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Review article

Critical review on the socio-economic impact of tendinopathy

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Abstract

There are currently no studies that determine the total burden that tendinopathy places on patients and society. A systematic search was conducted to understand the impact of tendinopathy. It demonstrated that the current prevalence is underestimated, particularly in active populations, such as athletes and workers. Search results demonstrate that due to the high prevalence, impact on patients' daily lives and the economic impact due to work-loss, treatments are significantly higher than currently observed. A well-accepted definition by medical professionals and the public will improve documentation and increase awareness, in order to better tackle the disease burden.

Keywords: incidence; prevalence; quality-of-life; socio-economic; tendinopathy

Introduction

Clinicians obtain insight into the burden of tendinopathy from their patients, yet their ability to alleviate this burden remains limited. From their observations, it is to be believed that tendinopathy has a significant socio-economic impact, but there is no direct evidence to support this claim. This review aims to determine the socio-economic burden of tendinopathy and how this burden may be alleviated. The definition and classification of tendinopathy currently adopted by medical subject headings are displayed in Figure 1. Tendinopathy is a blanket term for “tendinitis”, “tendinosis”, and “tenosynovitis”. “Tendinitis” was the original term to define pain and inflammation within the tendon, and “tendinosis” was the preferential term to describe the degenerative changes observed. Strictly speaking, “tenosynovitis” refers to inflammation of the synovial sheath surrounding the tendon, thus it should not be regarded as tendinopathy in which degenerative changes are mainly observed in the tendon itself. By contrast, spontaneous tendon rupture, which occurs without prior symptoms, is attributed to mechanical weakness of tendons due to tendinopathic changes.[1] In summary, tendinopathy is characterised by chronic tendon degeneration, resulting in pain and rupture, which are the basic criteria used when searching for relevant information.

The disease burden of tendinopathy can be primarily reflected by the number of patients, the effect on the patients' quality-of-life, cost effectiveness of treatments, and the

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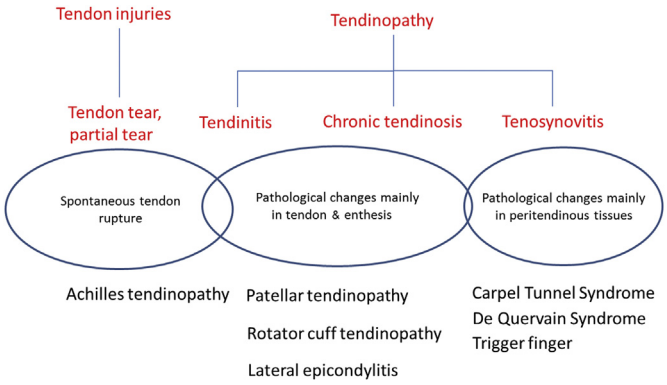

Figure 1. Nomenclature, definitions, and types of tendon disorders.

economic implications of work disability. Therefore, we performed a systematic search of prevalence and incidence data of tendinopathy, and gathered information about quality-of-life, work disability, and treatments specific to tendinopathy.

Prevalence and incidence of tendinopathy

A literature search was performed in PubMed in October 2015 using the search strategy: (Tendinopathy OR tendinitis OR tendonitis OR tendinosis OR tendon rupture OR tendon tear OR jumper's knee OR Sinding-Larsen-Johansson OR epicondylitis OR tennis elbow) AND (prevalence OR incidence OR epidemiology). Studies are included if prevalence or incidence of tendinopathy was reported. Studies on tenosynovitis and traumatic injuries were excluded. Non-English studies, reviews, animal, and cadaveric studies were also excluded. The search returned 1819 articles, of which 132 were included based on the selection criteria. The search results were tabulated according to the nature of the cohort (athletes, workers, general population, and patients with comorbidities), sample size, age group, type of tendinopathy involved, and the reported prevalence and incidence data.

Of the cohorts identified, athletes formed the major cohort with 42 studies, followed by workers (36 studies), individuals in the general population (35 studies), and individuals with comorbidities (19 studies). Achilles' tendinopathy, patellar tendinopathy, epicondylitis, and rotator cuff tendinopathy are identified as four major types of tendinopathy according to numbers of studies and the reported prevalence. The results are shown in Table 1.

Results

Athletes

The high intensity and frequency of physical activities in athletes exposes this group to overuse injuries due to the high stress exerted on the tendons. Records of medical attendance in the 2004 Olympics[2] and 2007 Pan-American Games[3] show that tendinopathy was within the top three most treated conditions in athletes. This record represents the significance of tendinopathy as a widespread condition in this group.

Studies on the prevalence of upper extremity tendinopathy in athletes have observed small cohorts, yet data from studies with the largest sample sizes place the prevalence for rotator cuff tendinopathy at 23.7% in volleyball players, and epicondylitis at 13.1% in climbers.[4,5] Older age may also play a role as evidenced in a study on elderly athletes where prevalence was seen to be as high as 48.2%.[6] There is no study on upper extremity tendinopathy in adolescents to our knowledge. A study on patellar tendinopathy reported a prevalence of approximately 17% in adults and 5.6% in adolescents.[7–10] Similarly, Achilles' tendinopathy was reported to be 12.5% in adults and 7.8% in adolescents.[11,12] Adolescents are seemingly less affected by tendinopathy based on these values alone. There is however no clear evidence that age influences tendinopathy.[13] In agreement with previous studies,[13,14] no clear trend is observed when comparing the prevalence or incidence between male and female athletes.

Lower extremity tendinopathy, particularly that of the patellar tendon, is the most frequently studied and arguably the most commonly affected. However, sports-related tendinopathy is challenging to generalise due to the difference in anatomical sites affected and the degree of exposure. For instance, dancers present with higher prevalence of Achilles' tendinopathy, while rowers would more frequently present with rotator cuff tendinopathy or epicondylitis. In addition, the degree of sport participation would differ widely between recreational athletes and professional athletes, but professional or elite athletes may suffer greater economic losses from injury as compared to recreational athletes. Studies on the degree of participation, the associated risk of tendinopathy development, and the associated impact would be valuable further studies.

Workers

Occupational exposure is of particular relevance because of the high economic impact procured by productivity-loss and compensation for disease. Highly repetitive movements are commonly observed in daily work tasks, and coupled with poor workplace ergonomics, workers are placed at an increased risk of developing tendinopathy. A distinction can be made between workers and athletes in that occupational exposure typically consists of relatively low demand and highly repetitive movements over a longer period of time compared to athletic exposure. Worker cohorts have generally been larger than the athlete cohort. Many of these cohorts have been merged from different workplaces and may possibly be highly heterogeneous even within the same study. Tendinopathy in workers is almost exclusively observed in the upper extremity. The most common and arguably most prevalent of which is lateral epicondylitis. A prevalence of 2–3% have been observed, but rates as high as 18% and 41% have also been reported in spine surgeons and coal miners, respectively.[15–17] Similar to athletic exposures, it is evident that the type of work influences the prevalence of tendinopathy.[17] Relative risk in occupational exposure with regards to frequency of repetitive motion, length of exposure, and ergonomic factors may be worthwhile studies.

Table 1
Prevalence and incidence of tendinopathy in different cohorts.

1st Author, year, Ref	Group	Cohort	*N*	Age	Type of tendinopathy	Prevalence	Incidence
Zapata, 2006[71]	General	Students	791	Adolescent	Tendonitis	2	n/a
Salaffi, 2005[23]	General	Italian general population	2155	Adults	LE	0.7	n/a
Miranda, 2005[18]	General	General population	8028	Adults	RC tendinitis	2	n/a
Rechardt, 2010[72]	General	General population	6237	Adults	RC tendinitis	2.8	n/a
Tajika, 2014[24]	General	Japanese mountain village community	422	Adults	LE	3.8	n/a
Joseph, 2012[73]	General	Asymptomatic active university student body	52	Adults	AT (US)	3.8	n/a
Koplas, 2011[27]	General	Elbow MRI examinations	801	Adults	Triceps tendon tear	3.8	n/a
Waldecker, 2012[74]	General	Non-athletes in orthopaedic clinic	697	Adults	AT tendinopathy	5.6	n/a
Schibany, 2004[75]	General	Asymptomatic patients	212	Adults	Supraspinatus rupture (US)	6	n/a
Zwerver, 2011[39]	General	Nonelite athletes	891	Adults	Jumper's knee	8.5	n/a
Fairley, 2014[35]	General	Community with no history of knee pain or injury	297	Adults	PT (MRI)	28.3	n/a
Walker-Bone, 2012[44]	General	General population	6038	Adults	LE ME	0.7 0.6	n/a
Shiri, 2006[21]	General	General population	4783	Adults	LE ME	1.3 0.4	n/a
Alvarez-Nemegyei, 2011[28]	General	General population	12,686	Adults	RC tendinopathy Bicipital tendinopathy AT tendinopathy	2.4 0.3 0.1	n/a
Walker-Bone, 2004[22]	General	General population	6038	Adults	RC tendinitis Bicipital tendinitis LE ME	3.3 0.4 0.7 0.6	n/a
Shiri, 2007[19]	General	General population	6254	Adults	RC tendinitis Bicipital tendinitis LE ME	3.8 0.5 1.1 0.3	n/a
Girish, 2011[36]	General	Asymptomatic shoulders	51	Adults	Supraspinatus (US) Subscapularis (US) Supraspinatus tear (US)	39 25 22	n/a
Safran, 2002[76]	General	General population	279,500	Adults	Biceps tendon rupture	n/a	1.2/100,000 PY
Witvrouw, 2001[52]	General	Students without knee conditions	138	Adults	PT tendinitis	n/a	13.8% (2 y CI)
Huttunen, 2014[69]	General	Nationwide Sweden	27,702	Adults	AT rupture	n/a	29.5/100,000 PY
Ostor, 2005[77]	General	General population	17,000	Adults	RC tendinopathy	n/a	8.1/1000 PY
Cretnik, 2010[78]	General	General population	572,929	Adults Elderly	AT rupture	n/a	7.6/100,000 PY 1.3/100,000 PY
Darmawan, 1995[25]	General	Indonesian population	1118	All	Epicondylitis	6.6	n/a
Moller, 1996[79]	General	Malmo population	n/a	All	AT rupture	n/a	0.06 (4 y CI)
Clayton, 2008[80]	General	General population	535,000	All	AT rupture	n/a	11.3/100,000 PY
Levi, 1997[81]	General	Copenhagen population	n/a	All	AT rupture	n/a	13.4/100,000 PY
Leppilahti, 1996[82]	General	Oulu population	n/a	All	AT rupture	n/a	18/100,000 PY
Houshian, 1998[83]	General	Danish county	220,000	All	AT rupture	n/a	37.3/100,000 PY
Maffulli, 1999[84]	General	General population	n/a	All	AT rupture	n/a	6/100,000 PY
van der Linden, 2001[70]	General	General population	n/a	All	Tendon rupture	n/a	6.32/100,000 PY
Suchak, 2005[85]	General	Canada general population	967,200	All	AT rupture	n/a	8.3/100,000 PY
Chard, 1987[20]	General	Geriatric unit not admitted for shoulder complaints	100	Elderly	RC tendinitis RC rupture	5 7	n/a
Horowitz, 2013[26]	General	General population	n/a	n/a	Retropharyngeal calcific tendinitis	n/a	0.5/100,000 PY
de Jonge, 2011[86]	General	General population	57,725	n/a	AT tendinopathy	n/a	1.8/1000 PY

(*continued on next page*)

Table 1 (*continued*)

1st Author, year, Ref	Group	Cohort	*N*	Age	Type of tendinopathy	Prevalence	Incidence
Nyyssonen, 2008[87]	General	Finnish population	5.2m	n/a	AT rupture	n/a	11.5/100,000 PY
McCormack, 1990[88]	Worker	Textile workers	2047	Adults	Epicondylitis	2	n/a
Roquelaure, 2006[15]	Worker	Workers	2685	Adults	LE	2.4	n/a
Almeida, 2012[89]	Worker	Workers	951	Adults	Tendinitis	3.2	n/a
Frost, 2002[90]	Worker	Workers	782	Adults	Shoulder tendinitis	3.2	n/a
Descatha, 2003[91]	Worker	Workers	1757	Adults	ME	5.2	1.5% (annual CI)
Fan, 2009[92]	Worker	Workers	733	Adults	LE	5.2	n/a
Rosenbaum 2013[93]	Worker	Latino poultry workers	516	Adults	Epicondylitis	5.8	n/a
Kryger, 2007[94]	Worker	Computer workers with neck or arm pain	1369	Adults	LE	5.8	n/a
Kaergaard, 2000[95]	Worker	Sewing machine operators	243	Adults	RC tendinitis	5.8	n/a
Dimberg, 1987[96]	Worker	Workers	540	Adults	LE	7.4	n/a
Roto, 1984[97]	Worker	Male meat cutters	90	Adults	Epicondylitis	8.9	n/a
Ono, 1998[98]	Worker	Nursery school cooks	209	Adults	Epicondylitis	11.5	n/a
Leclerc, 2001[99]	Worker	Workers	598	Adults	LE	12.2	12.2% (3 y CI)
Capone, 2010[100]	Worker	Plastic surgeons	339	Adults	Epicondylitis	13.5	n/a
Ritz, 1995[101]	Worker	Workers	290	Adults	Epicondylitis	14.1	n/a
Chiang, 1993[102]	Worker	Workers in fish-processing	207	Adults	Epicondylitis	15	n/a
Barrero, 2012[103]	Worker	Workers flower industry	158	Adults	Epicondylitis	15.2	n/a
Auerbach, 2011[16]	Worker	Spine surgeons	561	Adults	LE	18	n/a
Forde, 2005[104]	Worker	Ironworkers	981	Adults	Tendonitis	19	n/a
Sansone, 2015[37]	Worker	Female cashier	199	Adults	RC calcific tendinopathy (US)	22.6	n/a
Cunha-Miranda, 2010[34]	Worker	Workers	410,496	Adults	Shoulder tendonitis Elbow tendonitis Lower limb tendonitis	0.6 0.3 0.1	n/a
Werner, 2002[105]	Worker	Dental hygienists	305	Adults	Shoulder tendinitis Elbow tendinitis	13 6	n/a
Gold, 2009[106]	Worker	Automobile manufacturing workers	1214	Adults	LE ME RC tendonitis	3.3 2.2 12	n/a
Pullopdissakul, 2013[107]	Worker	Workers	591	Adults	LE ME	3.4 1.7	n/a
Nordander, 2009[108]	Worker	Workers	2677	Adults	Supraspinatus tendonitis Infraspinatus tendonitis Bicipital tendonitis LE ME	4.4 3 3.8 2.3 1.2	n/a
Silverstein, 2006[109]	Worker	Workers	436	Adults	RC tendinitis	4.4–7.6	2.9–5.5/100 PY
Ozdolap, 2013[17]	Worker	Coal miners	80	Adults	LE ME	41.2 12.5	n/a
Werner, 2005[38]	Worker	Dental hygiene students Clerical workers	343 164	Adults	Upper extremity tendinitis	5 12	n/a
Fan, 2014[110]	Worker	Workers	607	Adults	Epicondylitis LE ME	6 5 2	7.9/100 PY 5.1/100 PY 2.4/100 PT
Garg, 2014[111]	Worker	Workers	536	Adults	LE	7.3	3.67/100 PY
Alexandre, 2011[112]	Worker	Dentist Physicians Lawyers General population	173,094	Adults	Tendinitis	8.7 5.6 5.5 3.2	n/a
Herquelot, 2013[113]	Worker	Workers	3710	Adults	LE	n/a	1.0/100 PY
Werner, 2005[114]	Worker	Workers	501	Adults	Upper extremity tendonitis	n/a	4.5% (annual CI)
Fan, 2014 Feb[115]	Worker	Workers	611	Adults	LE	n/a	4.9/100 PY
Descatha, 2013[116]	Worker	Workers	699	Adults	Epicondylitis LE ME	n/a	6.9% (36 mo CI) 4.9% (36 mo CI) 4.3% (36 mo CI)

Table 1 (*continued*)

1st Author, year, Ref	Group	Cohort	*N*	Age	Type of tendinopathy	Prevalence	Incidence
McGaughey, 2003[117]	Worker	Expeditioners	292.3 PY	Adults	AT tendonitis	n/a	9.2/100 PY
Barber Foss, 2012[118]	Athletes	Female basketball players	419	Adolescent	SLJ	5	n/a
Tenforde, 2011[12]	Athletes	High school athletes	748	Adolescent	AT tendonitis	7.8	n/a
Emerson, 2010[119]	Athletes	Elite gymnasts	40	Adolescent	AT tendinopathy	15	n/a
Steinberg, 2011[120]	Athletes	Nonprofessional female dancers	1336	Adolescent	Ankle & foot tendonitis	18.8	n/a
Cassel, 2015[10]	Athletes	Adolescent athletes	760	Adolescent	AT tendinopathy PT tendinopathy AT rupture	1.8 5.6 0.1	n/a
Gisslen, 2005[121]	Athletes	Swedish elite junior volleyball players	57	Adolescent	Jumper's knee PT (US)	21 28.9	n/a
Le Gall, 2007[122]	Athletes	Early maturing athletes Late maturing athletes	233	Adolescent	Tendinopathy	n/a	0.06/1000 AE 0.02/1000 AE
Barber Foss, 2014[123]	Athletes	Female middle school athletes	268	Adolescent	SLJ	n/a	0.3/1000 AE
Beachy, 2014[124]	Athletes	Middle school athletes	14,038	Adolescent	Tendinitis	n/a	0.7/1000 AE
Leanderson, 2011[125]	Athletes	Ballet dancers	476	Adolescent	Foot tendinosis Jumper's knee Tendonitis genu Tendinosis groin	n/a	11.8% (7 y CI) 6.5% (7 y CI) 5.2% (7 y CI) 8.6% (7 y CI)
Hickey, 1997[126]	Athletes	Elite female basketball players	49	Adolescent	PT tendinitis	n/a	30.6% (6 y CI)
Dubravcic-Simunjak, 2003[127]	Athletes	Junior figure skaters	469	Adolescent	Jumper's knee AT tendinitis	n/a	8.1 (5 y CI) 2.1 (5 y CI)
Hagglund, 2011[128]	Athletes	Elite male soccer players	2229	Adults	PT tendinopathy	2.4 (season prevalence)	0.1/1000 h
Buda, 2013[11]	Athletes	Climbers	144	Adults	AT tendinitis	12.5	n/a
Pieber, 2012[5]	Athletes	Climbers	193	Adults	Epicondylitis	13.1	n/a
Durcan, 2014[129]	Athletes	Elite rugby academies	83	Adults	PT tendinopathy	13.3	n/a
Lian, 2005[8]	Athletes	Elite athletes	613	Adults	Jumper's knee	14.2	n/a
McCarthy, 2013[7]	Athletes	Women's basketball	496	Adults	PT tendinitis	17	n/a
van der Worp, 2011[9]	Athletes	Basketball & volleyball players	1505	Adults	Patellar tendinopathy	17.8	n/a
Cook, 1998[130]	Athletes	Elite athletes	160	Adults	PT (US)	22	n/a
Lopes, 2009[3]	Athletes	Athletes referred to PT	434	Adults	Tendinopathy	22.4	n/a
Wang, 2001[4]	Athletes	Elite volleyball athletes	59	Adults	RC tendinitis	23.7	n/a
Monteleone, 2014[33]	Athletes	Elite beach volleyball players	53	Adults	RC (US)	30	n/a
Longo, 2011[13]	Athletes	Veteran track & field athlete	174	Adults Elderly	PT tendinopathy	46.6	n/a
Rooks, 1995[131]	Athletes	Rock climbers	39	Adults	Upper extremity tendinitis	50	n/a
Walls, 2010[132]	Athletes	Professional dancers	18	Adults	AT tendinopathy (MRI)	78	n/a
Hagemann, 2004[133]	Athletes	Marathon kayakers	52	Adults	Supraspinatus (MRI) Supraspinatus tear (MRI) Subscapularis (MRI) Subscapularis tear (MRI)	11.5 7.7 1.9 1.9	n/a
Reuter, 2008[134]	Athletes	Ironman triathletes	23	Adults	RC partial tear Shoulder tendinopathy	22 43	n/a
Hadala, 2009[135]	Athletes	Elite yacht sailors	30	Adults	Epicondylitis Biceps brachii tendinitis Shoulder tendinopathy	30 3.3 13.3	n/a

(*continued on next page*)

Table 1 (*continued*)

1st Author, year, Ref	Group	Cohort	*N*	Age	Type of tendinopathy	Prevalence	Incidence
Comin, 2013[40]	Athletes	Ballet dancers	79	Adults	AT (US) PT (US)	8.9 8.9	n/a
Marshall, 2007[136]	Athletes	Collegiate women's softball athletes	9389	Adults	Shoulder tendinitis Elbow tendinitis	n/a	0.12/1000 AE 0.04/1000 AE
Krupnick, 1998[137]	Athletes	White water paddlers	54	Adults	Tendonitis	n/a	0.19/100 AE
Kelly, 2004[138]	Athletes	Elite football quarterbacks	1534	Adults	Biceps tendinitis	n/a	0.5/100 AE
Parekh, 2009[139]	Athletes	National Football League	n/a	Adults	AT rupture	n/a	0.9% (per game CI)
Heir, 1996[140]	Athletes	Military conscripts	6488	Adults	AT tendinitis Shoulder tendinitis	n/a	13.5/1000 conscript-mo 2.1/1000 conscript-mo
Wolf, 2010[141]	Athletes	US military population	n/a	Adults	LE ME	n/a	2.3/1000 PY 0.8/1000 PY
McFarland, 1998[142]	Athletes	Collegiate baseball players	12,828 AE	Adults	RC tendinitis	n/a	3.4/1000 AE
White, 2007[143]	Athletes	US army soldiers	93,224 AE	Adults	Tendon rupture	n/a	5.6/100 AE
Milgrom, 2003[144]	Athletes	Male infantry recruits	1405	Adults	AT tendinopathy	n/a	6.8% (4 period each 14 wk CI)
McMahon, 2014[6]	Athletes	Elite athletes	141	Elderly	RC tendinosis RC partial tear RC complete rupture	16.3 48.2 21.3	n/a
Kettunen, 2011[145]	Athletes	Former elite male athletes	785	Elderly	Shoulder tendinopathy Shoulder tendon rupture	n/a	33% (lifetime CI) 19% (lifetime CI)
Kujala, 2005[41]	Athletes	Former elite male athletes	785	Elderly	AT rupture AT tendinopathy	n/a	8.3% (lifetime CI) 23.9% (lifetime CI)
Njobvu, 2006[29]	Patients	HIV positive patients	65	Adults	Tendinitis	3.1	n/a
Cannon, 2007[146]	Patients	Cervical radiculopathy with upper limb symptoms	191	Adults	LE	4.7	n/a
Hautmann, 2014[147]	Patients	Patients with painful heel	101	Adults	AT tendinitis	11.9	n/a
Frey, 2007[31]	Patients	Overweight or obese	738	Adults	Ankle & foot tendinitis	16.7	n/a
Finley, 2004[32]	Patients	Manual wheelchair users	52	Adults	Biceps tendonitis	30.1	n/a
Baumann, 2008[148]	Patients	Diagnostic shoulder arthroscopies	1007	Adults	Shoulder tendinitis Shoulder partial tear	1.5 0.8	n/a
Chhajed, 2002[149]	Patients	Lung transplant recipients treated with ciprofloxacin	101	Adults	AT tendonitis AT rupture	15.8 5.9	n/a
Ramirez, 2014[150]	Patients	Patients with greater trochanteric pain	107	Adults	Gluteus medius tendinosis Gluteus minimus tendinosis	36.4 67.3	n/a
Taunton, 2002[151]	Patients	Patients with running related injury	2002	Adults	PT tendinopathy AT tendinopathy	4.2 4.8	n/a
Bird, 2001[152]	Patients	Patients with greater trochanteric pain	24	Adults	Gluteus medius tear Gluteus medius tendinitis	45.8 37.5	n/a
Shah, 2008[30]	Patients	Stroke patients with painful shoulder	89	Adults	RC tendinopathy RC tear	53 35	n/a
Pong, 2012[153]	Patients	Stroke patients with hemiplegic shoulders	76	Adults	Shoulder tendinopathy	68.4 Acute 80.3 Chronic	n/a
Kingzett-Taylor, 1999[154]	Patients	Patients with buttock, lateral hip, or groin pain	250	Adults	Gluteal tear Gluteal tendinosis	8.8 5.2	n/a
Chung, 2013[155]	Patients	Nurses with musculoskeletal disorder	3914	Adults	ME LE	n/a	0.25% (1 y CI) 0.58% (1 y CI)
Barge-Caballero, 2008[156]	Patients	Heart transplant patients under quinolones	149	Adults	AT tendinopathy AT rupture	n/a	9.4% (11 y CI) 2% (11 y CI)
Ramos, 2009[157]	Patients	Patients with knee pain	318	All	PT tendinopathy	32.3	n/a

Table 1 (*continued*)

1st Author, year, Ref	Group	Cohort	*N*	Age	Type of tendinopathy	Prevalence	Incidence
Helliwell, 2003[158]	Patients	Patients with soft tissue disorders	1382	All	Shoulder tendinitis LE	11.3 6.3	n/a
Sode, 2007[159]	Patients	First time fluoroquinolone users	28262	All	AT rupture	n/a	0.02 (90 d CI)
Zakaria, 2014[160]	Patients	Diabetes patients	1296	Elderly	Tendon rupture	n/a	5.21/1000 PY

AE = athlete exposure; AT = Achilles tendon; CI = cumulative incidence; h = hours; LE = lateral epicondylitis; ME = medial epicondylitis; MRI = magnetic resonance imaging diagnosed; N = sample/cohort size; n/a = not available; PT = patellar tendon; PY = person-years; RC = rotator cuff; SLJ = Sinding-Larsen-Johansson; US = ultrasound diagnosed; y = years.

General population

In the general population, the prevalence of clinically diagnosed rotator cuff tendinopathy in adults was reported to range from 2% to 3.8%,[18,19] with a marginally higher prevalence observed in the elderly population at 5–7%.[20] Although it may not be accurate to compare values from different studies, it is worth noting that the value in the general population approaches that of the worker cohorts. In the elbow joint, prevalence of lateral epicondylitis and medial epicondylitis in European cohorts were reported at 0.7–1.3% and 0.3–0.6%, respectively.[19,21–23] Two outliers were reported on lateral epicondylitis in a Japanese mountain village cohort at 3.8% and on epicondylitis in the Indonesian general population at 6.6%.[24,25] The divergence in values in these groups suggest that societal aspects also come into play and may be influenced by environmental, cultural, or economic differences among societies. Age and gender do not seem to influence tendinopathy within this cohort. Although upper extremity tendinopathy has been more frequently studied in the general population, less common conditions have also been observed, such as retropharyngeal tendinitis (0.5/100,000 person-years) triceps tendon tears (3.8%)[26,27] and bicipital tendinitis (0.3%–0.5%).[19,28]

Comorbidity cohorts

Nineteen studies reported tendinopathy in cohorts with other associated conditions such as HIV positive patients,[29] stroke survivors,[30] obese cohorts,[31] wheelchair users,[32] etc. (Table 1). Some studies do not investigate the association of tendinopathy with other disease conditions, but instead report tendinopathy as part of a group of patients with musculoskeletal complaints in general. A general trend of increased prevalence is seen when compared with the general population; however due to the variety of conditions, and how they impact tendinopathy, the data cannot be utilised to assess the prevalence of tendinopathy within this cohort. These studies provide evidence that there are intrinsic risk factors for tendinopathy and research into the relationship between them would be worthwhile in understanding the aetiology of tendinopathy.

Summary of systematic review

There is currently a gap in the available evidence on incidence rates as most studies carried out on the general population are on tendinopathic ruptures only. The actual prevalence of tendinopathy may be higher due to diagnosis. Clinical diagnosis is the main diagnostic technique, with radiological imaging, such as magnetic resonance imaging (MRI) and ultrasound being used to support the diagnosis. Studies that defined tendinopathy using radiological imaging revealed a higher incidence rate compared with studies that used clinical evaluation only.[33–39] This discrepancy is caused by the inclusion of patients who did not present with symptoms at the time of examination, suggesting that asymptomatic patients are left unnoticed in tendinopathy diagnosis.[40] This is important since the lifetime cumulative incidence of retired elderly athletes is approximately 25%, suggesting that symptoms may develop later than when the injury was sustained.[41]

In summary, specific types of tendinopathy are more prevalent in the different groups. Epicondylitis and rotator cuff tendinopathy were preferentially investigated in workers and the general population, with workers having a higher prevalence and incidence of tendinopathy. Patellar tendinopathy was more frequently investigated in the athlete population, revealing a higher prevalence and incidence when compared with the other groups. Finally, age and sex does not seem to play a factor in tendinopathy.

Effects of tendinopathy on quality-of-life and cost-effectiveness of treatment

A community-based survey compared the socio-economic impacts of four musculoskeletal conditions including tendinitis (tendinopathy), rheumatoid arthritis, osteoarthritis, and lower back pain. Although tendinopathy was found to be less influential to work loss,[42] shoulder tendinopathy took approximately 10 months to heal and workers take greater amounts of sick leave to recover,[43–45] report being less productive at work,[9] and require workers' compensation for disease.[46,47] Finally, even though patients may return to work within 6 weeks following operative repair, recovery may take a few months.[48] The burden placed on daily activities cannot be ignored, with one study claiming that about a quarter of patients with tennis elbow (epicondylitis) reported difficulty in activities such as dressing, carrying objects, driving, and sleeping.[49] The indirect costs can reach great amounts in terms of productivity loss and worker's compensation. Up to 5% of patients with lateral epicondylitis have claimed sickness absence with an average duration of 29 days in a year.[44] Thus, absenteeism (in the working population aged 25–64) due to

lateral epicondylitis in the United Kingdom alone is estimated to cost £27 million using 2012 global population statistics and median wage.[44,50,51] Productivity-loss and disease compensation associated with tendinopathy are remarkable, and the high prevalence of tendinopathy, as revealed by the search results on tendinopathy prevalence, suggests that the disease burden may be greater than currently understood.

The goals of tendinopathy treatment are pain reduction, recurrence prevention, and return to sports or preinjury functionality. Treatment aims to remain conservative with oral nonsteroidal anti-inflammatory drugs, corticosteroid injections, and physical therapy as the mainstay in tendinopathy management. Other therapies include injections of platelet-rich plasma or autologous blood. Finally, failure of conservative treatments leads to surgical intervention to excise the tendinopathic tissue and repair the ruptured tendon.[52,53] Yet the cost analysis on various tendinopathy treatments is inadequate. Direct outpatient medical costs were reported as ranging from €430/patient for corticosteroid injection to €921/patient for physical therapy, for lateral epicondylitis (currency in 2004).[54] Repeated medical visits are also a concern as lateral epicondylitis is recurrent, and almost half of those affected have seen their general practitioner within the past 12 months.[44] Cost/quality-adjusted-life-years for physical therapy and corticosteroid injection were £18,962 and £20,518, respectively, values which fall within the benchmark of £20,000 to £30,000 (currency in 2015) and are comparable to the common drug treatments for osteoarthritis and osteoporosis (currency in 2005 and 2004, respectively).[55–57] Economic evaluations on other tendinopathic conditions are lacking and research on this aspect would be valuable.

Documentation and awareness of tendinopathy

Although tendinopathy is well-recognised in the academic field as listed in the medical subject headings, only tendinitis and spontaneous tendon ruptures are stated within the current version of International Classification of Diseases (ICD) by the World Health Organization (WHO), but tendinosis and tendinopathy are absent.[58] Tendinitis and tendinosis, continue to be mainstay diagnostic terms, but as tendinopathy has become the accepted term within the medical field, it should be similarly recognised by the public. Healthcare organisations, such as WHO and the Centre for Disease Control (CDC), and orthopaedic organisations, such as the Bone Joint Decade (BJD) and the Fracture Fragility Network (FFN), do not have definitions or information for the term "tendinopathy". Evidence from our search has demonstrated that despite clinical diagnosis being the mainstay diagnostic technique, MRI and ultrasound are favourable, particularly for asymptomatic patients. Implementation of a standardised, radiological technique, would allow for the inclusion of symptomatic patients, asymptomatic patients, and patients with ruptures to be recognised under the definition of tendinopathy.

Failure to recognise and report an incident, and failure to seek medical attention, amongst other factors may lead to two thirds of tendinopathy cases going unreported, thus the proportion of individuals with tendinopathy may be higher than reported.[59] Tendinopathy appears to be particularly prevalent in productive populations that actively contribute to societal development, such as athletes and workers. Despite these indications that tendinopathy may be highly prevalent in society, it remains an under-recognised disease.

Osteoarthritis and osteoporosis are well recognised and studied by researchers, WHO, CDC, and are also key topics in BJD and FFN. These diseases are particularly prevalent in the elderly, thus, their impact on productive demographics may be lower, when compared with tendinopathy.[60,61] The National Coalition for Osteoporosis and Related Bone Diseases (with support from WHO) and The Arthritis Foundation (with support from CDC) have published action plans to address insufficiencies in tackling osteoporosis and osteoarthritis, respectively.[62,63] The Australian government published their own action plan (similar to the aforementioned plans) to tackle osteoporosis, osteoarthritis, and rheumatoid arthritis.[64] These action plans provide a framework to implement research, prevention, treatment, and education within the public. Internet resources are playing a greater role in how the public recognises diseases. Both CDC and WHO have published data on recognising symptoms, prevention, and treating both osteoarthritis and osteoporosis, targeted toward the general public for easy access to information. Our search results have demonstrated that tendinopathy is not well-documented in relation to other diseases; however, the awareness of risk-factors of osteoporosis and osteoarthritis are well-recognised, such as obesity and diabetes, allowing for better disease prevention. The International Osteoporosis Foundation and National Osteoporosis Foundation conducted a study to determine the global prevalence of osteoporosis, and the North Staffordshire Osteoarthritis Project conducted a census to determine the prevalence and impact of osteoarthritis.[65,66] These studies demonstrate that greater awareness, leads to support by well-established organisations, and aid in determining disease prevalence and impact. Current healthcare registries are a useful tool in tracking and studying diseases, and this has helped study the prevalence of osteoporosis through hip fracture and osteoarthritis through total knee replacements.[67] Thus, this implores the question as to why tendinopathy does not receive similar awareness and action, when the prevalence may be similar to osteoarthritis and osteoporosis.

Determining the true prevalence of tendinopathy is the first step in studying the impact that tendinopathy has on society, and for this, national health registries are a useful tool, with Sweden, Finland, and The Netherlands using their own registries to study the prevalence of tendon rupture.[68–70] However, in order for national health registries to run effectively, they require standardised nomenclature and diagnostics. For example, the Swedish Hospital Discharge Registry utilises the ICD in their system, yet without the recognition of tendinopathy in the database, incidences are not recorded. There is currently no organisation specialising in raising awareness for tendinopathy. Through such an organisation of specialists in this field, we may present a greater front in establishing these

standardised definitions of tendinopathy, and having established this, it is necessary to approach international organisations such as WHO, CDC, BJD, and FFN, to gain recognition of the disease in professional fields, as well as have the term properly recognised by the ICD. Establishing these foundational aspects, tendinopathy may be better recognised by the public, patients may be encouraged to seek earlier medical attention, resources will be appropriately allocated to alleviate the burden of tendinopathy, and conclusive studies on the prevalence and socio-economic impact of tendinopathy can be implemented.

Conclusion

The definition of tendinopathy is variable, making proper documentation difficult. Tendinopathy should be defined using widely accepted criteria used by professionals, to include symptomatic, asymptomatic, and rupture patients. Our search results demonstrate that tendinopathy is prevalent in a variety of demographics, particularly in younger generations that are most active in society, yet the public awareness is low. By encouraging awareness in both the professional and public fields, we will enhance our understanding and make appropriate changes in how to tackle the disease.

These proposed changes will be slow, and require persistent effort from experts in the field of tendinopathy. Furthermore, the capacity to make such changes varies widely around the globe, in which some societies may not be able to implement the same systems or interventions as others. However, through these actions we may be able to enhance global awareness of the disease and relieve the burden tendinopathy currently places on society.

Conflicts of interest

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