0.8
55–59	1158	3.4	14.8	9.0	0.2	7.0	3.5	0.5	3.2	1.8
60–64	1049	5.4	21.4	13.3	0.9	7.0	3.9	0.7	3.5	2.1
65–69	940	8.4	21.1	15.3	2.1	8.8	5.7	0.5	4.1	2.4
70–74	719	11.7	28.0	20.4	3.3	7.8	5.8	1.2	3.9	2.6
75–79	436	19.3	33.3	27.6	4.0	8.1	6.5	0.6	4.3	3.0
≥ 80	382	16.4	27.2	22.5	1.8	5.5	4.2	0.6	2.8	1.8
Total	14,233	3.2	8.6	6.0	0.5	3.4	2.0	0.3	1.5	0.9

prevalence of symptomatic knee, hand, and hip OA was 13.4%, 18.1% and 20.1%; 4.5%, 5.1% and 5.6%; and 1.9%, 2.4% and 2.5%, respectively. A pattern of increase of OA prevalence with age similar to that in the total target population was noted among both men and women (Table 3).

Risk factors associated with symptomatic OA. Multiple logistic regression analysis showed a significant positive association between female sex and age ≥ 50 years and symptomatic knee, hand, and hip OA; between obesity and symptomatic knee and hip OA; and between a low level of education and symptomatic knee OA (Table 4). Concerning the latter association, it is of interest that a significantly higher frequency of manual occupations was found among subjects with a low level of education (30.6%) than among subjects with a high level of education (3.3%) ($p < 0.0005$). A significant association was also found between a nonmanual occupation and symptomatic hand OA (Table 4), although no such association was found when the occupation was assessed individually by job title. Rural residence and socioeconomic status had no significant independent effects on the prevalence of OA. Finally, a significant negative association was found between modest alcohol consumption and symptomatic hand OA, and between having ever smoked cigarettes (mean consumption 25.3 pack-years, range 0.1–189) and symptomatic knee OA (Table 4). The negative association with knee OA remained when we used a cutoff standard of having ever smoked cigarettes of 2 pack-years (adjusted odds ratio 0.6, 95% CI 0.5–0.8, $p < 0.0005$), while it did not increase when the cutoff was 25 pack-years (OR 0.6, 95% CI 0.5–0.8, $p < 0.0005$). A separate analysis for current smokers and those having smoked cigarettes only in the past showed the same negative association with knee OA in the former group (OR 0.5, 95% CI 0.4–0.7, $p < 0.0005$), but no association in the latter (OR 1.0, 95% CI 0.8–1.3).

In addition, when analyzing separately for associations of age-specific OA prevalence with the factors shown in Table 1, we found certain differences in comparison with the associations of OA prevalence in the whole population. Thus, in the 40–49 age group the only association was that between obesity and knee OA (adjusted OR 5.7, 95% CI 3.1–10.7, $p < 0.0005$), while a stronger association of female sex with knee and hand OA was found in the 50–59 age group, and with hip OA in the 60–69 age group (Table 5). A stronger association of low level of education with knee OA was also found in the age groups 60–69 and ≥ 70 years. The negative associations of having ever smoked cigarettes with knee OA, and of modest alcohol consumption with hand OA, were found only in the age groups 60–69 and ≥ 70 years, and ≥ 70 years, respectively.

DISCUSSION

To our knowledge this study is the first to examine the prevalence of symptomatic knee, hand, and hip OA in the general adult population of Greece. We found that the age and sex adjusted prevalence of symptomatic knee, hand, and hip OA was 6.0%, 2.0%, and 0.9%, respectively; it was significantly higher among women than men, and increased significantly

Table 4. Estimated adjusted effects (OR with 95% CI) of sociodemographic factors on the prevalence of symptomatic knee, hand, and hip OA in the total target adult population.

	Knee OA		Hand OA		Hip OA	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Female sex	2.1 (1.8–2.6)	0.0005	4.7 (3.2–7.0)	0.0005	3.8 (2.2–6.6)	0.0005
Age ≥ 50 yrs	16.4 (12.4–21.8)	0.0005	25.1 (15.1–41.7)	0.0005	8.1 (4.6–14.1)	0.0005
Obesity	2.4 (2.0–2.8)	0.0005	1.3 (0.98–1.8)	0.07	2.3 (1.5–3.3)	0.0005
Low level of education	4.6 (2.9–7.4)	0.0005	1.2 (0.7–1.9)	0.54	1.5 (0.7–3.4)	0.34
Nonmanual occupation	1.1 (0.9–1.2)	0.60	2.3 (1.7–3.2)	0.0005	1.1 (0.8–1.7)	0.56
Modest alcohol consumption	1.1 (0.8–1.4)	0.55	0.5 (0.3–0.9)	0.014	0.8 (0.4–1.7)	0.58
Having ever smoked cigarettes	0.6 (0.5–0.8)	0.0005	1.0 (0.7–1.4)	0.98	0.9 (0.5–1.4)	0.57
Rural residence	1.0 (0.8–1.2)	0.87	1.1 (0.8–1.6)	0.69	0.7 (0.4–1.2)	0.15
Low socioeconomic status	0.8 (0.6–1.1)	0.19	0.7 (0.5–1.1)	0.15	1.4 (0.7–2.9)	0.38

Table 5. Estimated adjusted effects (OR with 95% CI) of risk factors on the age-specific prevalence of symptomatic knee, hand, and hip OA in the total target adult population.

	Age 50–59	p	Age 60–69	p	Age 70+	p
Knee OA						
Female sex	6.2 (3.6–10.7)	0.0005	2.4 (1.7–3.5)	0.005	1.7 (1.2–2.3)	0.003
Obesity	1.8 (1.2–2.7)	0.002	2.6 (2.0–3.5)	0.0005	2.3 (1.7–3.2)	0.0005
Low level of education	2.8 (1.1–7.0)	0.025	7.9 (2.6–24.4)	0.0005	4.6 (1.1–18.7)	0.035
Having ever smoked cigarettes	1.1 (0.7–1.6)	0.82	0.6 (0.5–0.9)	0.019	0.6 (0.4–0.9)	0.017
Hand OA						
Female sex	23.5 (5.9–92.9)	0.005	5.1 (2.7–9.9)	0.0005	2.2 (1.2–4.3)	0.016
Modest alcohol consumption	0.01 (0.0–775)	0.57	1.2 (0.6–2.3)	0.70	0.2 (0.04–0.7)	0.013
Nonmanual occupation	0.6 (0.3–1.1)	0.07	3.0 (1.6–5.3)	0.0005	2.0 (1.1–3.6)	0.021
Hip OA						
Female sex	2.7 (0.9–7.7)	0.06	10.1 (3.1–33.4)	0.0005	3.6 (1.2–10.8)	0.02
Obesity	1.1 (0.4–2.6)	0.87	2.8 (1.5–5.1)	0.001	3.0 (1.5–6.0)	0.002

with increasing age. In addition to female sex and age, obesity was associated with symptomatic knee and hip OA, and a low level of education with symptomatic knee OA.

Since OA has been considered a disease of the elderly, there is a paucity of studies in the literature assessing the prevalence of symptomatic OA in general adult populations including all age groups. The knees were the most common joints affected by symptomatic OA in our study, with a prevalence close to that estimated in the USA on the basis of data from the Framingham Study[22], but lower than in a study from Spain[17] and higher than in a study from Taiwan[18] (Table 6). Other studies have assessed the prevalence of symptomatic knee OA in various age groups of general adult populations using clinical and radiographic criteria[12,23,24] or only clinical criteria[16] (Table 6). The age-specific prevalence of symptomatic knee OA reported in northern England[23] and in Antalya, Turkey[24], is very close to that in our study. However, other studies have reported either a higher[16] or a lower age-specific prevalence of symptomatic knee OA[12] than that in our study (Table 6). Our estimate of the age-specific prevalence of symptomatic hand OA is comparable with that found in northern England[23] and in Beijing, China[15]. However, in a study from Spain[17], the prevalence of symptomatic hand OA in a general population sample was found to be substantially higher than that in our study, as was also the case for the age-specific prevalence of symptomatic hand OA in Framingham, USA[15], and in Dicomano, Italy[16] (Table 6). The prevalence of symptomatic hip OA in our study was much higher than that estimated in urban, suburban, and rural general adult populations in Taiwan[18]. Other studies have assessed the prevalence of symptomatic hip OA in various age groups; some reported a higher[16] and others a lower age-specific prevalence of symptomatic hip OA[1,14,25] than in our study (Table 6).

The broad variation in the prevalence of symptomatic knee, hand, and hip OA among different racial groups might be explained, in part, by methodological differences related mainly to screening questionnaires and to case definition criteria among the different studies. For instance, in the USA, Lawrence, *et al*[1], using data from the National Health and Nutrition Examination Survey I, estimated the prevalence of symptomatic hip OA to be 0.7% in adults aged 55–74; however, this is likely to be an underestimate, as stated by the authors, since the questionnaire did not include all the possible clinical manifestations of hip OA. Using clinical criteria without radiographic documentation, a study in Dicomano, Italy[16], on persons aged ≥ 65 years found the prevalence of

Table 6. Prevalence of symptomatic knee, hand, and hip OA in European, Asian, and American populations.

Age, yrs	Other Studies Reference	Country	Case Definition Criteria	Prevalence, %	Present Study Prevalence, %
Knee OA					
30+	22	USA	C & R	6.1	7.6
20+	18	Taiwan	C & R	1.9	6.2
20+	17	Spain	ACR	10.2	6.2
35+	23	England	C & R	9.4	8.6
50+	24	Turkey	C & R	14.8	13.4
60+	12	China	C & R	11.2	18.1
65+	16	Italy	Clinical	29.8	20.1
Hand OA					
20+	17	Spain	ACR	6.2	2.1
25–74	23	England	C & R	2.4	2.1
60+	15	China	C & R	4.7	5.1
		USA	C & R	20.5	5.1
65+	16	Italy	Clinical	14.9	5.6
Hip OA					
20+	18	Taiwan	C & R	0.06	1.0
55–74	1	USA	C & R	0.7	2.2
60+	14	China	C & R	1:1506	2.4
65+	16	Italy	C & R	7.7	2.5
65+ (women)	14, 25	USA	C & R	2.2	3.9

ACR: American College of Rheumatology; C & R: clinical and radiographic.

symptomatic knee, hand, and hip OA to be substantially higher than that in our study, which used both clinical and radiographic criteria for case definition. Other possible explanations for the variation in the prevalence of symptomatic knee, hand, and hip OA among different populations include differences in genetic factors, physical activities, lifestyle factors, and the prevalence of obesity. Given the high heritability of hand[26] and hip OA[27], it is possible that differences in the prevalence of disease susceptibility genes among various populations may account, at least in part, for the variation in the prevalence of symptomatic hand and hip OA. Differences in physical activities and in the prevalence of joint injury among various populations may also partly explain the differences in the prevalence of symptomatic knee and hip OA, since it has been shown that heavy physical activity is an important risk factor for the development of knee OA[28], and joint injury for both knee and hip OA[29,30]. Concerning lifestyle factors, it has been reported recently that prolonged squatting is a strong risk factor for radiographic knee OA among elderly Chinese in Beijing; this accounts, in part, for the higher prevalence of knee OA among the elderly in Beijing than in Framingham[12,31]. Obesity is a known risk factor for the development of both knee and hip OA[30,32]; therefore, differences in the prevalence of symptomatic knee and hip OA might be attributed, in part, to differences in the prevalence of obesity.

The significantly higher prevalence of symptomatic knee OA in the rural versus urban and suburban areas in this study could be explained, at least in part, by the fact that in the age groups 60–69 and ≥ 70 years there were significantly more people in the rural compared to the urban and suburban areas. Thus, given that knee OA prevalence increases with age[17,22], more people with knee OA would be expected and actually were found in the rural compared to the urban and suburban areas, resulting in a higher prevalence rate in the rural areas. Moreover, the higher prevalence of symptomatic knee OA in the rural areas may also be related to demanding physical activities, given the high frequency of farming or other hard manual occupational activities that result in repetitive laborious use of the knee joints, although we found no association between symptomatic knee OA and occupation, assessed either as manual or nonmanual or individually by job title.

Female sex and age ≥ 50 years are well established risk factors for OA[17,22]; our study also showed that both female sex and age ≥ 50 were strong independent predictors for symptomatic knee, hand, and hip OA. The underlying mechanism for this remains unclear, but it could be related to hormonal changes in postmenopausal women and to biologic changes that may occur in, for example, chondrocytes, joint ligaments, and shock absorbers or protectors, with aging in both sexes[22]. In accord with previous studies[30,32], obesity was found to be a risk factor for symptomatic knee and hip OA. The exact mechanism is unknown, but it may be related to an increased amount of forces on weight-bearing joints that could induce cartilage breakdown, and/or to the action of metabolic factors. Excess adipose tissue, for instance, may produce abnormal levels of certain hormones or growth factors that may affect cartilage or underlying bone in a way predisposing to development of OA[22]. Such factors, however, have not been identified.

Concerning our finding of a significant positive association

between a low level of education and knee OA, the underlying mechanisms are unknown, but they may be related to unawareness of preventive measures for knee OA among people with a low level of education, or to the higher frequency of physically demanding jobs among subjects with less education compared to those with higher education, as found in our study.

No association between rural residence and symptomatic knee OA was found in the multiple logistic regression analysis, although the univariate analysis showed that symptomatic knee OA was significantly more common in the rural than the urban and suburban populations. Thus, it appears that older age represents a confounding factor for the latter finding, since, first, as stated above, age ≥ 50 years was a strong independent risk factor for symptomatic knee OA, and second, the rural population was significantly older than the urban or suburban populations.

On the other hand, we found a significant negative association between smoking and knee OA. The association between smoking and OA remains controversial. There are reports of a lower prevalence of knee or hip OA in cigarette smokers[30,33], although other studies have not confirmed an inverse association between smoking and OA[34,35]. However, in a recent study, nicotine was reported to upregulate glycosaminoglycan and collagen synthesis by articular chondrocytes[36], thus offering a possible explanation of the protective effect of smoking.

Concerning hand OA, a significant positive correlation between a nonmanual occupation and this disorder was found in our study. This finding is analogous to that of a recent study[37] showing that moderate hand use may be protective against OA; this can be attributed at least in part to the strengthening of muscles and ligaments, which protects against wear and tear injuries.

We observed that modest alcohol consumption was negatively associated with hand OA. The reason for this association is unknown and merits further study.

The strengths and some potential limitations of this study must be noted. Population based studies entail a risk of selection bias. For instance, a low response rate in a population based study to assess symptomatic OA prevalence may result in underestimation or overestimation of symptomatic OA prevalence: patients with known symptomatic knee, hand, or hip OA might have been unwilling to participate in the study, or there may have been an increased probability of subjects with knee-hand-hip symptoms participating. However, the participation rate in our study was high (82.1%) and therefore a selection bias is only a remote possibility. Moreover, analysis of the data of a random sample of nonresponders showed no significant difference from responders with respect to the prevalence of symptomatic OA. Logistic regression also revealed that the nonselection and random selection of suburban and rural populations had no effect on the prevalence of symptomatic OA.

This cross-sectional study was based on one-to-one interviews with the participants by rheumatologists, and on clinical evaluation and laboratory investigation of the positive responders to the specific questionnaire for revealing OA, by the same rheumatologists. Greece has ethnic homogeneity and the regions studied, in northern, central, and southern mainland Greece, comprise an adult population that is representative of the total Greek adult population in terms of age and sex distribution. Thus, the prevalence of symptomatic knee, hand, and hip OA we found could reasonably be considered to be representative of the prevalence of these diseases in the general adult population of Greece.

Our findings show that symptomatic knee, hand, and hip OA is common in the general population of Greece; it is characterized by a female preponderance, and its prevalence increases with age. Female sex, age, and obesity are risk factors for symptomatic knee and hip OA; a low level of education for symptomatic knee OA; and female sex, age, and a nonmanual occupation for symptomatic hand OA.

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