EXTENDED REPORT

The global burden of other musculoskeletal disorders: estimates from the Global Burden of Disease 2010 study

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ABSTRACT

Objective To estimate disability from the remainder of musculoskeletal (MSK) disorders (categorised as other MSK) not covered by the estimates made specifically for osteoarthritis (OA), rheumatoid arthritis (RA), gout, low back pain and neck pain, as part of the Global Burden of Disease (GBD) 2010 study.

Methods Systematic reviews were conducted to gather the age-sex-specific epidemiological data for other MSK. The focus was on finding health surveys and published studies that measured the overall amount of MSK disorders and complaints, and classified the remainder of MSK disorders that was not RA, OA, gout, low back or neck pain. Six levels of severity were defined to derive disability weights (DWs) and severity distribution. The data, DWs and severity distribution were used to calculate years of life lived with disability (YLDs). Mortality was estimated for MSK-related deaths classified under other MSK. YLDs were added to years of life lost (YLLs) from the mortality estimates to derive overall burden in disability-adjusted life years (DALYs).

Results Global prevalence of other MSK was 8.4% (95% uncertainty interval (UI) 8.1% to 8.6%). DALYs increased from 20.6 million (95% UI 17.0 to 23.3 million) in 1990 to 30.9 million (95% UI 25.8 to 34.6 million) in 2010. The burden of other MSK increased with age. Globally, other MSK disability burden (YLD) ranked sixth.

Conclusions Ageing of the global population will further increase the burden of other MSK. Specific MSK conditions within this large category should be considered separately to enable more explicit estimates of their burden in future iterations of GBD.

INTRODUCTION

Rheumatoid arthritis (RA), osteoarthritis (OA), gout, low back pain (LBP) and neck pain (NP) are the five defined musculoskeletal (MSK) diseases in the Global Burden of Disease (GBD) 2010 study. However, apart from these five MSK diseases, there is a wide range of disorders of muscles, bones and ligaments that are not explicitly defined and are not captured as long-term sequelae of injuries. This heterogeneous remainder (rest) of MSK diseases has been categorised as 'other musculoskeletal disorders' (other MSK). Other MSK includes a wide range of specific conditions such as the autoimmune and other inflammatory disorders like systemic lupus erythematosus, ankylosing spondylitis and psoriatic arthritis, as well as the wide range of joint, ligament, tendon or muscle problems that cause regional or generalised pain, such as shoulder problems and fibromyalgia. The various proportions of each of the disorders could vary from survey to survey.

Most of the other 'remainder' or 'rest' categories in the GBD cause list, such as 'other cardiovascular diseases' or 'other neurological conditions', are relatively small, and estimates for the amount of disability are extrapolated from the relationship between disability and mortality of the more specific conditions in their respective categories. However, as disability is the main source of burden for MSK diseases, this method does not apply. Because there is such a wide range of MSK disorders not covered by the five defined MSK diseases —OA, RA, LBP, NP and gout—and together with a substantial level of disability resulting from the other MSK conditions globally, the explicit burden estimates were made for this heterogeneous remainder of combined MSK diseases.

This extended report on the burden of other MSK is part of the GBD 2010 study, recently published in *The Lancet* (Vol. 380 (9859) December 2012). The global burdens of LBP, occupationally related LBP, NP, OA, RA, gout and low bone mineral density, included in the GBD 2010 study, are reported in the issue.[1–7] Reflecting on the global burden of MSK conditions and lessons learnt from the GBD 2010 study, from the point of view of the Musculoskeletal Disorders and Risk Factors Expert Group (MSK EG), and suggestion for the next steps forward is also reported in this issue.[8]

METHODS

A full description of the methods used for the burden estimate of the MSK diseases, GBD 2010 study, is reported separately in the issue.[9]

Case definition

Other MSK category refers to the MSK diseases and symptoms other than LBP, NP, RA, OA and gout. Fractures/dislocations related to MSK disorders were not included in other MSK as they were captured and estimated as part of the non-fatal burden of injuries. International Classification of Diseases (ICD) codes assigned for other MSK in the GBD 2010 study are listed in table 1.

Table 1 ICD codes assigned for other MSK, GBD 2010 study

ICD-10 code	ICD-9 code
M00-M02—Infectious arthropathies M08, M11,M12-M13—Inflammatory polyarthropathies M20-M25—Other joint disorders M30-M35—Systemic connective tissue disorders M40-M43—Deforming dorsopathies M45-M46 (except M46.9), M48 (except M48.0, M48.1, M48.2, M48.8, M48.9)—Spondylopathies M60,M61-M62—Disorders of muscles M65-M68—Disorders of synovium and tendon M71, M72, M75-M79—Other soft tissue disorders M80-M85—Disorders of bone density and structure M87-M90—Other osteopathies M91-M94—Chondropathies M95-M99—Other disorders of the MSK system and connective tissue	710–711, 712–713, 716, 717–719, 720–721, 725–729, 730.3, 730.9, 731–733, 734–736, 737, 738–739

GBD, Global Burden of Disease; ICD, International Classification of Diseases; MSK, musculoskeletal.

Box 1 Conditions in the 28 studies with extracted prevalence data included in other musculoskeletal (MSK) category for DisMod-MR analysis, Global Burden of Disease 2010 study

1. All self-reported other diseases of MSK system with no specific classification.
2. All self-reported other diseases of MSK system and connective tissue mapped to ICD-9 codes, not classified as disorders of intervertebral disc, back problems (unspecified), osteoarthritis (OA), arthritis (NEC; not elsewhere classified).
3. All self-reported other diseases of MSK system and connective tissue mapped to ICD-10 codes, not classified as arthritis (rheumatoid, OA, other and type unknown), other arthropathies, rheumatism, back pain/problems not elsewhere classified/disc disorders, osteoporosis.
4. All self-reported MSK conditions mapped to ICD-10 codes, not classified as arthritis, rheumatism, gout, osteoporosis and disc and other back problems.
5. All self-reported arthritis (telephone questionnaire). Participants were asked if they had OA, rheumatoid arthritis (RA), another form of arthritis or if they did not know the type of arthritis they had.
6. Ankylosing spondylitis.
7. Arthralgia.
8. Behcet's disease.
9. Carpal tunnel syndrome.
10. Epicondylitis.
11. Fibromyalgia.
12. Myofascial pain syndrome.
13. Psoriatic arthritis.
14. Scoliosis.
15. Seronegative spondyloarthropathies.
16. Soft tissue rheumatism.
17. Systemic lupus erythematosus.
18. Tendinitis.
19. The rest (the remainder of other reported MSK conditions excluding the condition no. 6–18 listed above, and OA, RA, gout, low back and neck pain).

Literature search

The search for other MSK population-based epidemiological data concentrated on finding health surveys that measured an overall amount of MSK disorders and complaints, and reported the remainder of MSK diseases separately from RA, OA, gout, LBP and NP. National health surveys and studies by the Community Oriented Program for the Control of Rheumatic Diseases (COPCORD) were important sources of data. Twenty-eight studies (see online supplementary appendix 1 for details) with extracted prevalence data were included in the analysis. No studies on incidence or relative risk of mortality were identified. A risk of bias assessment tool[10] was adapted and used to assess the potential for bias of the included articles. The mapping of ICD-9 and ICD-10 codes to the other MSK category was essential for the estimation of deaths and years of life lost (YLLs). For years of life lived with disability (YLD) calculation, some of the data used to quantify the prevalence of other MSK were based largely on self-reported MSK conditions or symptoms. These were mapped to the ICD codes and assigned to predetermined MSK conditions and other MSK. The diseases and symptoms in the 28 studies included in other MSK category for DisMod-MR model are listed in box 1.

DisMod-MR model

The prevalence of all extracted data of the diseases and symptoms included in other MSK category was pooled in DisMod-MR. It is the newest iteration of a generic disease modelling software that has been redesigned using a Bayesian meta-regression tool.[11] With such a heterogeneous set of conditions included in the other MSK category, some assumptions on a plausible range of remission and mortality risk values had to be made. The bounds around remission and relative risk (of mortality) were set in the prior settings of DisMod-MR model, remission was set to vary between 0 and 0.25, and relative risk to range between 1 and 2 (see online supplementary appendix 2 for details). These assumptions were arbitrary but were not critical as the data input for YLD calculation was prevalence. It was assumed that there was no prevalence before age 10, mainly because the data captured for the analysis were mostly from the populations at the age of 10 and older.

Severity and disability weights

Consequences of diseases and injuries were referred to as sequelae in the GBD 2010 study. For other MSK, six sequelae representing different levels of health state and disease severity were defined, and were consistent with the sequelae of OA and RA. They were mild and severe OA; mild, moderate and severe RA. An additional health state was defined for mild other MSK of the legs. Each health state was described in lay terms according to a specific set of health domains. The lay descriptions (table 2) were then used in five household surveys and an open-access web-based survey by the GBD Disability Weights Group to collect data to derive study-wide disability weights (DWs).[12] DWs derived for each of the other MSK sequelae are shown in table 2. The average DWs for other MSK was 0.104 (95% uncertainty interval (UI) 0.072 to 0.144). Severity distribution between other MSK health states was derived from the Medical

Table 2 Sequelae and DWs for other MSK, GBD 2010 study

Sequela (health state)	Lay description	Disability weight (95% UI)	Severity distribution (95% UI)
Asymptomatic (no disability)		0	32.0% (31.4% to 32.6%)
MSK problems: legs, mild	This person has pain in the leg, which causes some difficulty running, walking long distances, and getting up and down	0.023 (0.013 to 0.039)	15.8% (10.1% to 23.4%)
MSK problems: legs, severe/ osteoarthritis, severe	This person has severe pain in the leg, which makes the person limp and causes a lot of difficulty walking, standing, lifting and carrying heavy things, getting up and down, and sleeping	0.171 (0.117 to 0.240)	6.6% (4.9% to 8.5%)
MSK problems: arms, mild/ osteoarthritis, mild	This person has mild pain and stiffness in the arms and hands. The person has some difficulty lifting, carrying and holding things	0.024 (0.014 to 0.041)	16.8% (11.9% to 22.0%)
MSK problems: arms, moderate/ rheumatoid arthritis, mild	This person has moderate pain and stiffness in the arms and hands, which causes difficulty lifting, carrying, and holding things, and trouble sleeping because of the pain	0.114 (0.077 to 0.159)	12.5% (9.2% to 15.4%)
MSK problems: generalised, moderate/rheumatoid arthritis, moderate	This person has pain and deformity in most joints, causing difficulty moving around, getting up and down, and using the hands for lifting and carrying. The person often feels fatigue	0.292 (0.197 to 0.410)	8.8% (6.7% to 10.8%)
MSK problems: generalised, severe/ rheumatoid arthritis, severe	This person has severe, constant pain and deformity in most joints, causing difficulty moving around, getting up and down, eating, dressing, lifting, carrying and using the hands. The person often feels sadness, anxiety and extreme fatigue	0.606 (0.421 to 0.771)	7.5% (4.3% to 11.9%)

DWs, disability weights; GBD, Global Burden of Disease; MSK, musculoskeletal.

Expenditure Panel Surveys (MEPs) in the USA, which combines diagnostic information with a general health status measure. To avoid double counting, the long-term consequences of fractures and dislocations, estimated as part of the non-fatal burden of injuries, were subtracted from the other MSK estimates (see online supplementary appendix 3 for details).

Mortality estimates

YLLs is the GBD measure for mortality. It is computed as the product of the number of cause-specific deaths multiplied by the remaining life expectancy at the age when death took place using values from the standard life table chosen for GBD 2010 as the 'survivorship goal'.[13] In the GBD 2010 study, for the MSK EG, mortality was explicitly modelled for the combined category of all MSK diseases, and separately for RA and, by subtraction, the other MSK category, from 1980 to 2010 for 20 age groups, both sexes, and 187 countries.[14] Causes of death estimates were developed using a comprehensive database of vital registration (VR), verbal autopsy, surveillance and other sources. In total, 2595 country-years of data from 124 countries were used for the estimation of MSK disease mortality.

Total deaths attributable to all MSK diseases, deaths attributable to RA and deaths attributable to other MSK conditions were modelled using the Cause of Death Ensemble Modeling (CODEm) strategy, estimating deaths for males and females separately. The subcause estimates for RA and other MSK were scaled to the total number of all MSK deaths, taking into account the levels of uncertainty associated with each estimate.

'Symptoms, signs and ill-defined conditions' category of the ICD codes was not listed in the GBD classification system. Deaths assigned to this category and some other codes used for ill-defined conditions were referred to as garbage codes (GCs). Using empirical algorithms, proportions of each group of GCs were reassigned to specific causes of death in the GBD classification scheme, including the other MSK category, to allow non-biased comparisons of cause of death patterns across countries and over time.[14]

YLDs and DALYs estimates

The standard metric used to quantify the overall disease burden is the disability-adjusted life year (DALY).[15] One DALY equals one lost year of healthy life. DALYs are the sum of years of life lost due to premature mortality (YLLs) and YLD, that is, any short-term or long-term health loss (YLDs). The age/sex/region-specific prevalence was multiplied by the severity distribution and the six DWs to derive YLDs for the years 1990 and 2010. Prevalence estimates were age-standardised using the 2001 WHO standard population.[16] YLDs were added to YLLs attained from the mortality estimates to derive the overall burden in DALYs. The UI around each estimate was calculated, bounded by the 2.5th and 97.5th centile, interpreted as a 95% UI, values of the 1000 iterations of all calculations systematically carrying forward uncertainty around data inputs and data manipulations. Details on the uncertainty calculation are explained elsewhere.[17]

RESULTS

Description of analysed data

There were 164 prevalence data points included in the final DisMod-MR analysis. These were from 19 countries, and 12 of the 21 GBD 2010 regions (see online supplementary appendix 1 for details). The majority of analysed data were from adult population of both sexes, with a broad age range.

Prevalence

Generally, other MSK disorders are common. In the GBD 2010 study, the prevalence of other MSK increased with age to a plateau of 20–40% at age 80. Overall, there was no significant change in prevalence of other MSK over the period 1990 to 2010. The global age-standardised prevalence of other MSK (from 0 to 100 years of age) in 2010 was estimated to be 8.4% (95% UI 8.1% to 8.6%). It was slightly higher in females (mean 8.7%; 95% UI 8.4% to 9.1%) than in males (mean 8.0%; 95% UI 7.7% to 8.3%). In both males and females, comparable patterns of the prevalence trends for the years 1990 and 2010 were noted (figure 1).

Among the 21 GBD 2010 regions, high age-standardised prevalence for 2010 was estimated in five high-income regions, all of which are in the super-region 0 (see online supplementary appendix 4 for details). These five GBD regions were North America high income (14.2%; 95% UI 13.4% to 15.1%), Asia

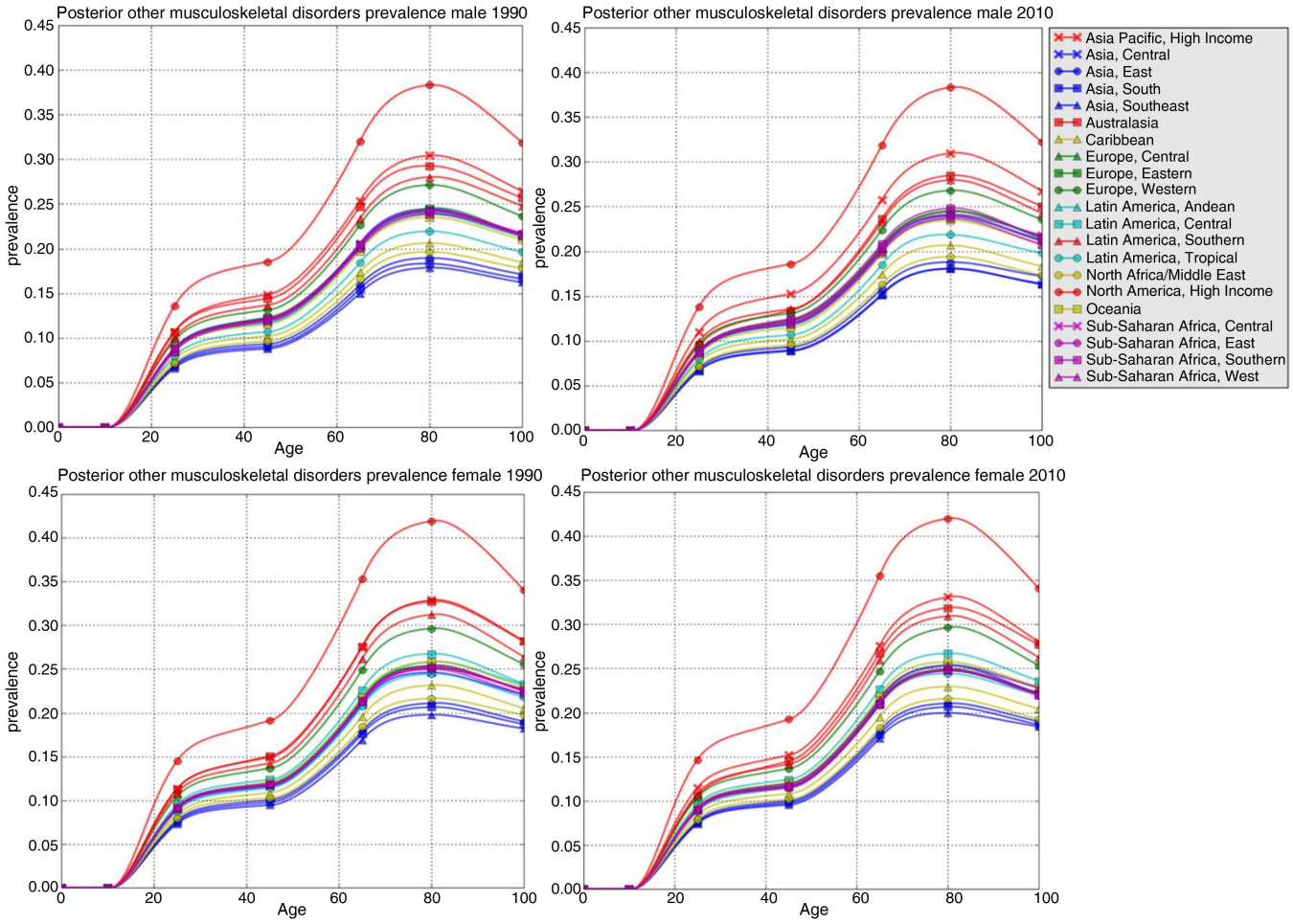

Figure 1 DisMod-generated 1990 and 2010 prevalence of other musculoskeletal disorders by age, sex, year and region, Global Burden of Disease 2010 study.

Pacific high income (11.3%; 95% UI 9.1% to 14.1%), Australasia (10.4%; 95% UI 9.8% to 11.1%), Southern Latin America (10.4%; 95% UI 8.6% to 12.7%) and Western Europe (10.1%; 95% UI 9.0% to 11.1%) (table 3).

YLDs and DALYs

Globally, all ages other MSK YLDs increased by 44.6%, from 19.6 million (95% UI 16.1 to 22.1 million) in 1990 to 28.2 million (95% UI 23.2 to 31.9 million) in 2010. Over the span of 20 years, the age-standardised YLD rate (per 100 000) increased by 11.3%, from 368 (95% UI 305 to 417) to 410 (95% UI 337 to 463).[11] The largest YLDs were estimated in East Asia, South Asia, Western Europe and North America high income, for the years 1990 and 2010, while the lowest YLD estimates were in Oceania, also for 1990 and 2010. Nonetheless, the disability estimates in Oceania almost doubled from 1990 to 2010. A similar trend was also noted in other regions of low-income and middle-income countries, including Latin Americas, North Africa/Middle East and Sub-Saharan regions. Detailed results of the other MSK country and regional YLDs could be further explored at http://viz.healthmetricsandevaluation.org/gbd-compare/.

In 1990, there were 35 963 deaths from other MSK or 0.08% (95% UI 0.05 to 0.09) of total deaths. In 2010, with 104 652 deaths, the contribution from other MSK to all ages death was 0.20% (95% UI 0.16 to 0.28) of total deaths. After the redistribution of the GCs to other MSK, the mortality from the category was increased by 25.9%.

While the global prevalence of other MSK remained relatively stable, its overall burden or DALYs increased by 50%, from 20.6 million (95% UI 17.0 to 23.3 million) in 1990 to 30.9 million (95% UI 25.8 to 34.6 million) in 2010 (table 2). Globally, in 2010, the DALY estimates were doubled in females (20.7 million; 95% UI 18.1 to 22.6 million) compared with males (10.1 million; 95% UI 7.6 to 12.2 million). High other MSK DALYs were observed in the regions of high income, and low-income and middle-income countries. Among the 21 GBD 2010 regions, the largest overall burden of other MSK was in East Asia (6.1 million; 95% UI 5.0 to 6.9 million), followed by South Asia (5.1 million; 95% UI 4.2 to 5.8 million), North America high income (3.2 million; 95% UI 2.6 to 3.6 million), Western Europe (2.9 million; 95% UI 2.4 to 3.4 million) and Southeast Asia (2.3 million; 95% UI 1.9 to 2.7 million) (table 3).

Other MSK was one of the top 10 causes contributing to global disability as measured by YLDs. Among the 291 conditions studied in the GBD 2010 study, other MSK YLDs ranked sixth globally, for the years 1990 and 2010. In 1990, other MSK YLDs ranked within the top 10 disease estimates in 18 of the 21 GBD 2010 regions and within the top 5 disease estimates in seven regions. In 2010, the YLDs ranked within the top 10 disease estimates in 20 regions and within the top 5 disease estimates in nine regions. Global DALYs rankings of other MSK

Table 3 Other MSK age-standardised prevalence (%) and DALYs (all ages, in thousands), with 95% uncertainty intervals, by region and sex for 2010, GBD 2010 study

Region	Sex	Prevalence	Prevalence UL	Prevalence LL	DALYs	DALYs UL	DALYs LL
Global	Total	8.36	8.13	8.60	30 856	34 583	25 815
	Males	8.00	7.68	8.30	10 120	12 259	7620
	Females	8.71	8.36	9.06	20 736	22 652	18 097
Central Asia	Total	8.87	7.76	10.14	352	422	282
	Males	8.68	7.10	10.66	115	151	81
	Females	9.02	7.38	10.93	237	292	188
East Asia	Total	7.19	6.77	7.61	6081	6909	5036
	Males	6.85	6.29	7.43	2037	2492	1478
	Females	7.54	6.99	8.17	4044	4535	3499
Asia Pacific high income	Total	11.26	9.08	14.06	1467	1875	1115
	Males	11.01	8.22	14.61	474	664	307
	Females	11.48	8.33	15.34	993	1335	713
South Asia	Total	6.94	6.47	7.45	5073	5793	4197
	Males	6.53	5.88	7.23	1652	2055	1211
	Females	7.37	6.67	8.10	3421	3876	2890
Southeast Asia	Total	6.92	6.12	7.94	2296	2732	1878
	Males	6.59	5.57	7.90	762	961	559
	Females	7.22	6.06	8.63	1533	1859	1258
Australasia	Total	10.40	9.75	11.08	179	204	148
	Males	9.86	9.05	10.71	57	70	42
	Females	10.93	9.92	11.89	122	138	105
Caribbean	Total	7.86	7.05	8.78	183	213	151
	Males	7.52	6.46	8.68	58	73	42
	Females	8.18	7.01	9.55	125	148	105
Central Europe	Total	8.89	7.78	10.11	695	835	559
	Males	8.91	7.37	10.66	226	301	161
	Females	8.86	7.34	10.60	468	572	375
Eastern Europe	Total	8.94	7.17	10.97	1292	1675	1000
	Males	8.91	6.59	11.70	388	534	264
	Females	8.97	6.61	12.18	904	1230	663
Western Europe	Total	10.05	9.00	11.12	2945	3423	2404
	Males	9.62	8.29	11.06	933	1189	667
	Females	10.46	9.03	12.04	2012	2344	1681
Andean Latin America	Total	8.78	7.27	10.54	224	278	174
	Males	8.64	6.51	11.14	75	101	52
	Females	8.92	6.82	11.68	148	192	114
Central Latin America	Total	9.07	8.31	10.02	1118	1292	939
	Males	8.64	7.61	9.96	348	442	259
	Females	9.47	8.39	10.74	769	895	658
Southern Latin America	Total	10.42	8.55	12.73	378	467	294
	Males	10.01	7.69	13.05	119	163	82
	Females	10.78	8.26	14.14	259	335	199
Tropical Latin America	Total	8.31	7.85	8.78	959	1087	794
	Males	7.89	7.24	8.57	304	374	229
	Females	8.69	8.03	9.42	655	738	562
North Africa and Middle East	Total	7.41	6.75	8.17	1530	1775	1253
	Males	7.06	6.19	8.15	531	669	387
	Females	7.76	6.78	8.94	1000	1184	824
North America high income	Total	14.21	13.43	15.07	3176	3647	2638
	Males	13.71	12.74	14.80	1010	1231	750
	Females	14.69	13.55	15.95	2167	2453	1869
Oceania	Total	8.80	7.11	10.69	45	58	34
	Males	8.45	6.38	11.29	18	28	11
	Females	9.14	6.89	12.07	27	36	20
Central Sub-Saharan Africa	Total	8.78	7.19	10.64	272	342	211
	Males	8.79	6.45	11.57	94	132	63
	Females	8.78	6.54	11.58	178	237	131
East Sub-Saharan Africa	Total	8.74	7.71	9.80	1223	1447	982

Continued

Table 3 Continued

Region	Sex	Prevalence	Prevalence UL	Prevalence LL	DALYs	DALYs UL	DALYs LL
	Males	8.74	7.39	10.45	430	564	307
	Females	8.74	7.33	10.36	794	971	636
Southern Sub-Saharan Africa	Total	8.88	7.04	11.14	306	392	236
	Males	8.95	6.48	12.18	111	159	75
	Females	8.81	6.37	12.16	195	263	146
West Sub-Saharan Africa	Total	8.82	7.54	10.35	1063	1306	822
	Males	8.65	6.93	10.76	378	509	266
	Females	8.99	7.19	11.12	684	864	534

DALY, disability-adjusted life year; GBD, Global Burden of Disease; LL, lower limit; MSK, musculoskeletal; UL, upper limit.

increased from rank 29th in 1990 to rank 23rd in 2010. In 1990, other MSK ranked within the top 10 causes in three GBD 2010 regions, and the number of regions increased to five in 2010 (table 4). Overall, Asia Pacific high income possessed the highest other MSK ranking for YLDs and DALYs in 1990 and 2010. The diseases were in the top 5 leading disability and overall burdens of the region. In 2010, all high-income regions of the super-region 0 had other MSK DALYs rankings within the top 10 disease estimates.

DISCUSSION

Estimates of the global burden of other MSK

Other MSK is one of the world's top 10 contributors to global disability burden (YLDs). Over the span of 20 years (1990–2010), the disease category has been one of the leading causes of the disability burden in the GBD 2010 regions within high-income countries. Other MSK is more prevalent in females than in males, and the adult female population carries double the amount of overall disease burden (DALYs). Most of the burden is from disability as the mortality contributes less than 10% to the DALYs. Due to ageing, the overall burden of other MSK is increasing throughout the world. Rapid reductions in child mortality rates[14] will lead to increasing numbers of people living with disability from other MSK.

Table 4 Regional other MSK YLD and DALY rankings in 2010 (out of 291 conditions), GBD 2010 study

	YLD ranking		DALY ranking	
Region	1990	2010	1990	2010
Global	6	6	29	23
Central Asia	7	7	27	19
East Asia	5	4	23	14
Asia Pacific high income	3	2	7	4
South Asia	8	8	42	30
Southeast Asia	8	8	36	22
Australasia	3	4	8	6
Caribbean	9	11	25	24
Central Europe	6	4	18	13
Eastern Europe	3	3	16	16
Western Europe	4	5	11	8
Andean Latin America	7	6	29	19
Central Latin America	6	4	21	15
Southern Latin America	5	4	13	8
Tropical Latin America	9	7	26	14
North Africa and Middle East	9	7	32	21
North America high income	3	3	8	6
Oceania	12	10	40	26
Central Sub-Saharan Africa	11	10	41	33
East Sub-Saharan Africa	11	9	38	34
Southern Sub-Saharan Africa	7	8	33	26
West Sub-Saharan Africa	11	10	37	35

DALY, disability-adjusted life year; GBD, Global Burden of Disease; MSK, musculoskeletal; YLDs, years of life lived with disability.

Overall, age-standardised mortality rate for all MSK conditions in the GBD 2010 study consists of the cause-specific mortality from RA and the mortality caused by other MSK. While the mortality caused by RA was negligible, the other MSK age-standardised mortality rate increased from 0.8 to 1.6 per 100 000 over the two decades.[14] Other MSK is a large and heterogeneous combination group of diseases. Some diseases in this group, such as systemic lupus erythematosus and other autoimmune diseases, caused relatively high mortality in comparison to other diseases within the group, and some other GBD identified causes/diseases. Increased ageing population, together with improvement of medical technology and diagnosis, and VR, leads to improved identification of the diseases and, hence, the increased incidence and mortality of these diseases. At present, no specific research report on the increasing of mortality rate in this heterogeneous combination of diseases could be found. However, from our data, yet to be published, raw numbers of mortality in many developed countries with good VR demonstrate this trend.

Strengths and limitations

For mortality estimation, the identification for inclusion of the MSK diseases in the other MSK category was clear and straightforward, guided by the GBD cause list and ICD-9 and ICD-10 code lists. For YLD estimation, some of the available data sources relied on self-reported MSK symptoms and self-reported diagnoses and, hence, were less precise.

More precise burden estimates were attributed considerably by the new set of DWs[12] developed for the disease burden estimation in the GBD 2010 study and by the analysis using DisMod-MR, the more complex and advanced version of disease modelling tool. Direct comparisons of the disease burden estimates between 1990 and 2010 were made possible by using the same methods to derive the estimates for both time periods.

In the GBD 2010 study, main concerns for the other MSK burden estimates were the paucity of epidemiological data necessary for the analysis. Originally, there were search strategies and inclusion and exclusion criteria set-up to find population-based epidemiological data for other MSK. But there were a lot

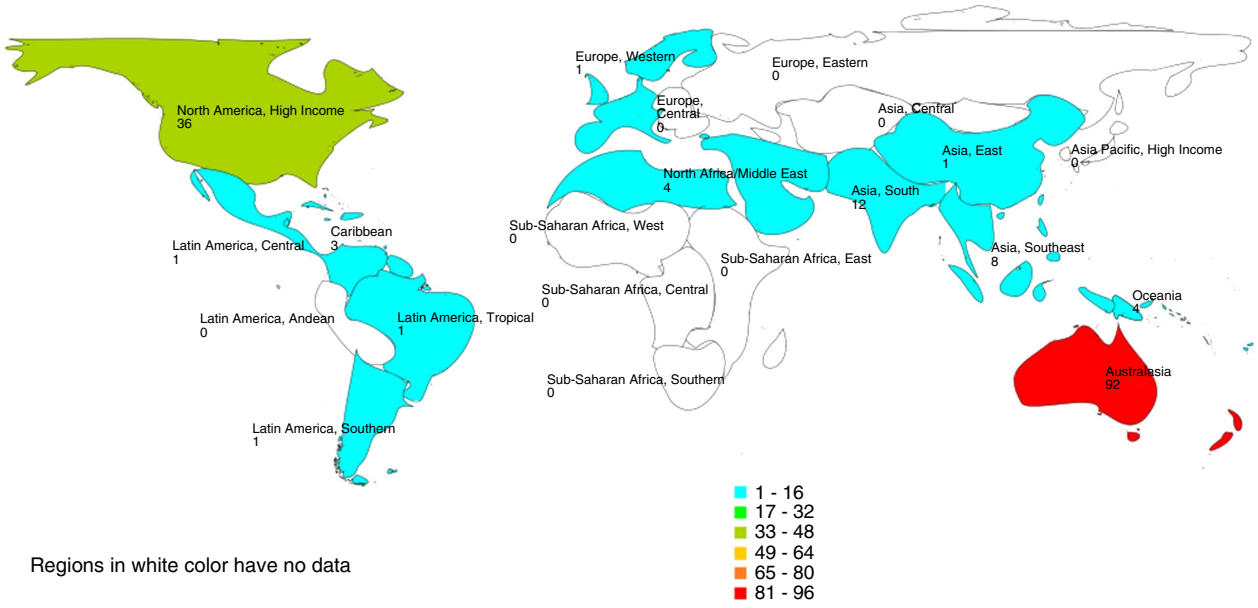

Figure 2 Total data count for other musculoskeletal DisMod-MR analysis, Global Burden of Disease 2010 study.

of difficulties in locating the data that were relevant and could actually be used for the particular complex analysis of the GBD 2010 study. After a long drawn process with little success, we decided to concentrate on finding health surveys that measured an overall amount of MSK disorders and complaints, and reported the remainder of MSK diseases separately from RA, OA, gout, LBP and NP. A number of national health surveys with sufficient information were identified, mostly in survey reports available on websites of national statistical agencies. There are likely to be more such surveys yet to be located that could be incorporated into future GBD updates. Out of 12 GBD 2010 regions with the data analysed, most data were from two regions only (figure 2). Also, 9 of the 21 GBD 2010 regions had no data at all. Consequently, for these regions, the data had to be statistically inferred from data of other regions, as a guiding principle in the GBD 2010 study was to make estimates for all regions even when the data are sparse. The estimates for these regions, therefore, are less precise and will tend to have wider uncertainty. Moreover, there was only one data source (MEPs) to determine the severity distribution, and this is another major limitation.

Suggested further research

More detailed estimations in the future GBD updates are recognised and emphasised by the large size of this heterogeneous remainder of MSK diseases. The GBD 2010 study identified other MSK category as a large contributor to global disability. However, for policy and decision-making purposes, it is desirable to have more detailed information on the amount of burden estimated explicitly for each of the specific conditions. In addition to the five defined MSK disorders, potential specific MSK conditions to be defined and to have their own burden estimates, in the future GBD updates, are those with relatively substantial prevalence or mortality among the diseases and symptoms in the other MSK category. These conditions are systemic lupus erythematosus and other autoimmune diseases, ankylosing spondylitis, psoriatic arthritis, juvenile idiopathic arthritis, osteomyelitis, fibromyalgia or chronic widespread MSK pain, and shoulder pain. Furthermore, finding existing national health surveys, having access to more detailed information than presented in the survey reports and encouraging more data collection on MSK disorders in the regions with missing data would make more precise disease burden estimates possible. It is recommended that questions in health surveys should be amended and improved to enable the underlying MSK conditions and symptoms to be better characterised and classified. Modifications of the statistical analysis procedures and reporting formats, especially for the national health surveys, such as in the USA, would help with the process of separating other MSK data and their uncertainty from those defined MSK conditions and other diseases surveyed. Further research on the disease levels of severity is needed to overcome the limitation of data source necessary for severity distribution estimates.

CONCLUSION

Other MSK category is a major contributor to global disability. Increasing global aged population will see this burden increase further. With the rapid rising of the burden, especially in the GBD regions with low-income and middle-income countries, it is apparent that the disease burden needs to be addressed. Decision making on the best health service in response to the large and increasing burden will require more detailed estimation of the contribution by this large other MSK category. In future iterations of GBD, therefore, it is recommended that specific MSK conditions within this large category should be considered separately to allow more explicit estimates of their burden.

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REFERENCES

1 Cross M, Smith E, Hoy D, *et al*. The global burden of rheumatoid arthritis: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014; Submitted.
2 Cross M, Smith E, Hoy D, *et al*. The global burden of hip and knee osteoarthritis: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014; Submitted.
3 Hoy D, March L, Brooks P, *et al*. The global burden of low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014; Submitted.
4 Hoy D, March L, Woolf A, *et al*. The global burden of neck pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014; Submitted.
5 Sanchez-Riera L, Carnahan E, Vos T, *et al*. Global Burden Attributable to Low Bone Mineral Density. *Ann Rheum Dis* 2014; Submitted.
6 Smith E, Hoy D, Cross M, *et al*. The global burden of gout: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014; Submitted.
7 Driscoll T, Jacklyn G, Orchard J, *et al*. The global burden of occupationally-related low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014; Submitted.
8 Hoy D, Smith E, Cross M, *et al*. Reflecting on the global burden of musculoskeletal conditions: lessons learnt from the Global Burden of Disease 2010 study and the next steps forward. *Ann Rheum Dis* 2014; Submitted.
9 Hoy D, Smith E, Cross M, *et al*. The global burden of musculoskeletal conditions for 2010: an overview of methods. *Ann Rheum Dis* 2014; Submitted.
10 Hoy D, Brooks P, Woolf A, *et al*. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. *J Clin Epidemiol* 2012;65:934–9.
11 Vos T, Flaxman AD, Naghavi M, *et al*. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2013;380:2163–96.
12 Salomon JA, Vos T, Hogan DR, *et al*. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. *Lancet* 2013;380:2129–43.
13 Lopez A, Mathers C, Ezzati M, *et al*. *Global burden of disease and risk factors*. New York, NY: Oxford University Press, 2006.
14 Lozano R, Naghavi M, Foreman K, *et al*. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2013;380:2095–128.
15 Murray C, Lopez A. *The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020*. Boston: Harvard University Press, 1996.
16 Ahmadi B, Boschi-Pinto C, Lopez A, *et al*. *Age standardization of rates: a new WHO standard*. Geneva: World Health Organisation, 2001.
17 Murray CJ, Vos T, Lozano R, *et al*. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2013;380: 2197–223.

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