



REVIEW

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Prevalence of hallux valgus in the general population: a systematic review and meta-analysis

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Abstract

Background: Hallux valgus (HV) is a foot deformity commonly seen in medical practice, often accompanied by significant functional disability and foot pain. Despite frequent mention in a diverse body of literature, a precise estimate of the prevalence of HV is difficult to ascertain. The purpose of this systematic review was to investigate prevalence of HV in the overall population and evaluate the influence of age and gender.

Methods: Electronic databases (Medline, Embase, and CINAHL) and reference lists of included papers were searched to June 2009 for papers on HV prevalence without language restriction. MeSH terms and keywords were used relating to HV or bunions, prevalence and various synonyms. Included studies were surveys reporting original data for prevalence of HV or bunions in healthy populations of any age group. Surveys reporting prevalence data grouped with other foot deformities and in specific disease groups (e.g. rheumatoid arthritis, diabetes) were excluded. Two independent investigators quality rated all included papers on the Epidemiological Appraisal Instrument. Data on raw prevalence, population studied and methodology were extracted. Prevalence proportions and the standard error were calculated, and meta-analysis was performed using a random effects model.

Results: A total of 78 papers reporting results of 76 surveys (total 496,957 participants) were included and grouped by study population for meta-analysis. Pooled prevalence estimates for HV were 23% in adults aged 18-65 years (CI: 16.3 to 29.6) and 35.7% in elderly people aged over 65 years (CI: 29.5 to 42.0). Prevalence increased with age and was higher in females [30% (CI: 22 to 38)] compared to males [13% (CI: 9 to 17)]. Potential sources of bias were sampling method, study quality and method of HV diagnosis.

Conclusions: Notwithstanding the wide variation in estimates, it is evident that HV is prevalent; more so in females and with increasing age. Methodological quality issues need to be addressed in interpreting reports in the literature and in future research.

Background

Hallux valgus (HV) is one of the most common chronic foot complaints presenting to foot and ankle specialists [1], occurring when the hallux deviates laterally towards the other toes, and the first metatarsal head becomes prominent medially [2]. As well as being a major contributor to the costs for forefoot surgery, HV has been linked to functional disability, including foot pain [3], impaired gait patterns [4], poor balance [5], and falls in older adults [6,7].

Although HV has gained substantial attention in both historic and recent literature, several authors have highlighted the fact that a true prevalence estimate for HV is difficult to ascertain [8,9]. A wide range of prevalence estimates for HV has been presented in a multitude of independent reports. National health surveys in the United States have reported a prevalence of 0.9% across all age groups [10], while a more recent survey in the UK reported a prevalence of 28.4% in adults [9]. Research conducted in elderly populations has indicated prevalence rates as high as 74% [11]. Individual studies have reported that HV is more common in female and elderly individuals [9,12]; however, there has been no synthesis of the literature to date or synopsis derived.

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Due to the lack of firm epidemiological data relating to HV, it is difficult to estimate the impact that this condition has on the population; thus, in order to establish the need for future research, a better understanding of HV prevalence is warranted. To date there has been no published systematic review investigating the prevalence of HV and the influence of age and gender. Therefore, the aim of this systematic review and meta-analysis was to examine HV prevalence in the overall population and in age and gender subgroups.

Methods

Data sources

Electronic databases (Medline, Embase, and CINAHL) were searched by the first author for all years available up to June 2009 to identify all publications discussing HV prevalence. Broad MeSH terms and keywords were used combining the following: the condition of interest (e.g. *bunion* or *hallux valgus* or *great toe deformity* or *foot deformity* or *foot problem*) and epidemiological terms (e.g. *questionnaire* or *survey* or *prevalence* or *incidence*). For the full search syntax with truncation used for each database refer to Additional file 1 (*Additional file 1.xls*). Reference lists of all included papers were hand-searched to identify grey literature (i.e. government publications and theses), articles that were too old to be indexed on electronic databases, and articles without abstracts that were missed by the initial search strategy.

Study selection

All titles and abstracts retrieved by the above search strategy were scanned by the first author using an initial screening question: *Does the article appear to discuss prevalence of hallux valgus or bunions?* The full text was sourced if required, and the same author undertook detailed eligibility assessment using pre-determined criteria based on HV diagnosis (including both clinically diagnosed HV and self-reported bunions), study design, and reports of original quantitative data for HV prevalence (Figure 1). Surveys of specific disease groups (e.g. rheumatoid arthritis or diabetes), intervention studies, and studies where prevalence data was grouped with other foot deformities were excluded. As this review was not restricted to the English language, translations were sourced for articles written in German, Russian, Spanish, Serbian, Turkish, and Chinese.

Quality assessment

Papers were scored for quality by two independent assessors using the Epidemiological Appraisal Instrument (EAI) [13], which has been shown to be a reliable and valid tool for assessing observational studies. Items not applicable to cross-sectional study designs were removed, resulting in a 17-item scale. Title, author and

journal details were removed to de-identify articles prior to rating. Disagreements between the two assessors were resolved by consultation with a third party. Each item was scored as either "Yes" (score = 2), "Partial" (score = 1), "No" (score = 0), "Unable to determine" (score = 0), or "Not Applicable" (item was removed from scoring). Detailed criteria to determine each response were modified from the original instrument and agreed upon by all assessors prior to rating. The overall score was derived as an average of the scores for all 17 items (range 0-2). Studies were then classified as either "high" or "low" quality using the median quality score (0.91).

Data extraction

Data extraction was performed by the first author, and queries discussed and resolved by all authors in regular meetings. Prevalence data were extracted for each study population and converted to raw counts of individuals with HV. Raw prevalence data for age and gender subgroups was also extracted separately wherever possible, as previously published literature has suggested that HV prevalence varies with these factors [9]. Authors were contacted where additional information was required.

Statistical methods

The summary statistic for each study or subgroup was a prevalence proportion, calculated as the ratio of the number of individuals with HV to the sample size of that study or subgroup. The standard error for each prevalence estimate was then calculated. Meta-analysis was performed to obtain pooled prevalence estimates using a random effects model, which gives an average estimate across studies weighted by sample size. A Chi-squared test was used to determine heterogeneity across studies. Due to the diversity of study populations, prevalence estimates were only pooled between studies with similar age and gender characteristics. For the purposes of this age subgroup analysis, we categorised age by three broad categories: juvenile (< 18 years), adult (18-65 years), and elderly (> 65 years). Studies in which the sample did not exactly fall within one of these age categories were categorised independently by each author, and if a consensus could not be reached data were excluded from the age subgroup analysis.

The subgroup (24 studies) that reported HV prevalence for the overall population (i.e. all ages included in their sample, and a prevalence estimate given that was not split by gender or age) was further analysed for potential sources of bias. Studies were grouped according to sampling method, definition of HV, and study quality to determine if these factors influenced prevalence estimates. Influence of sample size and publication year were investigated by funnel plots. All analyses were performed using Stata version 10 [14].

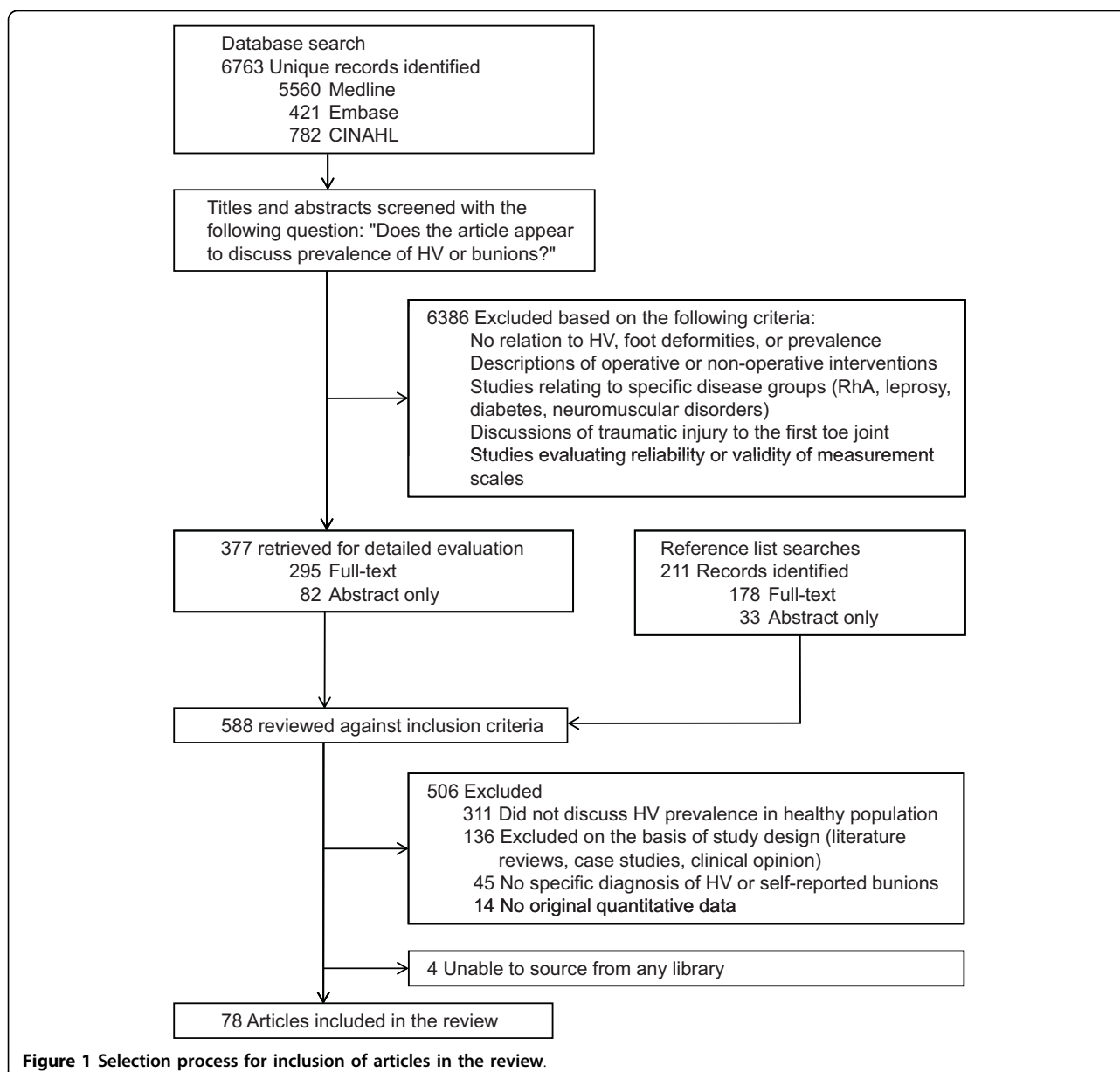


Figure 1 Selection process for inclusion of articles in the review.

Results

Database search

The database search yielded a total of 8456 hits, from which 1693 were removed as duplicates. The remaining 6763 citations were scanned by title and abstract, and 377 potentially relevant records were identified. Fifty-seven of these satisfied all eligibility criteria and gave original data for HV prevalence. Hand-searching of reference lists yielded another 211 potentially relevant titles, of which 21 met all eligibility criteria and were included in the review. A total of 78 papers were included and underwent quality assessment (Figure 1). Papers that reported on the same sample as a previously published study ($n = 7$) were only included once in the

analysis. Four papers reported data from more than one sample population; thus, data were extracted from a total of 76 studies (total 496,957 participants). One author was contacted to provide clarification that multiple papers reported data from the same sample. Another author who only provided graphical data for age and gender subgroups was also contacted during data extraction.

Study characteristics

Selected characteristics of all studies included in the review can be found in Additional file 2 (*Additional file 2.xls*). Study characteristics varied widely in terms of study population and methodology. Twenty-eight studies

(37%) were conducted in the USA, 21 (28%) in the UK, 8 (10%) in Australia, and 4 (5%) in Germany, with the remaining 15 studies (20%) conducted in other regions. More than half of studies (66%) conducted a clinical examination, while others utilised interviews (13%) or questionnaires (7%) to gather self-report data. Fifteen studies (20%) were published after the year 2000, and 19 studies (25%) were published before 1970. Sample sizes varied widely, with the smallest sample reported being 30 individuals [15], and the largest sample being 197,422 individuals surveyed in a US National Health Survey [16].

Quality assessment

Overall agreement for rating of quality of reporting and methodology between the two assessors was 87%. The results from the quality assessment can be found in Additional file 3 (*Additional file 3.xls*). The quality assessment revealed that only 18 studies (24%) used a random sampling method, only 39% of studies adequately described their sampling frame, and less than half of studies (47%) provided a simple description of study participant characteristics, such as age and gender. Despite the importance of a clear definition of HV, only twelve studies (16%) defined HV according to angular criteria. Reliability and validity of measurement methods were described in only five (7%) and four (5%) studies, respectively.

Meta-analysis

Studies included in the meta-analysis, grouped by age of study population, are listed in Additional file 4 (*Additional file 4.xls*). Meta-analysis by age subgroups revealed a prevalence of 23% (CI: 16.3 to 29.6) in adults aged 18-65 years (15 studies), and HV prevalence clearly increased with age (Table 1). Studies that reported HV prevalence by gender consistently showed a higher prevalence of HV in females [30% (CI: 22 to 38)] (23 studies) compared to males [13% (CI: 9 to 17)] (22 studies) (Figure 2). However, there was a high degree of heterogeneity between studies in all subgroups (χ^2 156.55 to 3213.78; $p < 0.0001$; $I^2 = 95.8\%$ to 99.6%).

Finally, prevalence estimates were influenced by method of HV diagnosis (self-report or clinically diagnosed), sampling methods (random, convenience, or biased) and study quality. Studies using self-report data and random sampling methods, as well as those with high quality scores on the EAI reported lower prevalence estimates. There was no consistent trend apparent with regard to sample size or publication year (Figure 3).

Discussion

This review revealed a wide variation in HV prevalence estimates, and meta-analysis showed that systematic

Table 1 Pooled random effects estimates for HV prevalence by age subgroup expressed as % (95% CI)

	Overall	Male	Female
Juvenile			
Pooled prevalence estimate	7.8 (6.2 to 9.5)	5.7 (3.7 to 7.6)	15.0 (7.7 to 22.3)
Number of studies	16	5	6
Adult			
Pooled prevalence estimate	23.0 (16.3 to 29.6)	8.5 (1.4 to 15.6)	26.3 (16.5 to 36.2)
Number of studies	15	8	9
Elderly			
Pooled prevalence estimate	35.7 (29.5 to 42.0)	16.0 (10.6 to 21.3)	36.0 (26.9 to 45.1)
Number of studies	37	16	16

differences in these estimates were related to a number of factors, including method of HV diagnosis, gender, age, study quality, and sampling method. The finding that substantial differences may be related to the method of HV diagnosis (i.e. self-report or clinical examination) (Figure 3), confirms the results of a number of studies that have shown lower prevalence rates with the self-report methods commonly used in large-scale surveys when directly compared to clinical examination [17-22]. Prevalence of HV may therefore be under-reported in epidemiological surveys that rely on self-report data.

Systematic differences according to gender and age were clearly demonstrated by our meta-analysis. The pooled estimate of HV prevalence in females (30%) was 2.3 times greater than the estimate for males (13%). This supports the observation of several individual reports that HV is more prevalent in females. For example, a recent large-scale epidemiological study of people older than 30 years reported a prevalence of 38% in women compared to 21% in men [9], and another recent survey of older adults reported a prevalence of 58% in women and 25% in men [12]. The trend for an increase in HV prevalence with age was also demonstrated by our data: 7.8% in juveniles (16 studies, $n = 73,030$), 23% in adults aged 18-65 years (15 studies, $n = 23,790$) and 35.7% in the elderly (37 studies, $n = 16,001$) (Table 1).

Variations in reported prevalence of HV in previous literature may also be explained by differences in study quality and methodological issues, particularly sampling bias (Figure 3). We identified a trend for higher prevalence estimates from studies with low quality scores on the EAI (score < 0.91). Higher prevalence estimates were also reported by studies using convenience samples [23-29] or biased samples of people seeking treatment for foot problems [15,30,31], in comparison to those

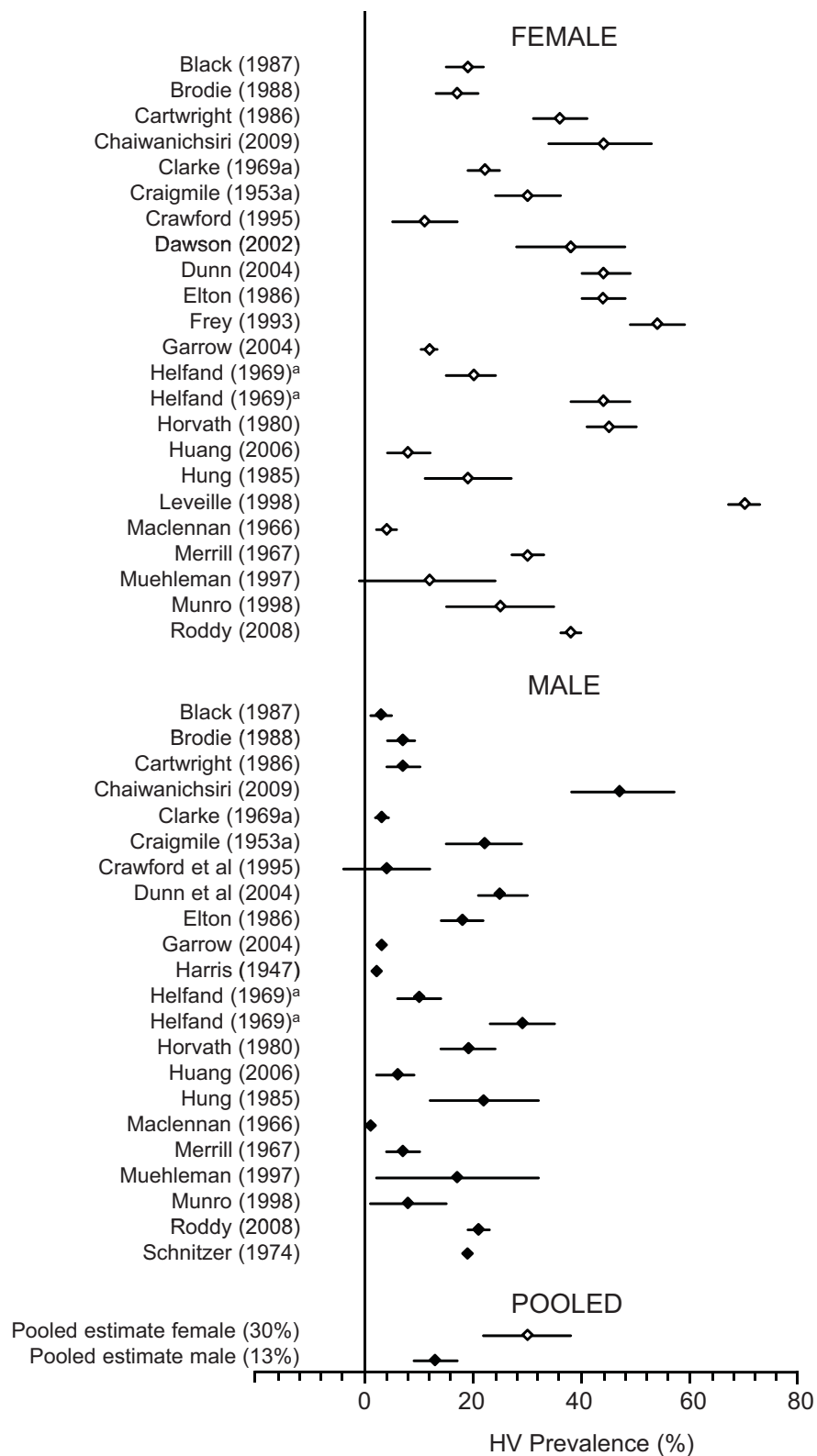
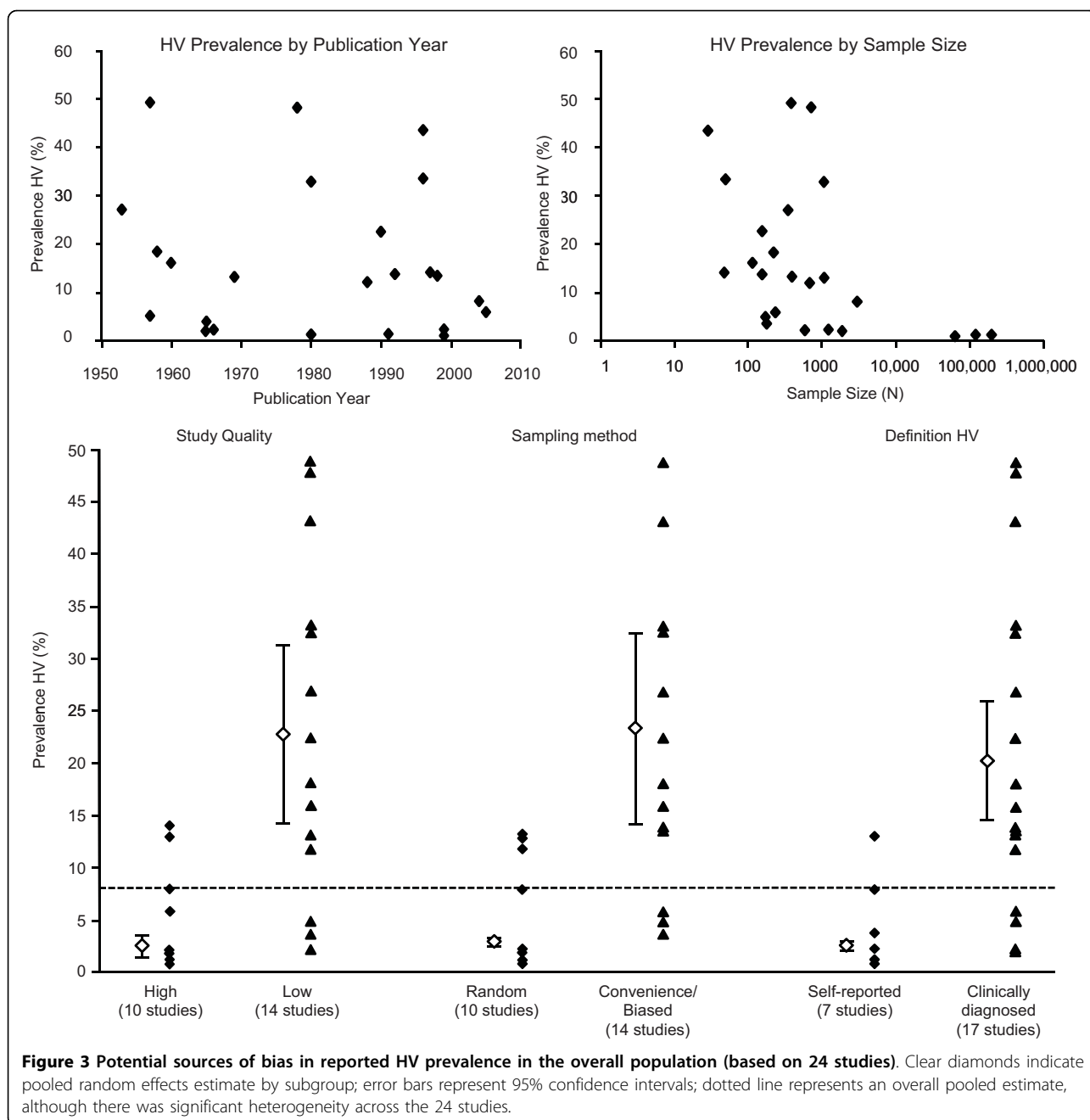


Figure 2 HV prevalence estimates by gender. Diamonds indicate prevalence estimates by male (black diamonds) and female (white diamonds) subgroups, with bars representing 95% confidence intervals. ^a Study reported more than one prevalence estimate based on different diagnostic methods in the same sample population (self-reported vs. clinically diagnosed HV).



studies that used random sampling from the general population [10,16,32-39]. Potential bias may be introduced by lower quality studies with sampling bias; however, as discussed previously, this trend may also be related to the fact that these “low” quality studies were mostly clinical studies that diagnosed HV rather than relying on self-report data.

Our findings should be considered in light of several limitations in the available literature concerning HV. One major concern is the lack of a clearly stated

definition of HV in the majority of studies reviewed. Even in those studies where HV was observed on clinical examination, very few described a quantifiable method of measuring HV. Only 16% of studies in our review defined a diagnosis of HV using angular criteria measured clinically or on x-ray. A few more recent studies used the Manchester Scale, a categorical scale based on standardised photographs with four gradings to classify HV severity [40-43]. Of those studies that collected self-reported prevalence data via interview or

questionnaire, only a few provided participants with a definition or diagram of HV [9,35,44]. In addition, there is confusion surrounding the interchangeable use of the terms “bunion” and “hallux valgus.” In this review both terms were considered to represent HV; however, the term “bunion” strictly refers to the medial bursitis that may develop over the first metatarsal head as a result of irritation [1]. Most included studies that used self-report data asked subjects about “bunions”; undoubtedly, a poor understanding of the terms used in a questionnaire or interview will result in inaccurate self-report data. Finally, there has been poor reporting of the reliability and validity of methods used to diagnose HV. Clearly, for accurate prevalence data to be collected and compared across different populations a consistent definition of HV and validated measurements should be employed.

Another consideration for our meta-analysis was the statistically significant degree of heterogeneity or variation across studies. Wide variations in sample populations meant that much of the retrieved data could not be pooled; however, pooling of estimates across age and gender subgroups was considered to be an important synopsis of the available literature pertaining to HV. Our subgroup meta-analysis was limited by the fact that not all studies reported HV prevalence by gender or age. Those studies that did report prevalence by age used a range of different age groupings, which rendered impossible further sub grouping the 18-65 years age bracket. Our analysis of potential sources of bias (Figure 3) was conducted to attempt to explain this variation between studies and highlight possible sources of heterogeneity.

Finally, insufficient data was available to examine the influence or adjust for other factors such as ethnicity, geographic location, shoe wearing or socioeconomic status on HV prevalence. Details of sampling frame and sample characteristics were also often poorly reported, as revealed by our quality assessment (Additional file 3 *Additional File 3.xls*). The vast majority of studies did not report on the presence of symptoms (i.e. pain or disability) related to HV, and therefore this factor could not be investigated by our review.

Having highlighted the limitations of the currently available epidemiological data relating to HV, further large-scale epidemiological studies are clearly warranted. Future studies should utilise rigorous methods, including random sampling from the general population and from different ethnic and socioeconomic groups. Validated tools should be used to diagnose HV, and results should be reported by gender and age as these factors are known to be associated with HV prevalence. Information relating to the presence of symptomatic versus asymptomatic HV would also be of great benefit in determining the impact of HV on the general population. Clear reporting of all these factors in future studies

will provide an evidence base that will enhance our understanding of the impact of HV on the population and the health care system, and subsequently assist with the delivery of appropriate treatment. Due to its prevalence in the aging population, further research should focus on the impact of HV on mobility and quality of life in the elderly.

Conclusions

This meta-analysis reveals a high prevalence of HV in the overall population and highlights the wide variation in prevalence estimates across studies. Our results also support the commonly held view that HV is more prevalent in women and the elderly. This study has highlighted the issues that make it difficult to provide a true estimate of HV prevalence in the general population, with recommendations for future research.

Additional material

Additional file 1: Search syntax used for electronic databases.

Additional file 2: Selected characteristics of papers included in systematic review [4,5,9-11,15-38,37-40,42-87].

Additional file 3: Results from quality assessment.

Additional file 4: Studies included in meta-analysis, grouped by age of study population.

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Authors' contributions

All authors contributed equally to the conception and design of this study. SN carried out literature searches, quality assessments, data extraction and statistical analysis and was responsible for drafting of the manuscript. MS also carried out quality assessments. MS and BV were responsible for supervision, including interpretation of data and critical revision of the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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References

1. Vanore JV, Christensen JC, Kravitz SR, Schuberth JM, Thomas JL, Weil LS, Zlotoff HJ, Couture SD: **Diagnosis and treatment of First Metatarsophalangeal Joint Disorders. Section 1: Hallux valgus.** *J Foot Ankle Surg* 2003, **42**:112-123.
2. Mann RA, Coughlin MJ: **Adult Hallux Valgus.** In *Surgery of the Foot and Ankle*. Edited by: Coughlin MJ, Mann RA. St. Louis: Mosby; , 7 1999:1:150-175.
3. Benvenuti F, Ferrucci L, Guralnik JM, Gangemi S, Baroni A: **Foot pain and disability in older persons: an epidemiologic survey.** *J Am Geriatr Soc* 1995, **43**:479-484.

4. Menz HB, Lord SR: **Gait instability in older people with hallux valgus.** *Foot Ankle* 2005, **26**:483-489.
5. Menz HB, Lord SR: **The contribution of foot problems to mobility impairment and falls in community-dwelling older people.** *J Am Geriatr Soc* 2001, **49**:1651-1656.
6. Koski K, Luukinen H, Laippala P, Kivela SL: **Physiological factors and medications as predictors of injurious falls by elderly people: a prospective population-based study.** *Age Ageing* 1996, **25**:29-38.
7. Tinetti ME, Speechley M, Ginter SF: **Risk factors for falls among elderly persons living in the community.** *N Engl J Med* 1988, **319**:1701-1707.
8. Menz HB, Munteanu SE: **Radiographic validation of the Manchester scale for the classification of hallux valgus deformity.** *Rheumatology* 2005, **44**:1061-1066.
9. Roddy E, Zhang W, Doherty M: **Prevalence and associations of hallux valgus in a primary care population.** *Arthritis Rheum* 2008, **59**:857-862.
10. Adams PF, Hendershot GE, Marano MA: **Current estimates from the National Health Interview Survey, 1996.** National Center for Health Statistics. *Vital Health Stat 10* 1999, 1-203.
11. Menz HB, Lord SR: **Foot pain impairs balance and functional ability in community-dwelling older people.** *J Am Podiatr Med Assoc* 2001, **91**:222-229.
12. Nguyen USDT, Hillstrom HJ, Li W, Dufour AB, Kiel DP, Procter-Gray E, Gagnon MM, Hannan MT: **Factors associated with hallux valgus in a population-based study of older women and men: the MOBILIZE Boston Study.** *Osteoarthritis Cartilage* 2010, **18**:41-46.
13. Genaidy AM, Lemasters GK, Lockey J, Succop P, Deddens J, Sobehi T, Dunning K: **An epidemiological appraisal instrument - a tool for evaluation of epidemiological studies.** *Ergonomics* 2007, **50**:920-960.
14. StataCorp: *Stata Statistical Software: Release 10* College Station, TX: StataCorp LP 2007.
15. Robbins JM, Roth LS, Villanueva MC: **"Stand down for the homeless". Podiatric screening of a homeless population in Cleveland.** *J Am Podiatr Med Assoc* 1996, **86**:275-279.
16. Wilder MH: **Prevalence of chronic skin and musculoskeletal conditions, United States, 1969.** National Center for Health Statistics. *Vital Health Stat 10* 1980, 1-65.
17. Cartwright A, Henderson G: *More Trouble with Feet: A Survey of the Foot Problems and Chiropody Needs of the Elderly* London: HMSO Publications Centre 1986.
18. Helfand AE: **A study in podogeriatrics: a pilot study of foot problems in the aged and chronically ill.** *J Am Podiatry Assoc* 1963, **53**:655-662.
19. Helfand AE: **The foot of South Mountain: a foot health survey of the residents of a state geriatric institution.** *J Am Podiatry Assoc* 1969, **59**:133-139.
20. Helfand AE: **Foot problems in older patients: a focused podogeriatric assessment study in ambulatory care.** *J Am Podiatr Med Assoc* 2004, **94**:293-304.
21. Helfand AE, Cooke HL, Walinsky MD, Demp PH: **Foot problems associated with older patients. A focused podogeriatric study.** *J Am Podiatr Med Assoc* 1998, **88**:237-241.
22. Helfand AE, Cooke HL, Walinsky MD, Demp PH, Snyder Phillips B: **Foot pain and disability in older persons. Pilot study in assessment and education.** *J Am Podiatr Med Assoc* 1996, **86**:93-98.
23. Craigmile DA: **Incidence, origin, and prevention of certain foot defects.** *Br Med J* 1953, **2**:749-752.
24. Fridland MO, Tverdynin MS: **Role of osteoarthritis in the development of hallux valgus.** *Ortop Travmatol Protez* 1960, **21**:16-20.
25. Hughes J, Clark P, Klenerman L: **The importance of the toes in walking.** *J Bone Joint Surg Br* 1990, **72**:245-251.
26. Mays SA: **Paleopathological study of hallux valgus.** *Am J Epidemiol* 2005, **126**:139-149.
27. Morris JB, Brash LF, Hird MD: **Chiropodial survey of geriatric and psychiatric hospital in-patients-Angus District.** *Health Bull (Edinb)* 1978, **36**:241-250.
28. Muehleman C, Bareither D, Huch K, Cole AA, Kuettner KE: **Prevalence of degenerative morphological changes in the joints of the lower extremity.** *Osteoarthritis Cartilage* 1997, **5**:23-37.
29. Sim-Fook LAM, Hodgson AR: **A Comparison of Foot Forms Among the Non-Shoe and Shoe-Wearing Chinese Population.** *J Bone Joint Surg Am* 1958, **40**:1058-1062.
30. Durman DC: **Metatarsus primus varus and hallux valgus.** *AMA Arch Surg* 1957, **74**:128-135.
31. Jones RO, Christenson CJ, Lednar WM: **Podiatric utilization referral patterns at an Army medical center.** *Mil Med* 1992, **157**:7-11.
32. Adams PF, Benson V: **Current estimates from the National Health Interview Survey.** National Center for Health Statistics. *Vital Health Stat 10* 1991, 1-212.
33. Brodie BS, Rees CL, Robins DJ: **Wessex feet: a regional foot health survey.** *Chiropodist* 1988, **43**:152-165.
34. Clarke M: *Trouble With Feet* London: G. Bell and Sons, Ltd 1969.
35. Garrow AP, Silman AJ, Macfarlane GJ: **The Cheshire Foot Pain and Disability Survey: a population survey assessing prevalence and associations.** *Pain* 2004, **110**:378-384.
36. MacLennan R: **Prevalence of hallux valgus in a neolithic New Guinea population.** *Lancet* 1966, **1**:1398-1400.
37. Marr S, Berry G, Wood G, Stevenson M, Cole J: **Foot and boot problems of miners working underground.** *J Occup Health Saf Aust NZ* 1998, **14**:255-257.
38. Nancarrow SA: **Reported rates of foot problems in rural south-east Queensland.** *Australasian J Podiatric Med* 1999, **33**:45-50.
39. Shine IB: **Incidence of Hallux Valgus in a Partially Shoe-Wearing Community.** *Br Med J* 1965, **1**:1648-1650.
40. Chaiwanichsiri D, Janchai S, Tantisiriwat N: **Foot disorders and falls in older persons.** *Gerontology* 2009, **55**:296-302.
41. Menz HB, Morris ME: **Clinical determinants of plantar forces and pressures during walking in older people.** *Gait Posture* 2006, **24**:229-236.
42. Menz HB, Zammit GV, Munteanu SE: **Plantar pressures are higher under callused regions of the foot in older people.** *Clin Exp Dermatol* 2007, **32**:375-380.
43. Scott G, Menz HB, Newcombe L: **Age-related differences in foot structure and function.** *Gait Posture* 2007, **26**:68-75.
44. Keegan THM, Kelsey JL, Sidney S, Quesenberry CP Jr: **Foot problems as risk factors of fractures.** *Am J Epidemiol* 2002, **155**:926-931.
45. Al-Abdulwahab SS, Al-Dosry RD: **Hallux valgus and preferred shoe types among young healthy Saudi Arabian females.** *Ann Saudi Med* 2000, **20**:319-321.
46. Anonymous: **An assessment of foot health problems and related health manpower utilization and requirements.** *J Am Podiatry Assoc* 1977, **67**:102-114.
47. Badlissi F, Dunn JE, Link CL, Keysor JJ, McKinlay JB, Felson DT: **Foot musculoskeletal disorders, pain, and foot-related functional limitation in older persons.** *J Am Geriatr Soc* 2005, **53**:1029-1033.
48. Black JR, Hale WE: **Prevalence of foot complaints in the elderly.** *J Am Podiatr Med Assoc* 1987, **77**:308-311.
49. Cho NH, Kim S, Kwon DJ, Kim HA: **The prevalence of hallux valgus and its association with foot pain and function in a rural Korean community.** *J Bone Joint Surg Br* 2009, **91**:494-498.
50. Cole AE: **Foot inspection of the school child.** *J Am Podiatry Assoc* 1959, **49**:446-454.
51. Conrad D: **Foot education and screening programs for the elderly.** *J Gerontol Nurs* 1977, **3**:11, 14-15.
52. Cramer JS, Forrest K: **A survey of deployed foot problems in a desert environment.** *Mil Med* 2008, **173**:359-361.
53. Crawford VL, Ashford RL, McPeake B, Stout RW: **Conservative podiatric medicine and disability in elderly people.** *J Am Podiatr Med Assoc* 1995, **85**:255-259.
54. Dawson J, Thorogood M, Marks S-A, Juszczak E, Dodd C, Lavis G, Fitzpatrick R: **The prevalence of foot problems in older women: a cause for concern.** *J Public Health Med* 2002, **24**:77-84.
55. Denvir VJ: **A school foot health service after 10 years.** *Chiropodist* 1972, **27**:291-301.
56. Dunn JE, Link CL, Felson DT, Crincoli MG, Keysor JJ, McKinlay JB: **Prevalence of foot and ankle conditions in a multiethnic community sample of older adults.** *Am J Epidemiol* 2004, **159**:491-498.
57. Ebrahim SB, Sainsbury R, Watson S: **Foot problems of the elderly: a hospital survey.** *Br Med J* 1981, **283**:949-950.
58. Elton PJ, Sanderson SP: **A chiropodial survey of elderly persons over 65 years in the community.** *Public Health* 1986, **100**:219-222.
59. Emslie M: **Prevention of foot deformities in children.** *Lancet* 1939, **234**:1260-1263.
60. Enwemeka CS: **Physical deformities in Nigerian schools: the Port Harcourt Cohort study.** *Int J Rehabil Res* 1984, **7**:163-172.

61. Evans SL, Nixon BP, Lee I, Yee D, Mooradian AD: **The prevalence and nature of podiatric problems in elderly diabetic patients.** *J Am Geriatr Soc* 1991, **39**:241-245.
62. Frey C, Thompson F, Smith J, Sanders M, Horstman H: **American Orthopaedic Foot and Ankle Society women's shoe survey.** *Foot Ankle* 1993, **14**:78-81.
63. Greenberg L: **Foot care data from two recent nationwide surveys. A comparative analysis.** *J Am Podiatr Med Assoc* 1994, **84**:365-370.
64. Greenberg L, Davis H: **Foot problems in the US. The 1990 National Health Interview Survey.** *J Am Podiatr Med Assoc* 1993, **83**:475-483.
65. Harris RI, Beath T: *Army Foot Survey. An investigation of foot ailments in canadian soldiers* Ottawa: National Research Council of Canada 1947.
66. Helfand AE: **Arthritis in older patients as seen in podiatry practices. A pilot survey by the American College of Foot Orthopedists, 1966.** *J Am Podiatry Assoc* 1967, **57**:82-84.
67. Horvath F, Bender G, Sillar P, Lengyel E: **Arthrosis of the first foot segment in aged patients.** *Z Orthop Ihre Grenzgeb* 1980, **118**:251-255.
68. Huang ZG, Li Y, Zhang YL, Chi YY, Xu F: **Indirect measurement of the foot shape of 319 college students of Han nationality in Liaoning province.** *Chinese J Clin Rehab* 2006, **10**:37-40.
69. Hung LK, Ho YF, Leung PC: **Survey of foot deformities among 166 geriatric inpatients.** *Foot Ankle* 1985, **5**:156-164.
70. Jerosch J, Mamsch H: **Deformities and misalignment of feet in children—a field study of 345 students.** *Z Orthop Ihre Grenzgeb* 1998, **136**:215-220.
71. Kemp J, Winkler JT: *Problems afoot: need and efficiency in footcare* London: Disabled Living Foundation 1984.
72. Kilmartin TE, Barrington RL, Wallace WA: **Metatarsus primus varus. A statistical study.** *J Bone Joint Surg Br* 1991, **73**:937-940.
73. Leveille SG, Guralnik JM, Ferrucci L, Hirsch R, Simonsick E, Hochberg MC: **Foot pain and disability in older women.** *Am J Epidemiol* 1998, **148**:657-665.
74. Levy LA: **Prevalence of chronic podiatric conditions in the US. National Health Survey 1990.** *J Am Podiatr Med Assoc* 1992, **82**:221-223.
75. Mahrle DA: **Foot Health Survey of a Sample Farming Population of the State of Nebraska.** *J Am Podiatry Assoc* 1965, **55**:450-453.
76. Marr SJ, D'Abbrera HJ: **Survey of joint mobility and foot problems of 191 Australian children.** *J Am Podiatr Med Assoc* 1985, **75**:597-602.
77. Merrill HE, Frankson J Jr, Tarara EL: **Podiatry survey of 1011 nursing home patients in Minnesota.** *J Am Podiatry Assoc* 1967, **57**:57-64.
78. Munro BJ, Steele JR: **Foot-care awareness. A survey of persons aged 65 years and older.** *J Am Podiatr Med Assoc* 1998, **88**:242-248.
79. Ooppel U, Bajjer D, Wilke U: **Epidemiology and early functional treatment of the hallux valgus in juveniles.** *Orthopadische Praxis* 1984, **20**:533-537.
80. Podrushniak EP, Marchenko AE: **Static deformities of feet in the process of ageing of man.** *Ortop Travmatol Protez* 1980, **9**:31-34.
81. Robinson J: *The Aldersgate Study* Bedford Park, Australia: Flinders Medical Centre 1989.
82. Saez Aldana F, Martinez Galarreta MV, Martinez-Iniguez Blasco J: **Analysis of falls producing hip fracture in the elderly.** *Rev Ortop Traumatol* 1999, **43**:99-106.
83. Schank MJ: **A survey of the well-elderly: their foot problems, practices and needs.** *J Gerontol Nurs* 1977, **3**:10,12-13.
84. Schnitzer JS, Hoeffler DF: **The distribution and etiology of foot disorders in a Navy recruit population.** *J Am Podiatry Assoc* 1974, **64**:854-853.
85. Smetisko Z: **Malposition of feet in the prone position as the exogenous factor in the formation of hallux vagus in adolescents.** *Arh Zast* 1989, **33**:311-317.
86. Spahn G, Schiele R, Hell AK, Klinger HM, Jung R, Langlotz A: **The prevalence of pain and deformities in the feet of adolescents. Results of a cross-sectional study.** *Z Orthop Ihre Grenzgeb* 2004, **142**:389-396.
87. White EG, Mulley GP: **Footcare for very elderly people: a community survey.** *Age Ageing* 1989, **18**:276-278.

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