Global burden of osteoarthritis in the year 2000

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1. Introduction

Osteoarthritis (OA) is a complex disease entity that is difficult to diagnose and define. The Subcommittee on Osteoarthritis of the American College of Rheumatology Diagnostic and Therapeutic Criteria Committee defined osteoarthritis (OA) as "A heterogeneous group of conditions that lead to joint symptoms and signs which are associated with defective integrity of articular cartilage, in addition to related changes in the underlying bone at the joint margins" (1). Clinically, the condition is characterized by joint pain, tenderness, limitation of movement, crepitus, occasional effusion, and variable degrees of local inflammation.

The concept that binds the different conditions labelled 'OA' together is a pathological one. The pathological definition is of a condition characterised by focal areas of loss of articular cartilage within synovial joints, associated with hypertrophy of bone (osteophytes and subchondral bone sclerosis) and thickening of the capsule. In this sense it is the reaction of synovial joints to injury. Histologically, the disease is characterized early by fragmentation of the cartilage surface, cloning of chondrocytes, vertical clefts in the cartilage, variable crystal deposition, remodeling, and eventual violation of the tidemark by blood vessels (2). This phenomenon can occur in any joint, but is most common in selected joints of the hand, spine, knee, foot and hip.

This pathological change, when severe, results in radiological changes (loss of joint space and osteophytes) which have been used in epidemiological studies to estimate prevalence of OA at different joint sites. A Kellgren & Lawrence radiological OA score of 2-4 is still the most widely used definition of radiological OA in epidemiological studies (section 2) (5).

Osteoarthritis is more common in women than men but the prevalence increases dramatically with age. 45% of women over the age of 65 have symptoms while radiological evidence is found in 70% of those over 65(3). Osteoarthritis of the knee is a major cause of mobility impairment, particularly among females. OA was estimated to be the 10th leading cause of non-fatal burden in the world in 1990, accounting for 2.8% of total YLD, around the same percentage as schizophrenia and congenital anomalies (4). In the Version 2 estimates for the Global Burden of Disease 2000 study, published in the World Health Report 2002(5), OA is the 4th leading cause of YLDs at global level,

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accounting for 3.0% of total global YLDs. This draft paper summarises the data and methods used to produce the Version 2 estimates of OA burden for the year 2000.

2. Case and sequelae definitions

The most widely using classification schemes for OA are based on the radiological appearance of the joint. The radiological hallmarks of OA are osteophyte formation, joint space narrowing, sclerosis and cyst formation. Severity may be graded based on the 0-4 scale developed by Kellgren and Lawrence (6). The scoring system is based on comparing films with those in a standard atlas of radiographs. Tables 1 and 2 below describe the categories for osteoarthritis of the knee and hip. Based solely on radiographic findings, osteoarthritis can be classified as: 0-absent 1-doubtful, 2-minimal, 3-moderate, and 4-severe. Studies commonly use either grades 2-4 or grades 3-4 for establishing OA, resulting in greatly differing prevalence estimates. Including grade 2 results in estimates 4-17 times higher for OA of the knee and 2-8 times higher for the hip (7).

Table 2.1 Radiographic grades of severity for osteoarthritis of the knee (atlas of standard radiographs, 1963)

Grade	Verbal description
Grade 1	Doubtful narrowing of joint space and possible osteophytic lipping.
Grade 2	Definite osteophytes and possible narrowing of joint space.
Grade 3	Moderate multiple osteophytes, definit narrowing of joint space, and some sclerosis and possible deformity of bone ends.
Grade 4	Large osteophytes, marked narrowing of joint space, severe sclerosis, and definite deformity of bone ends.

Table 2.2 Radiographic grades of severity for osteoarthritis of the hip (atlas of standard radiographs, 1963)

Grade	Verbal description
Grade 1	Doubtful narrowing of joint space medially and possible osteophytes around femoral head.
Grade 2	Definite narrowing of joint space inferiorly, definite osteophyes, and slight sclerosis.
Grade 3	Marked narrowing of joint pace, slight osteophytes, some sclerosis and cyst formation, and deformity of femoral head and acetabulum.
Grade 4	Gross loss of joint space with sclerosis and cysts, marked deformity of femoral head and acetabulum, and large osteophytes.

Some (but not the majority) of people with these pathological (radiographic) changes have joint symptoms (pain, stiffness and loss of function) that are likely to be related to the presence of the joint pathology. These symptoms are not specific, and there is no clinical definition of OA at any joint site that has been properly validated. The symptom severity depends on joint damage, but also varies across individuals and joint. There are clinical criteria for the classification of OA of hand, hip and knee (1;8;9). Pain is an obligatory symptom in these OA classifications.

The Global Burden of Disease 1990 study found high correlation between hand and hip OA and assumed that cases with hip or knee OA would cover most OA (10). We maintain this assumption

for the GBD 2000 estimates. Hence only hip and knee OA were used for analysis of the analysis of OA disease burden.

As radiological changes are not always accompanied by symptoms such as pain, stiffness, and loss of function, their sole use as classification criteria can lead to overestimates of the burden of disease. One study of women aged 45-65 in the UK showed that the prevalence knee OA was 2.3% based on symptoms compared to 17% based on radiological criteria (11). The preferred definition for OA includes x-ray findings accompanied by symptoms such as joint pain on most days. In 1981 the Subcommittee on Osteoarthritis of the American College of Rheumatology's Diagnostic and Therapeutic Criteria Committee was formed to establish clinical criteria for the classification of OA. Algorithms for the knee and hip are summarized in Tables 2.3 and 2.4.

Table 2.3 ACR classification of OA of the knee*

Clinical	
1	Knee pain for most days of prior monty
2	Crepitus on active joint motion
3	Morning stiffness # 30 min in duration
4	Age∃38 years
5	Bony enlargement of the knee on examination
	OA present if items 1, 2, 3, 4, or 1, 2, 5 or 1, 4, 5 are present
Clinical and radiological	
1	Knee pain for most days of prior month
2	Osteophytes at joint margins (X-ray)
3	Synovial fluid typical of osteoarthritis (laboratory)
4	Age ∃ 40 years
5	Morning stiffness # 30 min
6	Crepitus on active joint motion
	OA present if items 1, 2 or 1, 3, 5, 6 or 1, 4, 5, 6 are present

*Modified from Altman (1986) (1), Altman (1991)

Table 2.4 ACR classification of OA of the hip*

Clinical and radiological	
1	Hip pain for most days of the prior month
2	Erythrocyte sedimentation rate # 20 mm/h (laboratory)
3	Radiographic fermoral and/or acetabular osteophytes
4	Radiographic hip joint space narrowing
	OA present if items 1, 2, 3, or 1, 2, 4 or 1, 3, 4 are present

*Modified from references (1) and (7)

Many national health surveys include questions asking for self-reported chronic conditions including osteoarthritis. For example, the 1995 Australian National Health Survey found that reported

prevalence of osteoarthritis plus arthritis (not further specified as osteoarthritis or rheumatoid arthritis), but excluding rheumatoid arthritis, and rheumatism was 10% for males and 15% for females (all ages. For those aged 65-74 years, reported prevalences were 33% for males and 49% for females, rising slightly to 37% for males and 51% for females for those aged 75 years and over (12). March et al (13) reported that 10% of men and 19.5% of women aged 45-64 in North Sydney were diagnosed with OA. These are considerably lower than the self-report prevalences in the National Health Survey. Surveys using radiographic plus symptomatic criteria in other developed countries also find prevalences at older ages considerably lower than self-reported prevalences. It is very likely that a wide range of musculoskeletal conditions are being self-reported as osteoarthritis in such surveys, and as a result, we have chosen to base the case definitions for the GBD 2000 on the radiological plus symptomatic criteria as shown in Table 2.5.

Table 2.5 GBD 2000 case and sequelae definitions for osteoarthritis

Cause category	GBD 2000 Code	ICD 9 codes	ICD 10 codes
Osteoarthritis	U127	715	M15-M19

Sequela	Definition	Definition
Osteoarthritis of the hip	Symptomatic osteoarthritis of the hip, radiologically confirmed as Kellgren-Lawrence grade 2 or greater.	Radiological grade 2-4 (Kellgren-Lawrence) Radiological grade 3-4 (Kellgren-Lawrence) ACR clinical criteria (8;9)
Osteoarthritis of the knee	Symptomatic osteoarthritis of the knee, radiologically confirmed as Kellgren-Lawrence grade 2 or greater.	Radiological grade 2-4 (Kellgren-Lawrence) Radiological grade 3-4 (Kellgren-Lawrence) ACR clinical criteria (8;9)

3. Population prevalence and incidence studies

As OA is not reversible, the prevalence of OA increases indefinitely with age. Males are affected more often than females below age 45, while females are affected more frequently after age 55 (14). An exception is OA of the hip where, in the 45-64 year age group males are affected more often than women. There are some ethnic and geographical differences in prevalence. African American females are more prone than Caucasian females to OA of the knee (15) but not for the hip (16). OA of the hip occurs more often in European Caucasians than in Jamaican blacks (17), African or South African blacks (18;19), Chinese (20) or Asian Indians (Jukhopadhaya and Barooah 1967).

3.1 Prevalence

The prevalence of osteoarthritis using radiographic criteria has been studied world-wide (6;19;21-32). These data have been reviewed and summarized by others, most notably Kelsey (33), Lawrence (34),Van Sasse *et al*. (32) and Silman and Hochberg. (14).

Available data on OA prevalence derive particularly from studies performed in the USA and Europe, with minimal information on other parts of the world. These studies have been recently reviewed (14). We estimate that approximately 10% of the world's population who are 60 years or older have symptomatic problems that can be attributed to OA. The prevalence in developing countries is variable; some studies show lower prevalence rates while others show similar levels to those in developed countries (Table 3.1).

The two largest surveys are those from the US National Health Surveys and the Zoetermeer Community Survey in the Netherlands (7;32). The latter survey was more extensive and included 22 joints and joint groups whereas the US survey was more limited.

Table 3.1 Prevalence studies for knee osteoarthritis

Region	Study population	Ref.	Years	Sample size	Diagnostic criteria	Prev. (45+) per 100,000
AFRO	Rural Tswana population of Phokeng, South Africa.	(18)		300	Clinical assessment. Grading based on Kellgren & Lawrence criteria	M 20238 (35+) F 30208 (35+)
AMRO	Probability samples of the US civilian, non-institutionalised population.	(35)	1971-1975		Radiographs graded according to Kellgren & Lawrence criteria; grades 2-4	M 9904 (45-74) F 8880 (45-74)
	Framingham Heart Study, population-based cohort.	(36)	Sept 1983-Sept 1985	1805 (1424 X-rays)	Radiographs graded according to Kellgren & Lawrence criteria; grades 2-4	
	Probability samples of US civilian, non-institutionalised population.	(37)	1971-75	6913	Radiographs graded according to Kellgren & Lawrence criteria; grades 3-4	M 3800 (35-74) F 7600 (35-74)
	Lawrence Tavern, Jamaica. Clinical exam and X-rays.	(17)		600	Radiographs graded according to Kellgren & Lawrence criteria; grades 2-4	M 20000 (35-64) F 28500 (35-64)
EURO	Spanish population, continental and islanders. Cluster sampling from census of 20 municipalities.	(38)	1998-1999	2998	Clinical and ACR criteria	M 5720 F 14007 (20+)
	Zoetermeer, Holland. Questionnaires, clinical examination, radiographs.	(39)	April 1975-April 1978	6584	Radiological degenerative changes.	M 14100 F 22800
	Sofia, Bulgaria.	(26)		4318	Radiographic	M 8791 F 10244
SEARO	Karachi, Pakistan. Survey of consecutive houses in poor and relatively affluent communities.	(40)		4232 interviewed; 245 examined	Clinical assessment	M 2369 F 6211
	Bhigwan villagers, India	(41)		4304	ACR criteria	
WPRO	Inhabitants of Matsudai Town, Japan.	(42)	1979 and 1986	979	Radiographic, joint space narrowing	M 12000 (47-72) F 26100 (47-72)
	Hospitalised Hong Kong Chinese at Queen Elizabeth Hospital. Selected from those	(20)	Sept 1967	500	Classification according to Kellgren & Lawrence criteria; grades 3-4	M 5000 (55+) F 13000

admitted, as well as from outpatient department.	(55+)

Table 3.2. Prevalence studies for hip osteoarthritis

Region	Study population	Ref.	Years	Sample size	Diagnostic criteria	Prev. (45+) per 100,000
AFRO	Rural Tswana population of Phokeng, South Africa. Clinical assessment.	(18)		300	Clinical assessment. Grading based on Kellgren & Lawrence criteria	M 3278 (55+) F 725 (55+)
	Rural Tswana population of Phokeng, South Africa.	(19)	1975	307	Radiographs graded according to Kellgren & Lawrence criteria; grades 2-4	M 3279 (55+) F 2899 (55+)
AMRO	Probability samples of US civilian, non-institutionalised population.	(37)	1971-75		Radiographs graded according to Kellgren & Lawrence criteria; grades 2-4	
	Lawrence Tavern, Jamaica. Clinical exam and X-rays.	(17)		600	Radiographs graded according to Kellgren & Lawrence criteria; grades 2-4	M 2500 (35-64) F 5000 (35-64)
EURO	Random population sample in Jerusalem previously enrolled in osteoporosis study.	(43)		641	Radiographs graded according to Kellgren & Lawrence criteria; grades 3-4	M 3904 (45-84) F 4221 (45-84)
	Malmö, southern Sweden. All adult patients with radiographs of colon taken between 1987-95.	(44)	1987-1995	4121	Radiographic Danielsson – joint space less than 4mm if aged <70, less than 3mm if aged = 70	M 1945 F 2305
	Iceland. All colon radiographs at 3 radiographic departments examined.	(45)	1990-1996	1517	Measurement of joint space	M 12700 F 11783
	Sofia, Bulgaria.	(26)		4318	Radiographic	M 1319 F 1057

3.2 Incidence

Few studies have examined the incidence of osteoarthritis. Two longitudinal studies of hand osteoarthritis (46;47) found that incidence of osteoarthritis increased with duration of follow-up and with advancing age. In addition, existing osteoarthritis progressed with longer follow-up and the rate of progression increased at older ages.

Oliveria et al (48) reported findings from a large-scale study (N=130,000) in Massachusetts, in which subjects were members of a health maintenance organisation. Incidence of radiographic OA (Grade 2 and above) by affected joint, age and sex are listed in Table 3.3.

Table 3.3. Incidence of hand, hip and knee osteoarthritis

	Cases						Person-	Incidence	Incidence per 100,000
	Hand	Thumb	Finger	Hip	Knee	Total	years	(All)	(Hip and knee*)
Women									
20-29	0	0	0	0	0	0	21886	0	0
30-39	0	0	0	1	5	6	24950	24	24
40-49	11	8	2	0	22	43	18808	229	117
50-59	21	8	15	6	30	80	10901	734	330
60-69	40	23	30	27	74	194	11339	1711	891
70-79	53	30	39	58	106	286	10021	2854	1637
80-89	10	5	8	14	33	70	3219	2175	1460
All						679	101124	671	0
Men									
20-29	0	0	0	0	1	1	20669	5	5
30-39	2	0	2	2	10	16	25461	63	47
40-49	2	0	1	4	23	30	19045	158	142
50-59	3	1	3	3	27	37	10916	339	275
60-69	21	9	16	16	49	111	10158	1093	640
70-79	26	12	17	36	67	158	8152	1938	1263
80-89	6	2	5	6	14	33	2287	1443	875
All						386	96688	399	0

*There is not much overlap between hip and knee cases.

3.3 Time trends in osteoarthritis

Future changes in the incidence and prevalence of OA are difficult to predict. As incidence and prevalence rise with increasing age, extending life expectancy will result in greater numbers with OA. The burden will be the greatest in developing countries where improvements in life expectancy are expected but access to arthroplasty and joint replacement is not readily available.

Due to the paucity of data on time trends in incidence rates for osteoarthritis arthritis, these rates have been assumed to be stable over time. Prevalence studies over the last 30 years were used to assess regional prevalence rates. Where necessary, incidence rates have been modelled from older prevalence studies assuming zero remission rates. These incidence rates have then been used with estimated remission rates for 2000 to re-estimate prevalence rates for 2000 to take into account the effects of joint surgery on prevalence rates (see Section 5.2).

3.4 Risk factors for the development of OA

Risk factors for OA include age, a positive family history, occupation, diabetes mellitus, and hysterectomy. There is a negative association with osteoporosis and smoking (49). OA knee is the most common form worldwide and is more common in females. The predominant risk factors are age, obesity, previous trauma (particularly in men), and activities requiring repeated knee bends.

One study showed obesity to result in an odds ratio of about 8.0 for developing OA knee (50). Occupational groups showing increased risk for OA include miners (51), dock workers (52), jobs involving high knee-bending demands (15), and farmers (53). The latter study showed farming to present the greatest relative risk for OA of the hip: 4.5 for farming 1-9 years and 9.3 for farming ten years or more. OA of the hip and knee are the most important from the viewpoint of public health, based on their prevalence and associated disability.

4. Health state descriptions and disability weights

The course of the disease varies but often is progressive, leading to increased pain and disability changes ((54-56). Progression of OA of the knee is accelerated by obesity (57). OA continues to get slowly worse with time, as measured by radiographic criteria. Two groups have analysed data from the National Health and Nutrition Examination Survey - I Epidemiologic Follow Up Survey to determine the occurrence of physical disability in long-term survivors with knee osteoarthritis (58-60). Subjects with knee osteoarthritis defined by radiography at baseline were significantly more likely to have difficulty walking from one room to another or up or down two steps and arising from an armless straight chair or getting in and out of bed. Futhermore, those individuals with symptomatic knee pain at baseline were significantly more likely to report difficulty with these activities at follow-up than those with radiographic changes alone.

Radiographic changes of osteoarthritis appear to inexorably progress, albeit at a slow rate, in the hands (46;61), the knees (54;55), and the hips (62), although isolated reports of improvement in the radiographic features of hip osteoarthritis have been noted (63). In the hand, radiographic changes progress at a greater rate with increasing age (61); the rate of progression does not appear to be associated with body mass index, bone mineral density, body fat distribution, grip strength or forearm circumference (64). In the knee, however, obesity does predict progression of joint space narrowing (57). Further considerations of factors which may influence prognosis in ostearthritis have recently been reviewed by Brandt and Flusser (65). Health state descriptions for OA stages are given in Table 4.1.

Table 4.1 Health state descriptions for osteoarthritis

Sequela/stage/severity level	Health state description
Osteoarthritis of the hip Grade 2 symptomatic	Definite osteophytes and possible narrowing of joint spaces. Hip pain on most days. Availability of treatment (pain medication, anti-inflammatories) may result in reduced pain and disability.
Osteoarthritis of the hip Grade 3-4 symptomatic	Marked narrowing of joint spaces, definite osteophytes and deformity of femoral head. Hip pain on most days. Availability of treatment (pain medication, anti-inflammatories) may result in reduced pain and disability. Joint replacement likely in developed countries for Grade 4+ with significant disability (model this as reduction in prevalence of Grade 3-4 rather than reduced disability weight).
Osteoarthritis of the knee Grade 2 symptomatic	Possible narrowing of joint spaces and definite osteophytes. Knee pain on most days, tenderness, morning stiffness and crepitus on active joint motion. Availability of treatment (pain medication, anti-inflammatories) may result in reduced pain and disability. Around 8% of symptomatic cases with grade 2+ OA need assistance with stair climbing (compared to 2% of non-cases in Framingham study), 30% not able to walk a mile (compared to 14% non-cases), 11% needed assistance with housekeeping (cf. 6%).

Osteoarthritis of the knee Grade 3-4 symptomatic	Definite or marked narrowing of joint spaces, multiple moderate to large osteophytes, and possible to definite deformity of bone ends. Knee pain on most days, tenderness, morning stiffness and crepitus on active joint motion. Availability of treatment (pain medication, anti-inflammatories) may result in reduced pain and disability. Joint replacement may occur in developed countries for Grade 4+ with significant disability (model as reduction in prevalence).

Guccione, Felson and Anderson (66) measured functional status according to radiological grade of OA in the Framingham Ostearthritis study. Subjects with knee OA were graded using Kellgren and Lawrence radiological grades 2 and 3-4 for osteoarthritis in the more severely affected knee. Symptoms were defined as pain in or around the knee lasting at least a month within the previous year. Among 589 men and 827 women (N=1416), there were 214 subjects with asymptomatic grade 2 osteoarthritis, 151 with asymptomatic grade 3+ osteoarthritis, 103 with knee pain and at least grade 2 osteoarthritis, and 57 with knee symptoms but no radiographic evidence of disease. Apart from those with knee pain, asymptomatic subjects with radiographic OA also had significant disability (in terms of self care and usual activities), and the authors suggested they are probably people who limit their activities to avoid pain. Those with pain but no radiographic RA probably have other knee disorders.

Taking the above figures, and assuming that of the 103 people with knee pain the proportions with grade 2 and 3+ OA is proportional to those asymptomatic but with a twice as high chance of symptoms in grade 3+, we obtain the symptomatic proportions shown in Table 4.2. The proportion of total radiographic grade 2+ OA that are grade 3+ are derived from the Framingham study (Felson 1990).

Table 4.2 Proportion symptomatic by radiographic grade for osteoarthritis

	No pain	Pain	all	%	% symptomatic
Grade 2	214	43	257	55%	17%
Grade 3+	151	60	211	45%	29%
Total	365	103	468	100%	

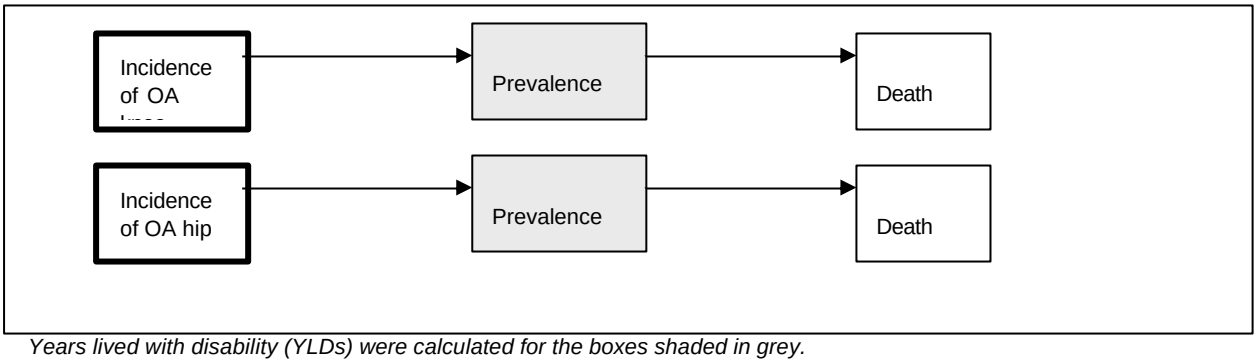
The GBD 1990 study estimated disability weights for treated and untreated OA as shown in Table 4.3. The proportion of cases treated was assumed to range from 80% in developed regions, to around 50% in AMRO B and D, down to 20% in AFRO D and E. This resulted in disability weights ranging from 0.185 in A regions to 0.221 in AFRO D and E. The Netherlands disability weights study (67) estimated disability weights for three levels of severity of OA. The Australian Burden of Disease Study (Mathers et al 1999) calculated disability weights for radiographic OA based on the above proportions asymptomatic for grade 2 and grade 3 and the Dutch disability weights for symptomatic OA (Stouthard et al. 1997).

Table 4.3 Disability weights for osteoarthritis

Stage/sequela	GBD 1990	Netherlands Study	Australian BOD Study
Hip or knee	0.108 (treated) 0.156 (untreated)	0.14 (Grade 2 radiol.) 0.42 (Grade 3-4 radiol.)	0.010 (Grade 2 asymptomatic) 0.14 (Grade 2 symptomatic) 0.14 (Grade 3-4 asymptomatic) 0.42 (Grade 3-4 symptomatic) 0.117-0.127 average weight

5. Disease model for osteoarthritis

The disease model for osteoarthritis is shown in Figure 5.1. Hip and knee OA are assumed to be independent, and their incidence and prevalence rates separately estimated. As noted before, we assume that prevalent hip OA will include most cases of hand OA.



Years lived with disability (YLDs) were calculated for the boxes shaded in grey.

Figure 5.1: Osteoarthritis disease model.

5.1 Mortality and case fatality

OA, by itself, is not a life threatening disease. Drugs commonly used to treat OA such as non-steroidal anti-inflammatory medications, can lead to excess mortality. Obesity, a risk factor for OA, can also lead to reduced life expectancy. People with osteoarthritis have a somewhat higher risk of death than others, but it is thought that this is due to an increased likelihood of significant comorbidities (not related to the osteoarthritis). An all-cause relative risk of 1.1 was used in DISMOD to model average duration of osteoarthritis.

5.2 Remission rates for osteoarthritis

The underlying disease process of OA does not remit, although it may fail to progress. Relief of symptoms may be achieved by arthroplasty or joint replacement surgery. Total joint replacement is a highly cost effective operation for severe osteoarthritis and provides good pain relief and improvement in mobility and quality of life in the majority of patients. In the United States, osteoarthritis is the most common indication for total hip arthoplasty, accounting for the majority of elective procedures in Americans aged 65 and above.

A remission rate equal to the rate of knee arthroplasties performed in the US population for reference year 1996[4] was used in modeling knee OA in DISMOD 2. US knee joint replacement surgery rates were also assumed for other A regions; knee replacement rates were assumed to be zero in other regions.

Hip OA remission rates were estimated from hip replacement surgery rates (primary total hip replacement) in the USA (AMRO A) and Scandinavian countries (for EURO A, WPRO A), and

[4] From Joint Procedures chapter in book by American Academy of Orthopedic Surgeons.

assumed to be 0 in other regions Primary total hip replacement rates were available from Sweden (Herberts and Malchau 2000), Norway (Havelin et al 2000), and Denmark (Lucht 2000).

5.3 DISMOD estimation of incidence and duration for osteoarthritis

The observed incidence rates from the Rochester study for hip and knee OA were input to DISMOD 2 together with the estimated remission rates and a RR for mortality of 1.1. The resulting calculated prevalence rates were in reasonably good agreement with the prevalence rates observed in the NHANES study, suggesting that the remission and RR assumptions are acceptable.

Osteoarthritis disease model and assumptions are shown in Table 5.1. Table 5.2 compares the GBD 2000 assumptions with those used in 1990.

Table 5.1. Osteoarthritis disease model and assumptions

Definitions	ACR clinical criteria assumed = symptomatic
	Prevalence symptomatic hip OA = 33% of KL Grade 2+ radiological prevalence
	Prevalence symptomatic hip OA = 50% of KL Grade 3+ radiological prevalence
Incidence	Incidence rates from Rochester USA adjusted for various regions to match prevalences
Remission	Knee: US knee joint replacement surgery rates in A regions, zero in other regions
	Hip: Hip replacement surgery rates (primary THR) in USA (AMRO A) and Scandinavian countries (EURO A, WPRO A), zero in other regions
Case fatality	RR=1.1 (due to obesity mainly)
Severity distribution	0.108 (treated), 0.156 (untreated)
Other assumptions	OA knee rates higher in US blacks (1.25 male, 2.0 female)
Data	Incidence of knee and hip OA in 2 US populations, prevalence studies of varying quality and time periods for other regions of the world.

Table 5.2. Comparison between GBD 1990 and GBD 2000 disease models

	GBD 1990	**GBD 2000**
Stages/Sequelae	Symptomatic osteoarthritis of the hip or knee, radiologically confirmed as Kellgren-Lawrence grade 2 or greater.	Symptomatic osteoarthritis of the hip or knee, radiologically confirmed as Kellgren-Lawrence grade 2 or greater.
Incidence rates	DISMOD 1 used to estimate from prevalence rates	DISMOD 2 used to estimate from prevalence rates
Remission	0	Based on hip and knee replacement rates in A regions, 0 elsewhere
Case fatality	RR=1.0	RR=1.1
Disability weights	0.108 (treated) 0.156 (untreated)	0.108 (treated) 0.156 (untreated)

6. Regional incidence, prevalence and mortality estimates

Table 6.1 summarises the data and assumptions used to estimate regional prevalence rates.

Table 6.1 Data and assumptions used to estimate regional prevalence rates for hip and knee osteoarthritis.

AFRO	Based on AFRO E.
AFRO E	One study from South Africa – high rates. Used Jamaican rates adjusted with regard to this study for knee. Used South African study adjusted to age pattern of other developing regions for hip.
AMRO A	Incidence of OA in Massachusetts (Oliveria 1995) and Rochester, Minnesota (Wilson et al 1990) adjusted for knee and hip surgery rates (USBODI 2001). Severity distribution from Framingham study (Guccione et al 1990). Comparison with prevalence from NHANES I
AMRO B	Based on Jamaican study.
AMRO D	Based on AMRO B
EMRO B	No new studies. Overall prevalence similar to that for MEC in GBD 1990 with some adjustments based on SEARO studies.
EMRO D	Same as EMRO B.
EURO A	Incidence of OA in Rochester, Minnesota adjusted for knee surgery rates. Prevalence matched to UK radiological study (Lawrence). Primary total hip replacement rates from Sweden (Herberts and Malchau 2000), Norway(Havelin et al 2000), and Denmark (Lucht 2000).
EURO B1	Based on EURO A and Bulgaria, Sofia 1968.
EURO B2	Based on EURO C and EMRO B.
EURO B3	Based on EURO B1.
SEARO B	No new studies. Overall prevalence similar to that for OAI in GBD 1990.
SEARO D	One COPCORD study in rural village. Used female age pattern of COPCORD study applied to estimated GBD 1990 prevalences for India.
WPRO A	WPRO A based on EURO A adjusted for Japanese rates (based on K-G grade 2+ prevalence at ages 55+)
WPRO B1	No new data. Prevalence similar to that for China in GBD 1990.
WPRO B2	No new studies. Overall prevalence similar to that for OAI in GBD 1990.
WPRO B3	No new studies. Overall prevalence similar to that for OAI in GBD 1990.

For those regions with no available OA prevalence or incidence studies, prevalence rates were assumed to be similar to other selected regions, comparable in terms of level of development and population age structure. An estimate derived from a different region is more likely to be correct than the assumption that the condition does not exist in the region with no data of its own. In some instances, there are sufficient data from a region to indicate whether it is likely to be a high or low prevalence area for OA, but not to give a clear age pattern. In these cases, age patterns have been based on those seen in other regions. This process can also be used to decide where further work is needed. It is not necessary for a comprehensive set of surveys to be conducted in every country. A few large, high quality surveys are needed from representative areas.

Table 6.2 Hip and knee osteoarthritis: age-standardized incidence and prevalence rate estimates for WHO epidemiological subregions, 2000.

	Age-std. incidence per 100,000				Age-std. prevalence per 100,000			
	Hip		Knee		Hip		Knee	
Subregion	Males	Females	Males	Females	Males	Females	Males	Females
AFRO D	39.0	33.8	148.1	183.5	473	373	2176	2894
AFRO E	40.5	34.3	148.1	183.5	475	382	2176	2894
AMRO A	38.0	53.1	123.8	155.6	413	576	1641	1915
AMRO B	36.1	52.6	144.7	181.2	375	558	1900	2224
AMRO D	37.7	52.6	144.7	181.4	397	544	1879	2184
EMRO B	22.2	14.6	67.7	136.8	277	167	1163	2325
EMRO D	22.2	15.7	75.2	142.4	274	162	1234	2273
EURO A	38.1	53.3	119.9	144.9	413	577	1583	1773
EURO B1	40.3	34.4	176.9	248.2	700	601	3086	3942
EURO B2	22.0	13.5	110.4	176.8	273	156	1737	2752
EURO C	40.5	31.4	188.1	253.1	633	490	2869	3683
SEARO B	31.2	13.3	179.6	195.2	381	151	2819	3236
SEARO D	32.7	13.5	70.0	141.6	406	159	1197	2327
WPRO A	36.4	55.4	120.3	156.2	398	598	1593	2040
WPRO B1	31.6	12.8	99.0	174.4	391	149	1476	2996
WPRO B2	30.0	12.8	176.7	192.7	368	145	2886	3406
WPRO B3	34.6	15.0	194.9	213.4	427	169	3089	3654
World	*35.0*	*30.8*	*119.7*	*178.6*	*426*	*371*	*1770*	*2693*

- Age-standardized to World Standard Population(68).

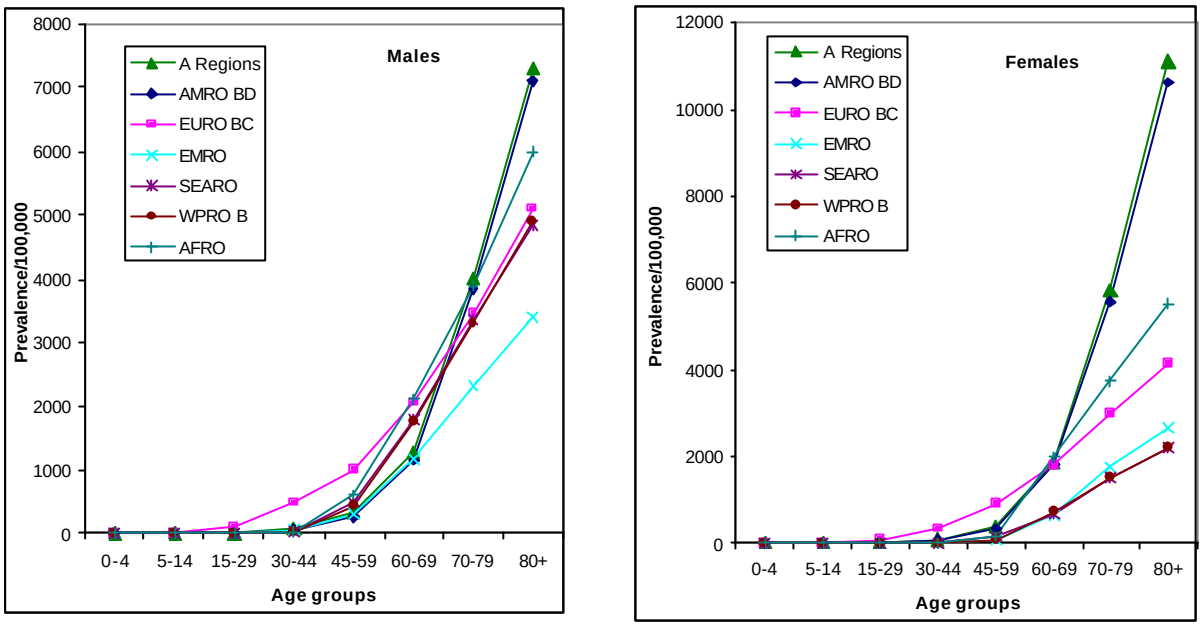


Figure 6.1. Hip OA prevalence rates, age group and sex, broad regions, 2000.

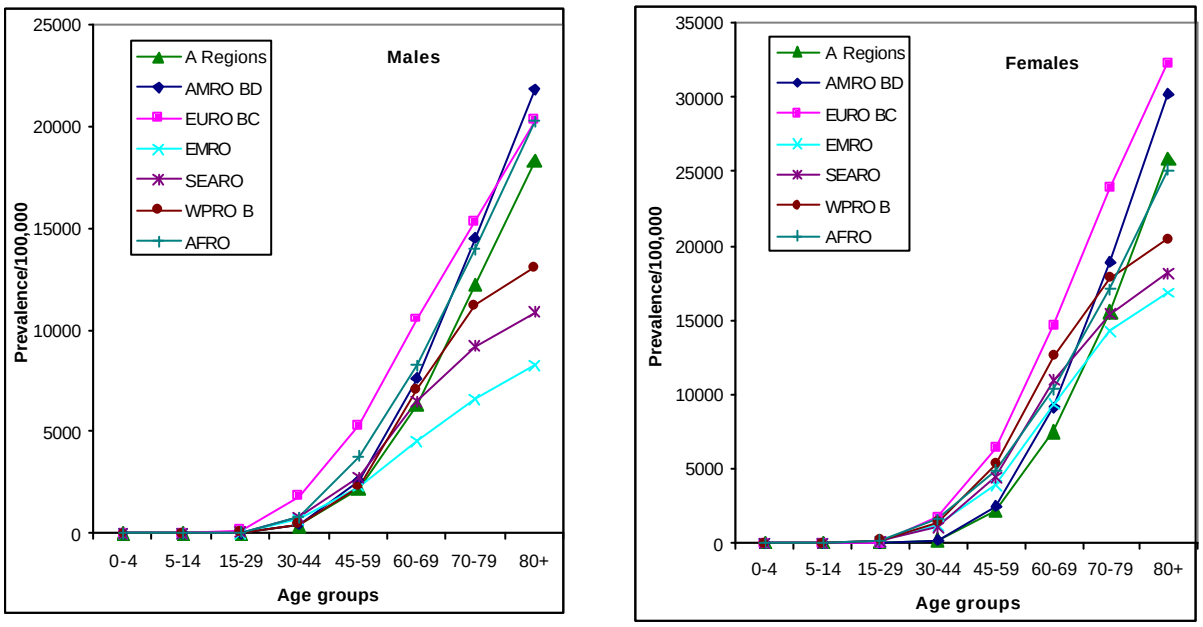


Figure 6.2. Knee OA prevalence rates, age group and sex, broad regions, 2000.

7. Global burden of osteoarthritis in 2000

General methods used for the estimation of the global burden of disease are given elsewhere (69). The tables and graphs below summarise the global burden of OA estimates for the GBD 2000 and compare them with the OA estimates from the GBD 1990 (4).

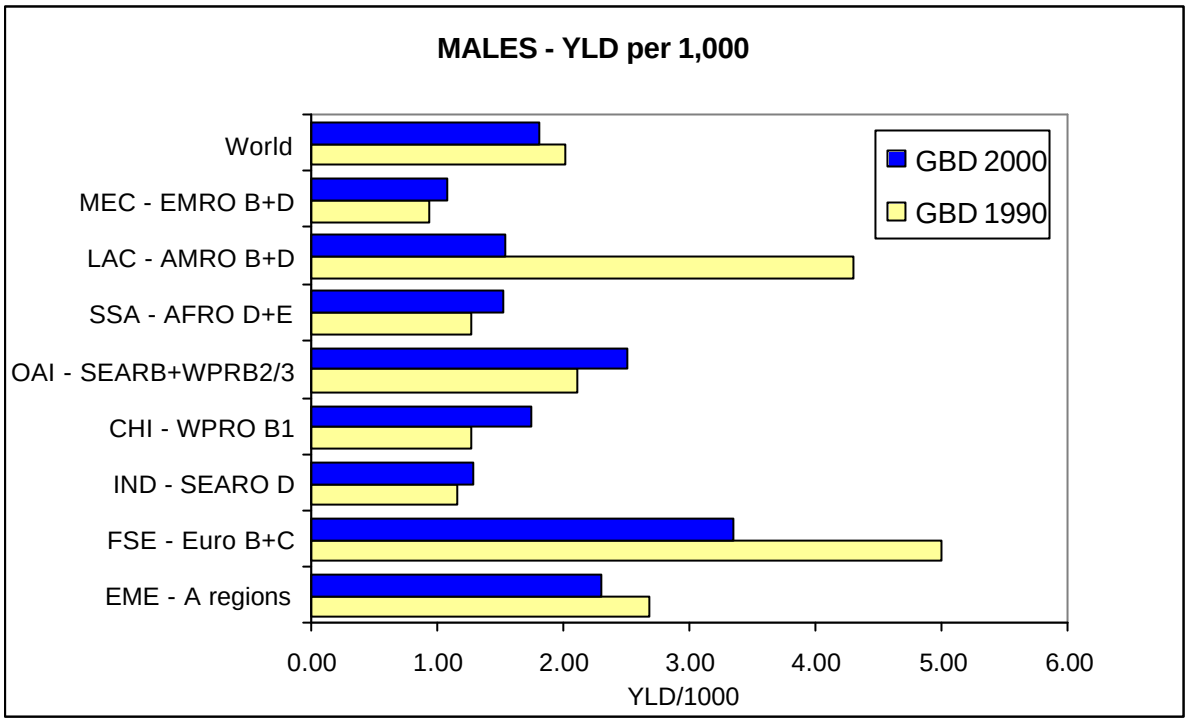
Table 7.1: Osteoarthritis: global total YLD, YLL and DALY estimates, 1990 and 2000.

	Males	*Females*	*Persons*
YLD('000)			
GBD1990	5,341	7,934	13,275
GBD2000	5,549	8,667	14,216
YLL('000)			
GBD1990	-	-	-
GBD2000	5	8	13
DALY('000)			
GBD1990	5,341	7,934	13,275
GBD2000	5,554	8,675	14,230

Table 7.2: Osteoarthritis: YLD, YLL and DALY estimates for WHO epidemiological subregions, 2000.

	YLD/100,000		YLL/100,000		YLD	YLL	DALY
Subregion	**Males**	**Females**	**Males**	**Females**	**('000)**	**('000)**	**('000)**
AFRO D	162	227	0.0	0.0	650	0	650
AFRO E	143	208	0.0	0.0	593	0	593
AMRO A	212	299	0.5	1.1	794	2	796
AMRO B	159	212	0.5	0.8	823	3	826
AMRO D	122	146	0.0	1.3	96	0	96
EMRO B	107	185	0.0	0.0	202	0	202
EMRO D	107	180	0.0	0.0	198	0	198
EURO A	231	331	0.7	1.3	1,159	4	1,163
EURO B1	374	482	0.2	0.2	711	0	711
EURO B2	142	236	0.4	0.2	96	0	97
EURO C	349	516	0.6	0.4	1,075	1	1,076
SEARO B	256	307	0.2	0.2	1,109	1	1,110
SEARO D	127	210	0.0	0.0	2,254	0	2,254
WPRO A	254	401	0.1	0.3	491	0	492
WPRO B1	174	354	0.0	0.1	3,550	1	3,551
WPRO B2	238	320	0.0	0.0	397	0	397

WPRO B3	236	294	0.0	0.0	18	0	18
World	*182*	*289*	*0.2*	*0.3*	*14,216*	*13*	*14,230*



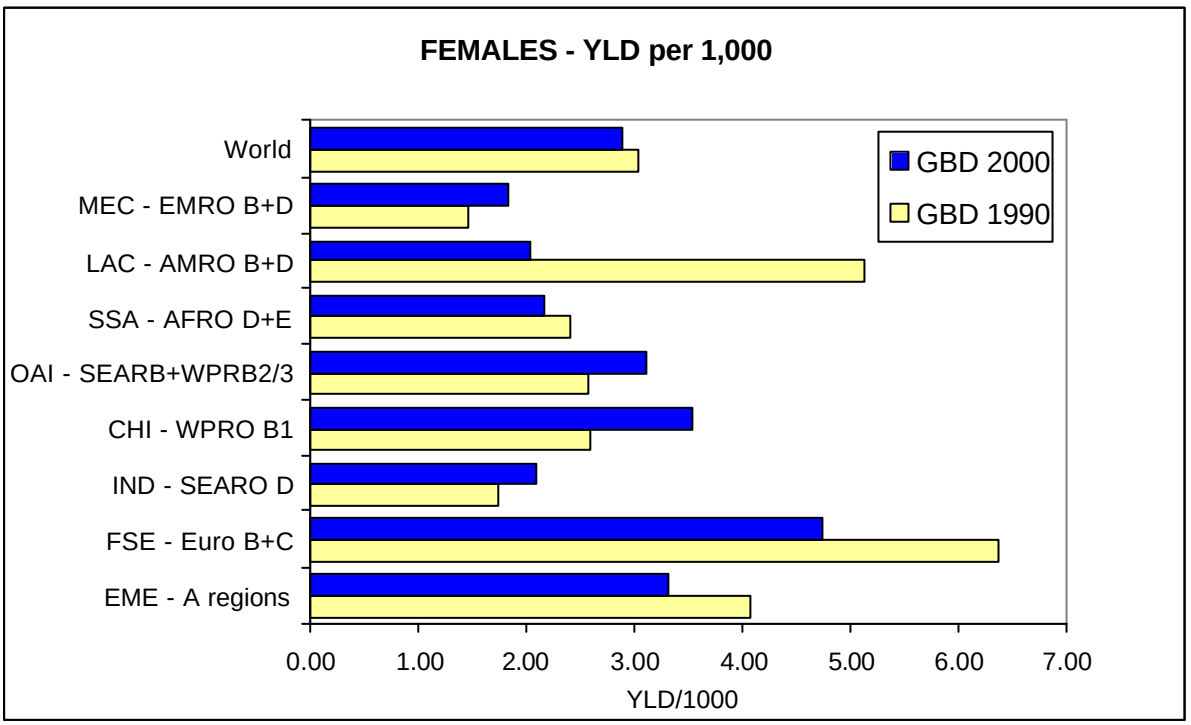
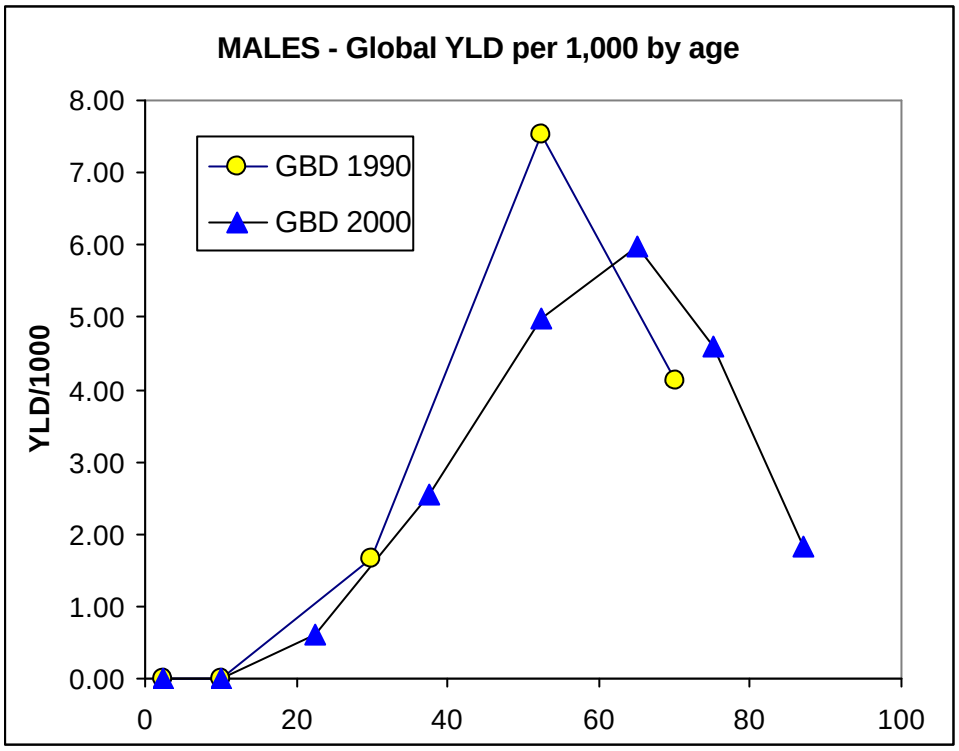


Figure 7.1. OA YLD rates, by sex, broad regions, 1990 and 2000.



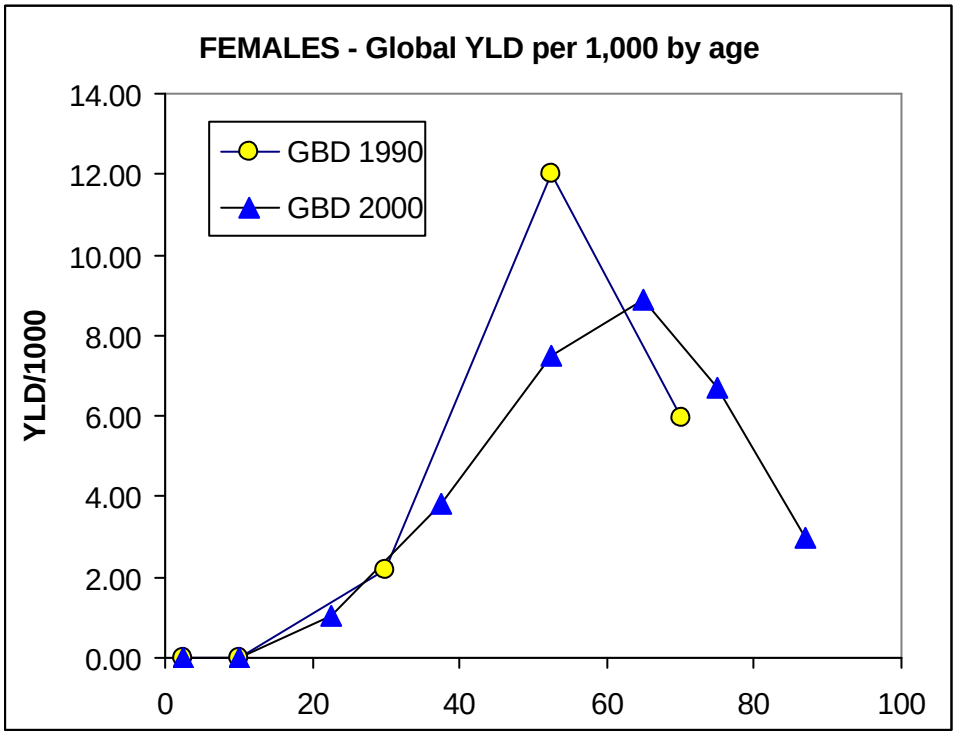


Figure 7.2. Global OA YLD rates, by age and sex, 1990 and 2000.

8. Uncertainty analysis

General methods for uncertainty analysis of estimates for the Global Burden of Disease 2000 are outlined elsewhere (70). Uncertainty analysis for OA is currently underway.

9. Conclusions

These are version 2 estimates for the GBD 2000. Apart from the uncertainty analysis, updating estimates to reflect revisions of mortality estimates and any new or revised epidemiological data or evidence, it is not intended to undertake any major addition revision of these estimates. It will be important to fill some of the major gaps in population studies – for example in Eastern Europe, South America and Africa – for future burden of disease analyses, although it is possible to move forward with uncertain estimates of numbers rather than delaying progress by waiting for more precise figures. Uncertainty intervals will be provided for OA burden estimates.

We welcome comments and criticisms of these draft estimates, and information on additional sources of data and evidence. Please contact Colin Mathers (EBD/GPE) on email mathersc@who.int

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