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Incidence and Progression of Hallux Valgus: a Prospective Cohort Study

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ABSTRACT

Objective

Hallux valgus is a common and disabling condition. The objective of this study was to identify factors associated with hallux valgus incidence and progression.

Methods

Participants were from a population-based prospective cohort study, the Clinical Assessment Study of the Foot. All adults aged ≥50 years registered with four general practices in North Staffordshire, UK were invited to take part in a postal survey at baseline and at 7-year follow-up which included health questionnaires and self-assessment of hallux valgus using line drawings.

Results

Complete baseline and follow-up data were available for 1,482 participants (739 women and 743 men, mean [standard deviation] age 62.9 [8.1] years), of whom 450 (30.4%) had hallux valgus in at least one foot at baseline. Incident hallux valgus was identified in 207 (20.1%) participants (349 [15.4%] feet) and was associated with baseline age, poorer physical health, foot pain and wearing shoes with a very narrow toe-box shape between the age of 20 and 29 years. Hallux valgus progression was identified in 497 (33.6%) participants (719 [24.3%] feet) but was not associated with any baseline factors.

Conclusion

Incident hallux valgus develops in one in five adults aged ≥50 years over a 7-year period and is related to age, poorer physical health, foot pain and previous use of constrictive footwear. Progression occurs in one in three adults. These findings suggest that changes in first metatarsophalangeal joint alignment may still occur beyond the age of 50 years.

Key words: epidemiology; hallux valgus; foot pain; footwear

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Significance and Innovations

- This is the largest prospective study of hallux valgus progression to date
- Incident hallux valgus occurred in one in five participants and was associated with age, poorer physical health, foot pain and constrictive footwear
- Hallux valgus progression occurred in one in three participants
- Changes in first metatarsophalangeal joint alignment may still occur beyond the age of 50 years

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Hallux valgus is a common foot disorder affecting one in three older people (1) and is characterised by the progressive lateral deviation of the great toe (hallux) and medial deviation of the first metatarsal (2). The cause of hallux valgus is uncertain but is likely to be multifactorial, with increased age (3), female sex (4), genetic predisposition (5) abnormal foot biomechanics (6) and constrictive footwear (7) identified as possible risk factors. Hallux valgus is frequently painful (8) and interferes with the loadbearing function of the foot (9), leading to abnormal walking patterns (10), balance impairment (11) and an increased risk of falls (12). Consequently, hallux valgus has a negative impact on health-related quality of life (13), and is among the most common foot disorders managed by health professionals, including general practitioners (14), podiatrists (15) and orthopaedic surgeons (16).

Despite the high prevalence and significant burden of hallux valgus, very little is known about its incidence, age of onset, or rate of progression. In surgical case series studies, most patients report first noticing the deformity during the third or fourth decade of life (17, 18). Progression has mostly been studied in small clinical populations with short duration of follow-up and has yielded inconsistent findings. A study of 38 patients (mean age 63 years) on a waiting list for hallux valgus surgery found that x-ray measures of hallux angulation increased only slightly (1 to 2 degrees) over a 2 year period (19). In contrast, a study of 33 patients (mean age 58 years) followed up for 5 years reported that 42% progressed from unilateral to bilateral hallux valgus (defined as a hallux valgus angle >20 degrees), with progressors having greater baseline hallux angulation and an age of onset of less than 40 years (20). More recently, a study of 72 hallux valgus patients (mean age 58 years) followed up for 2 years found that progression (defined as an increase of >5 degrees in the hallux valgus angle) occurred in 26% of cases and was associated with greater baseline deformity (21).

These findings provide limited insight into hallux valgus progression due to the use of small samples of surgical patients, short duration of follow-up, and inconsistent definitions of progression. Therefore, the objectives of this study were to estimate the rate of, and factors associated with, hallux valgus incidence and progression by analysing baseline and 7-year follow-up data from the Clinical Assessment Study of the Foot, a large, population-based study in the United Kingdom which collected comprehensive general health and foot-specific information (22).

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METHODS

Study Design

The Clinical Assessment Study of the Foot is a population-based prospective cohort study in North Staffordshire, United Kingdom (23). Adults aged 50 years and over registered with four general practices were invited to take part in the study, irrespective of consultation for foot pain or problems. Ethical approval was obtained from Coventry Research Ethics Committee (reference number: 10/H1210/5).

Health Survey Questionnaire

All eligible participants were mailed a baseline health survey questionnaire that gathered information on current demographic and socioeconomic characteristics (age, sex, education and occupation), general health (the Short-Form 12 [SF-12]) (24), anxiety and depression (the Hospital Anxiety and Depression scale [HAD]) (25) and foot pain (pain in and around the foot in the past 12 months, foot pain location using a foot manikin template (© The University of Manchester 2000. All rights reserved) (26) and the Manchester Foot Pain and Disability Index [MFPDI]) (27). Higher scores on the SF-12 represent better health, while higher scores on the MFPDI and HAD represent worse pain and anxiety/depression, respectively. Past footwear use was assessed by line drawings depicting four toe box shapes (very wide, wide, narrow and very narrow) (7). For each period of their life (divided into decades, commencing with 20 to 29 years of age), participants were asked to indicate which toe box shape they wore most of the time.

Hallux Valgus Assessment

The presence and severity of hallux valgus was documented at baseline and 7-year follow-up using a validated line-drawing instrument, with five drawings illustrating a sequential 15 degree increase in the hallux valgus angle (28) for the left and right feet (Figure 1). The drawings were accompanied by instructions for participants to stand barefoot and select the drawing which best represented each foot. The hallux valgus line drawing score was dichotomised for each foot by classifying the two least severe grades (A and B) as absent and the three most severe grades (C, D and E) as present. A foot was deemed to have *incident hallux valgus* if hallux valgus was absent at baseline (grade A or B) but present at 7-year follow-up (grades C, D or E, as per the original case

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definition) (28). *Hallux valgus progression* was defined as an increase in the hallux valgus line drawing score of at least one grade from baseline to follow-up in those with grades A, B, C or D at baseline.

Statistical Analysis

All analyses were conducted using IBM SPSS Statistics version 26.0 (IBM Corp, Armonk, NY, USA). Two separate analyses were undertaken. First, we examined baseline predictors of incident hallux valgus, adjusting for age and baseline hallux valgus severity. Second, we examined baseline predictors of hallux valgus progression, adjusting for age. For both analyses, generalized estimating equations were used to account for the correlation between measurements obtained from the right and left feet. Odds ratios (OR) with 95% confidence intervals (CI) were calculated. Level of significance was set at $p<0.05$. Complete case analysis was undertaken as the primary analysis, with multiple imputation applied for sensitivity purposes.

RESULTS

Study Population

As previously reported, a total of 5,109 completed Health Survey questionnaires were received at baseline (adjusted response rate of 56%) (22). Of these, 1,575 (31%) participants completed the 7-year follow-up. Compared to participants who did not complete follow-up, those who completed follow-up were younger, more likely to be male, scored higher on the SF-12 physical and mental components, had lower anxiety and depression scores, were less likely to have major chronic medical conditions, more likely to have foot pain and less likely to have hallux valgus at baseline (Supplementary file 1). Of these participants, 1,496 (95%) had complete hallux valgus data at both baseline and follow-up. Fourteen participants were excluded as they had reported undergoing foot surgery since their baseline assessment, leaving a sample of 1,482 participants (2,964 feet) for this analysis (739 women and 743 men, mean [SD] age 62.9 [8.1] years, mean [SD] body mass index 27.5 [4.9] kg/m^2). A flow chart of the study is shown in Figure 2.

Participant Hallux Valgus Status at Baseline and Follow-Up

At baseline, hallux valgus was present in at least one foot in 450 (30.4%) participants (left foot 330 [22.3%], right foot 364 [24.6%]). There were 206 (46%) unilateral cases and 244 (54%)

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bilateral cases. At 7-year follow-up, hallux valgus was present in 548 (37.0%) participants (left foot 404 [27.3%], right foot 429 [28.9%]). There were 263 (48%) unilateral cases and 285 (52%) bilateral cases. Of the 1,032 participants without hallux valgus at baseline, 207 had hallux valgus at follow-up (incidence 20.1%), and of the 206 participants with unilateral hallux valgus at baseline, 58 (28.1%) progressed to bilateral hallux valgus. After excluding participants with grade E hallux valgus in both feet at baseline (n=3), progression in at least one foot at follow-up was observed in 497 (33.6%) participants.

Hallux Valgus Grades at Baseline and Follow-Up

The distribution of hallux valgus grades for the 2,964 feet at baseline were: A: 696 (23.5%), B: 1,574 (53.1%), C: 603 (20.3%), D: 77 (2.6%), E: 14 (0.5%), and at 7-year follow-up were: A: 656 (22.1%), B: 1,475 (49.8%), C: 709 (23.9%), D: 102 (3.4%), E: 22 (0.7%). Comparison of baseline and follow-up indicated that hallux valgus severity grades were stable in 1,711 (57.7%) feet, progressed (by at least one grade) in 719 (24.3%) feet, and improved (by at least one grade) in 534 (18.0%) feet. Very few feet exhibited progression by two (68, 2.3%) or three (2, 0.1%) grades. Progression of hallux valgus was more likely to occur in feet with grades A or B at baseline (Figure 3).

Baseline Factors Associated with Incident Hallux Valgus

From the 2,270 feet without hallux valgus at baseline, incident hallux valgus was identified in 349 (15.4%) feet. Participants who developed incident hallux valgus were older than those who did not (63.2 [8.0] vs 62.1 [8.0] years, p=0.018), although incident cases were observed in participants ranging in age from 50 to 82 years (Supplementary file 2). Table 1 reports the baseline factors associated with incident hallux valgus at 7-year follow-up, adjusted for age and baseline hallux valgus severity. Incident hallux valgus was associated with lower scores on the SF-12 physical component subscale (OR 0.99, 95% CI 0.97 – 1.00, p=0.017), pain in and around the foot (OR 1.50, 95% CI 1.14 to 1.98, p=0.004) and on the dorsum of the hallux (OR 1.68, 95% CI 1.10 to 2.55, p=0.016), and previous use of footwear with a very narrow toe-box between the ages of 20 and 29 years (OR 1.58, 95% CI 1.15 to 2.17, p=0.004). Results of the multiple imputation sensitivity analysis are provided in Supplementary file 3. The overall patterns of association were very similar, although the associations between incident hallux valgus and female sex, the SF-12

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mental component subscale, HAD anxiety subscale and first metatarsophalangeal joint pain reached statistical significance, and the association with previous use of footwear with a very narrow toe-box shape was slightly attenuated (OR 1.25, 95% CI 0.96 – 1.62, p=0.093).

Baseline Factors Associated with Hallux Valgus Progression

Hallux valgus progression, defined as an increase of one or more grades in those with grades A, B, C or D at baseline (n=2,950), was identified in 719 (24.3%) feet. Progression was observed in participants ranging in age from 50 to 85 years (Supplementary file 2). Table 2 reports the baseline factors associated with hallux progression at 7-year follow-up, adjusted for age. There were no significant associations between baseline characteristics and progression of hallux valgus. Results of the multiple imputation sensitivity analysis are provided in Supplementary file 3. The overall patterns of association were very similar.

DISCUSSION

The objective of this study was to identify factors associated with hallux valgus incidence and progression by analysing baseline and 7-year follow-up data from the population-based Clinical Assessment Study of the Foot (CASF) (23). We found that the incidence of hallux valgus was 20%, and progression occurred in 33% of participants. Older age, poorer physical health, foot pain and previous use of constrictive footwear were associated with incident hallux valgus, but there were no significant baseline predictors of hallux valgus progression. Taken together, these findings suggest that significant changes in first metatarsophalangeal joint alignment may still occur beyond the age of 50 years.

Hallux valgus is strongly associated with age, with a recent meta-analysis reporting pooled prevalence estimates of 7.8% in juveniles, 23% in those aged 18 to 65 years, and 35.7% in those aged over 65 years (1). The age of onset is uncertain, although studies relying on recall by patients undergoing hallux valgus surgery most commonly report that the condition was first noted in the third and fourth decades, with less than 10% reporting onset after the age of 50 (17, 18). Our findings indicate that approximately one in five people may develop hallux valgus beyond the age of 50 years, with incident cases even observed in participants in their 80s. This suggests that susceptibility to hallux valgus is not limited to early adulthood or middle age. However, cohort

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studies encompassing a broader age range and longer duration of follow-up would be required to fully understand the trajectory of the condition.

We identified several potential risk factors for the development of hallux valgus, with baseline older age, poorer physical health, foot pain and previous use of constrictive footwear being significantly associated with incident hallux valgus. Older age may contribute to hallux valgus due to its association with pronated foot posture and reduced muscle strength – factors that have been shown to be associated with hallux valgus in cross-sectional studies (11, 29). Foot pain, particularly pain localised to the hallux, may precede the development of hallux valgus either as a consequence of compression from footwear or as a symptom of osteoarthritis affecting the first metatarsophalangeal joint (30). Consistent with our previous observation of a dose-response relationship between toe-box shape and hallux valgus after stratification by age (7), our results suggest that wearing constrictive footwear between the age of 20 and 29 years increases the risk of developing hallux valgus. Although such a temporal relationship is difficult to confirm, it is plausible that changes in skeletal alignment and soft tissue adaptations resulting from long-term use of constrictive footwear may increase susceptibility to hallux valgus when combined with other risk factors later in life.

There have been very few previous studies of hallux valgus incidence. A study of 62 patients (mean age 36 years) with a range of foot disorders (excluding hallux valgus) who were followed for 10 years noted that the hallux valgus angle from radiographs increased by 1.5 degrees per year, with a greater increase noted in patients with a round compared to square first metatarsal head shape (31). However, no case definition of hallux valgus was provided to enable incidence to be calculated. To the best of our knowledge, the only other study examining incidence of hallux valgus was conducted in children (mean age 6 years) undergoing treatment for in-toeing gait, which reported that 29 of the 139 children (21%) who were prescribed reverse shoe treatment (i.e. wearing their shoes on the opposite feet) developed hallux valgus over a 12 month period (32). Although this study provides limited insight into the natural history of hallux valgus, it provides the first empirical evidence to support a causal relationship between toe-box shape and hallux valgus.

Progression of hallux valgus was observed in one in three participants in our study but was mostly driven by shifts from grades A to B or B to C. Progression beyond grade C – the lowest grade of

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the dichotomous case definition – was rare, with less than 5% of the sample reporting grade D or E hallux valgus at follow-up. This is not surprising, given that grades D and E represent hallux valgus angles of greater than 45 degrees, which is commonly classified as a severe deformity (2, 33). Comparing these findings to the available literature is difficult, as previous studies were conducted in small clinical populations with shorter duration of follow-up (2 to 5 years), used inconsistent definitions, and focused on radiographic parameters as potential predictors (19-21). In contrast to our findings, both Young et al (20) and Lee et al (21) found that those with more severe hallux valgus were more likely to demonstrate progression. It is worth noting, however, that the angular change considered to represent progression in these studies (2 to 5 degree increase in the hallux valgus angle from radiographs) is substantially smaller than the 15 degree increase in the hallux valgus angle represented by an increase of one grade in our study (28).

Strengths of our study include the large sample, prospective design and detailed characterisation of participants in the health survey. However, our findings need to be considered in the context of several study design limitations. First, our participants were aged 50 years and over, so many of the risk factor exposures responsible for the development and progression of hallux valgus may have already occurred. Second, the duration of follow-up was only 7 years. Although this is an improvement on previous studies, a longer period of follow-up may be required to fully understand the natural history of the condition. Third, documentation of hallux valgus relied on self-report using line drawings. Although we have shown this approach to be both reliable and valid (28), it is possible that some misclassification occurred, and the five grades may not have been sensitive enough to identify more subtle changes in hallux angulation. Fourth, this analysis used the postal survey component of the CASF study, so we were unable to determine whether any clinically or radiographically assessed foot structure variables influenced the incidence or progression of hallux valgus. Finally, there was significant and differential loss to follow-up at 7 years. Overall, responders were generally healthier and less likely to have reported hallux valgus at baseline. While imputed estimates of rates and associations were very similar to those obtained from complete case analysis, the former relies on the assumption of outcome data missing at random. Caution is therefore still needed when interpreting our findings given the level of attrition and relatively long intervals between observations.

In conclusion, this study has shown that over a 7-year period, in one in five adults aged 50 years and over developed incident hallux valgus, and one in three experienced progression of hallux

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valgus. Incident hallux valgus was associated with baseline age, poorer physical health, foot pain and previous use of constrictive footwear, while progression of hallux valgus was more likely to occur in those with less hallux angulation at baseline. These findings suggest that although many cases of hallux valgus develop earlier in life, significant changes in first metatarsophalangeal joint alignment may still occur beyond the age of 50 years and could potentially be amenable to prevention and treatment.

AUTHOR CONTRIBUTIONS

Study conception and design. Menz, Marshall, Thomas, Peat, Roddy.

Acquisition of data. Marshall, Thomas, Roddy.

Analysis and interpretation of data. Menz, Marshall, Thomas, Rathod-Mistry, Peat, Roddy

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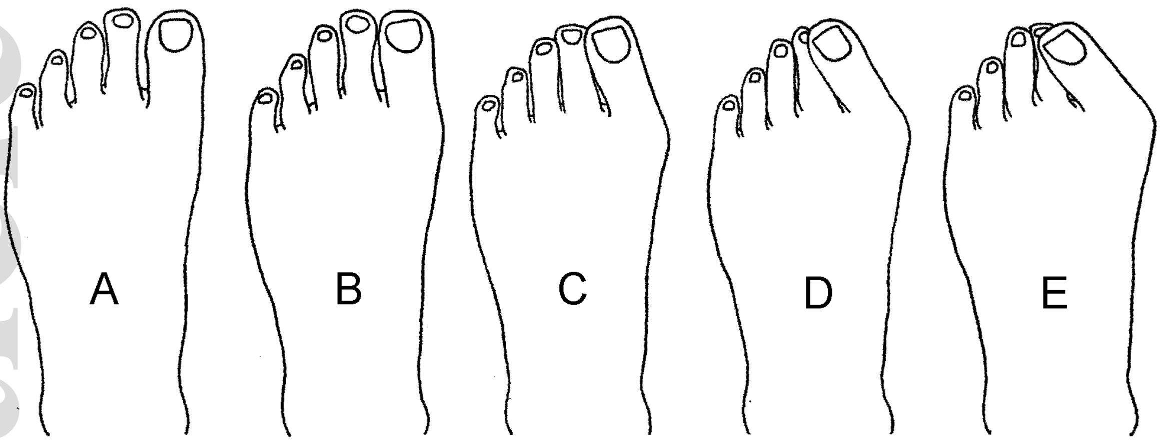

Figure 1. Self-report instrument for assessment of hallux valgus (left foot images shown). To create a dichotomous case definition of hallux valgus, grades A and B were classified as absent and grades C, D and E as present. Hallux valgus progression was defined as an increase of at least one grade from baseline to follow-up. Figure reproduced with permission from *Osteoarthritis & Cartilage* 2007;15:1008-12.

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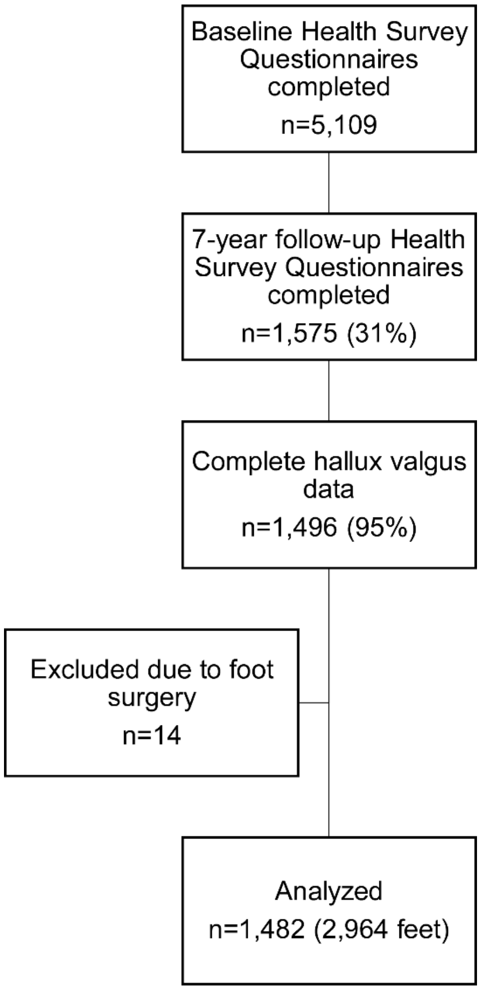

Figure 2. Study flow chart.

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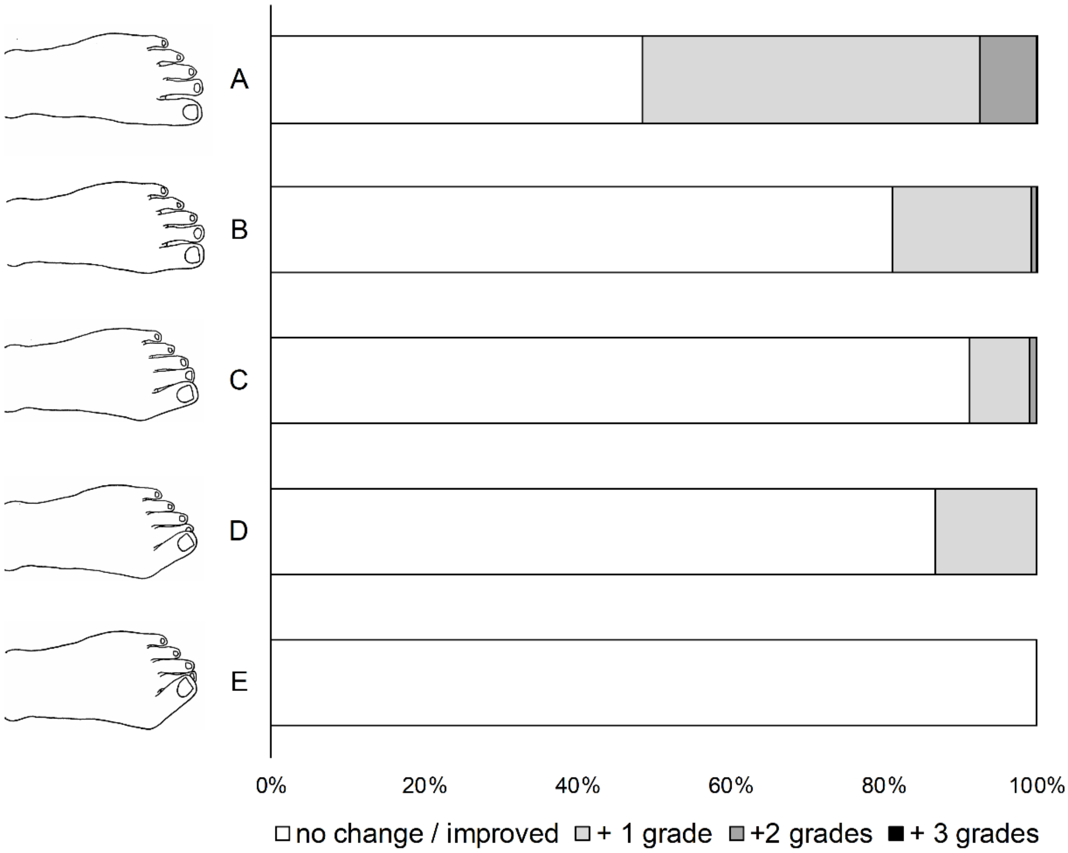

Figure 3. Hallux valgus progression (no change/improved or +1, +2, or +3 grades) over 7 years according to baseline grade.

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Table 1. Baseline factors associated with incident hallux valgus at 7-year follow-up, adjusted for age and baseline severity.

	No HV (n=1,921)	Incident HV (n=349)	OR (95% CI)	*p*
Age – years, mean (SD)	62.1 (8.0)	63.2 (8.0)	1.02 (1.00 – 1.04)	0.018
Sex, n (%) female	853 (44.4)	174 (49.9)	1.16 (0.89 – 1.52)	0.271
Obese (BMI>30kg/m^2), n (%)	472 (25.1)	100 (29.6)	1.24 (0.92 – 1.67)	0.164
Higher education, n (%)	422 (22.5)	84 (24.8)	1.13 (0.82 – 1.55)	0.452
Occupational class, n (%)				
Managerial/professional	564 (30.7)	86 (26.5)	1 (referent)	
Intermediate	375 (20.4)	76 (23.5)	1.32 (0.90 – 1.94)	0.154
Routine/manual	901 (49.0)	162 (50.0)	1.20 (0.86 – 1.68)	0.280
Chronic conditions, n (%)				
Heart problems	244 (12.7)	44 (12.6)	0.95 (0.65 – 1.38)	0.945
High blood pressure	755 (39.3)	142 (40.7)	1.02 (0.77 – 1.35)	0.909
Diabetes	207 (10.8)	36 (10.3)	0.89 (0.59 – 1.33)	0.563
Stroke	66 (3.4)	19 (5.4)	1.40 (0.82 – 2.40)	0.222
Cancer	81 (4.2)	15 (4.3)	0.93 (0.50 – 1.73)	0.829
Liver disease	34 (1.8)	6 (1.7)	0.94 (0.41 – 2.18)	0.887
Kidney disease	49 (2.6)	11 (3.2)	1.06 (0.51 – 2.20)	0.886
Circulation problems	329 (17.1)	69 (19.8)	1.06 (0.76 – 1.49)	0.731
Rheumatoid arthritis	194 (10.1)	46 (13.2)	1.14 (0.76 – 1.71)	0.516
2 or more, n (%)	752 (39.1)	150 (43.0)	1.04 (0.78 – 1.39)	0.778
General health and quality of life, mean (SD)				
SF-12 – physical	45.8 (11.3)	43.0 (12.3)	0.99 (0.97 – 1.00)	0.017
SF-12 – mental	51.7 (10.1)	50.7 (10.0)	0.99 (0.98 – 1.00)	0.149
HAD – anxiety	5.6 (4.2)	6.2 (4.3)	1.03 (0.99 – 1.06)	0.087
HAD – depression	3.9 (3.5)	4.3 (3.7)	1.03 (0.99 – 1.07)	0.134
Foot pain				
MFPDI – pain, mean (SD)*	-0.59 (1.52)	-0.51 (1.69)	1.01 (0.87 – 1.17)	0.869
MFPDI – function, mean (SD)*	-1.27 (2.00)	-0.93 (2.01)	1.06 (0.96 – 1.19)	0.264
Pain in or around the foot, n (%)	640 (33.7)	147 (42.9)	1.50 (1.14 – 1.98)	0.004
Hallux pain – dorsal, n (%)	113 (5.9)	40 (11.5)	1.68 (1.10 – 2.55)	0.016
Hallux pain – plantar, n (%)	46 (2.4)	17 (4.9)	1.75 (0.92 – 3.35)	0.088
1st MTP joint pain – dorsal, n (%)	114 (5.9)	35 (10.0)	1.35 (0.83 – 2.19)	0.232
1st MTP joint pain – plantar, n (%)	93 (4.8)	29 (8.3)	1.59 (0.98 – 2.59)	0.062
Very narrow toe-box shape, n (%)				
20 – 29 years	342 (20.2)	89 (28.3)	1.58 (1.15 – 2.17)	0.004
30 – 39 years	97 (5.7)	21 (6.7)	1.22 (0.71 – 2.10)	0.475
40 – 49 years	22 (1.3)	2 (0.6)	0.59 (0.17 – 2.02)	0.402
50 – 59 years	13 (1.4)	1 (0.5)	0.50 (0.06 – 4.40)	0.529

HV: hallux valgus, BMI: body mass index, SF12: Short Form 12, HAD: Hospital Anxiety and Depression Scale, MFPDI: Manchester Foot Pain and Disability Index, MTP: metatarsophalangeal, OR: odds ratio, CI: confidence interval.

* Rasch-transformed scores

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Table 2. Baseline factors associated with hallux valgus progression at 7-year follow-up, adjusted for age and excluding grade E cases at baseline (n=14).

	No HV progression (n=2,231)	HV progression (n=719)	OR (95% CI)	*p*
Age – years, mean (SD)	62.8 (8.0)	63.3 (8.3)	0.99 (0.98 – 1.01)	0.202
Sex, n (%) female	1,116 (50.0)	349 (48.5)	0.94 (0.77 – 1.15)	0.551
Obese (BMI>30kg/m^2), n (%)	544 (24.9)	187 (26.8)	1.10 (0.87 – 1.40)	0.388
Higher education, n (%)	483 (22.2)	170 (24.4)	1.14 (0.89 – 1.46)	0.297
Occupational class, n (%)				
Managerial/professional	645 (30.4)	193 (28.5)	1 (referent)	
Intermediate	426 (20.0)	155 (22.9)	1.21 (0.91 – 1.63)	0.194
Routine/manual	1,054 (49.6)	329 (48.6)	1.06 (0.83 – 1.34)	0.668
Chronic conditions, n (%)				
Heart problems	262 (11.7)	111 (15.4)	1.33 (0.99 – 1.78)	0.060
High blood pressure	896 (40.2)	297 (41.3)	1.01 (0.82 – 1.25)	0.910
Diabetes	238 (10.7)	71 (9.9)	0.90 (0.65 – 1.26)	0.545
Stroke	81 (3.6)	31 (4.3)	1.14 (0.72 – 1.80)	0.576
Cancer	103 (4.6)	27 (3.8)	0.77 (0.46 – 1.28)	0.313
Liver disease	34 (1.5)	13 (1.8)	1.20 (0.62 – 2.33)	0.589
Kidney disease	55 (2.5)	21 (2.9)	1.17 (0.65 – 2.07)	0.604
Circulation problems	436 (19.5)	129 (17.9)	0.87 (0.66 – 1.13)	0.286
Rheumatoid arthritis	250 (11.2)	73 (10.2)	0.87 (0.63 – 1.20)	0.401
2 or more, n (%)	911 (40.8)	303 (42.1)	1.02 (0.82 – 1.26)	0.876
General health and quality of life, mean (SD)				
SF-12 – physical	45.0 (11.6)	44.4 (11.7)	1.00 (0.99 – 1.01)	0.996
SF-12 – mental	51.7 (10.1)	51.5 (9.1)	1.00 (0.99 – 1.01)	0.706
HAD – anxiety	5.9 (4.2)	5.7 (4.1)	0.99 (0.97 – 1.02)	0.486
HAD – depression	4.1 (3.6)	4.0 (3.5)	0.99 (0.96 – 1.02)	0.663
Foot pain				
MFPDI – pain	-0.54 (1.51)	-0.62 (1.57)	0.97 (0.87 -1.08)	0.567
MFPDI – function	-1.19 (1.99)	-1.00 (1.96)	1.05 (0.97 – 1.14)	0.248
Pain in or around the foot, n (%)	857 (38.9)	272 (38.5)	0.98 (0.79 – 1.21)	0.861
Hallux pain – dorsal, n (%)	193 (8.7)	68 (9.5)	0.92 (0.66 – 1.30)	0.640
Hallux pain – plantar, n (%)	73 (3.3)	26 (3.6)	0.98 (0.59 – 1.64)	0.943
1st MTP joint pain – dorsal, n (%)	192 (8.6)	66 (9.2)	0.97 (0.69 – 1.37)	0.865
1st MTP joint pain – plantar, n (%)	138 (6.2)	51 (7.1)	1.04 (0.71 – 1.53)	0.839
Very narrow toe-box shape, n (%)				
20 – 29 years	1,178 (58.9)	362 (57.4)	0.93 (0.75 – 1.17)	0.547
30 – 39 years	846 (42.4)	278 (44.3)	1.08 (0.86 – 1.34)	0.516
40 – 49 years	506 (25.4)	152 (24.3)	0.93 (0.73 – 1.20)	0.580
50 – 59 years	246 (12.4)	79 (12.7)	1.02 (0.73 – 1.43)	0.899

HV: hallux valgus, BMI: body mass index, SF12: Short Form 12, HAD: Hospital Anxiety and Depression Scale, MFPDI: Manchester Foot Pain and Disability Index, MTP: metatarsophalangeal, OR: odds ratio, CI: confidence interval.

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