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ORIGINAL ARTICLE

Prevalence of hallux valgus and risk factors among Japanese community dwellers

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Abstract

Background To investigate the prevalence and severity of radiographically detected hallux valgus (HV) as well as associated risk factors among Japanese residents of Miyagawa, a mountain village located in the center of Mie Prefecture.

Methods The height, weight and body mass index (BMI) of 403 participants (male $n = 135$, female $n = 268$) recruited from among the residents of Miyagawa Village, Japan aged ≥65 years were measured, and baseline data, including age, sex and medical history were obtained from interviews and questionnaires. Knee osteoarthritis (KOA) was determined from radiographs of the feet and knees, and osteoporosis was determined by measuring bone mineral density. Hallux valgus, defined as angulation of the big toe at the first metatarsophalangeal joint of >20°, was classified as: mild (20°–30°), moderate (30°–40°) or severe (>40°). Risk factors for HV were calculated using multivariate logistic regression analysis that included age, sex, obesity (BMI ≥25), KOA, osteoporosis, Heberden's nodes and low back pain as variables.

Results The overall prevalence of definite radiographic HV was 22.8 % (184/806), and mild, moderate and severe HV was found in 66.3, 27.2 and 6.5 % of the participants, respectively. Hallux valgus was found in at least one foot in 120 (29.8 %) of the participants and the prevalence significantly differed between females with and without HV and KOA (odds ratios: 2.54 and 1.71, respectively).

Conclusions The prevalence of definite radiographic HV was 29.8 %. Female sex and KOA were significantly associated with increased risk for radiographic HV.

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Introduction

Hallux valgus (HV) is a common deformity in adults that is characterized by abnormal angulation, rotation and lateral deviation of the big toe at the first metatarsophalangeal joint [1, 2]. Wearing footwear causes individuals with HV pain and difficulty in walking [3], and many such patients require orthosis and/or surgery [4, 5]. Understanding the associated risk factors is very important to prevent HV and determine the ratio of individuals with HV. However, the community prevalence of HV estimated by epidemiological studies varies between 21 and 70 % [6–10]. This variation is partly attributable to differences in study populations and unclear definitions of HV, with the terms "hallux valgus" and "bunion" specifically causing confusion. Most epidemiological HV studies have used a self-check sheet or footprint rather than X-rays to detect HV [11] and very few community-based studies have incorporated such radiographic imaging [12]. We initiated a cohort study in 1997 to investigate the epidemiology of knee osteoarthritis (KOA) [13–15] and osteoporosis [16]. The present study of HV started from the seventh (2009) and eighth (2011) biennial examinations.

The present cross-sectional study investigates the prevalence of radiographic HV and associated risk factors among Japanese inhabitants of Miyagawa. Whether having radiographic HV affected their quality of life (QOL) was determined using the Japanese version of the EuroQol 5D (EQ-5D) questionnaire [17, 18].

Materials and methods

Individuals aged ≥65 years were recruited from among the inhabitants of Miyagawa, a mountain village located in the center of the Mie Prefecture, Japan. The population of this village was 3,364 in the year 2012, and 1,522 residents met the age criterion. The study that started in 1997 was designed to determine factors associated with KOA and osteoporosis by analyzing data from a representative sample of a rural elderly population every 2 years. The present study analyzes data from the seventh and eighth biennial examinations in 2009 and 2011, respectively.

The Ethics Committee for Human Research at our institution approved this study, and written informed consent was obtained from all participants before enrollment.

Baseline data were obtained at one-to-one interviews using standard questionnaires designed by orthopedic surgeons. These data included information about age, sex, medical history, cigarette smoking, and health-related QOL determined from the EQ-5D questionnaire. Height and body weight were measured, and body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2) at the baseline assessment. Obesity was defined as BMI >25. Bunions and callosities were identified by palpation. Pain was determined by applying pressure to the bunion. The location of callosities was categorized from maps of the soles of the feet. Heberden's nodes were located by visual inspection and palpation.

The EQ-5D is a standardized, characterized instrument for assessing the course of health processes [17] that was translated into Japanese for the present study. The EQ-5D contains a self-assessment section in which participants provide a description of their health status from the viewpoints of mobility, self-care, daily activities, pain (discomfort and anxiety) and depression. They selected the most appropriate of three statements about each of the five QOL dimensions to indicate their current health status. Each statement represents an increasing degree of severity. The results were coded and converted to utility scores using a table of values [18].

Other medical examinations consisted of radiography of the feet and knees and measurement of bone mineral density (BMD) at the distal third of the non-dominant side radius using dual energy X-ray absorptiometry (DCS-600EX; Aloka, Tokyo, Japan). Osteoporosis was defined as 2.5 standard deviations (SD) of BMD below that of the young adult mean (YAM) of a healthy young adult of the same sex.

Fully extended anteroposterior (AP) radiographs of both knees while standing were scored for radiographic KOA according to the Kellgren Lawrence (K/L) grading system [19]. Confirmed radiographic KOA was defined as a K/L grade of ≥2.

Foot X-rays were taken from participants standing upright with both feet on the cassette as described by Saltzman [20]. The standardized radiographic projection was indicated for weight-bearing views, in which the X-ray beam was inclined at 20° at a distance of 40 in., and centered between the bilateral feet. The hallux valgus angle (HVA), which is formed by the bone axes of the first metatarsal and the first proximal phalanx, and the M1-M2 angle formed by the bone axes of the first and second metatarsals on all radiographs, were consistently measured by the same examiner (AN) [21] and analyzed using Image J version 1.37 software (National Institutes of Health, Bethesda, MD, USA). The HVA value was taken as the mean of three determinations.

Hallux valgus was defined as an HV angle >20°, according to the Japanese Orthopaedic Society criteria and severity was classified as mild (20°–30°), moderate (30°–40°) or severe (>40°) [22].

Statistical analysis

Means ± standard deviations (SD) were calculated for variables unless otherwise noted. Risk factors for HV were determined from multivariate logistic regression analysis that included age, sex, obesity, KOA, osteoporosis, Heberden's nodes and low back pain as variables. The relationship between HVA and the M1-M2 angle was assessed using Pearson's correlation coefficient. The relationship between the severity of HV and of KOA (except total knee arthroplasty) was assessed using the Spearman rank correlation coefficient. Risk factors for HV are summarized as odds ratios (OR) with 95 % confidence intervals (CI). The EQ-5D values for normal feet or for each grade of HV were determined using a one-way ANOVA with Dunnett's post hoc test.

Significance at the level of 5 % was taken for all tests. All data were statistically analyzed using PASW Statistics for Windows version 18 (SPSS Inc, Chicago, IL, USA).

Results

A total of 314 (105 men, 209 women) and 221 (74 men, 147 women) elderly residents participated in the seventh and eighth Miyagawa studies, respectively, of whom 130 participated in both. Two residents declined X-ray examinations, and thus data from 403 (overall mean age: 75.5 ± 6.4 years, range: 65–94 years, female: 75.8 ± 6.6 years, male: 75.4 ± 6.3 years) participants (806 feet) who fulfilled the study criteria were analyzed. None of the participants had a history of surgically treated HV.

Table 1 shows the distribution of HV severity in the 806 feet. The overall prevalence of definite radiographic HV was 22.8 % (184/806), and 11.6 % (28/270) and 41.1 % (156/536) in men and women, respectively. The ratios of residents with mild, moderate and severe HV were 66.3 % (122/184), 27.2 % (50/184) and 6.5 % (12/184), respectively. The HV was bilateral in 64 (15.9 %), unilateral in 56 (13.9 %), and on at least one side in 120 (29.8 %) of the participants.

Figure 1 shows that HVA significantly correlated with the M1-M2 angle (Pearson's correlation coefficient (r) = 0.762, $p < 0.001$).

Table 2 shows relationships between each risk factor and the prevalence of HV. The prevalence of females significantly differed between groups with and without HV ($p = 0.003$, OR: 2.54, 95 % CI: 1.38–4.66) and KOA ($p = 0.028$, OR: 1.71, 95 % CI: 1.06–2.76).

The incidences of bunions on normal feet and on feet with mild, moderate and severe HV were 2.7 % (17/622), 28.7 % (35/122), 54.0 % (27/50), and 91.7 % (11/12), respectively (Fig. 2a). The incidences of painful bunions on normal feet and on feet with mild, moderate and severe HV were 0.3 % (2/622), 5.7 % (6/122), 8.0 % (4/50), and 16.7 % (2/12), respectively. The rate of painful bunions on all those with HV was 6.5 % (12/184). The incidences of callosities located on the balls (the first metatarsal head) of both normal feet and on feet with mild, moderate and severe HV were 3.2 % (20/622), 7.4 % (9/122), 2.0 % (1/50), and 0 % (0/12), respectively. On the other hand, the incidences of callosities located on the second, third, and fourth metatarsal heads of normal feet and of feet with mild, moderate and severe HV

Table 1 Distribution of hallux valgus severity

Participants	Normal	Mild	Moderate	Severe
Men	242	22	5	1
Women	380	100	45	11
Total	622	122	50	12

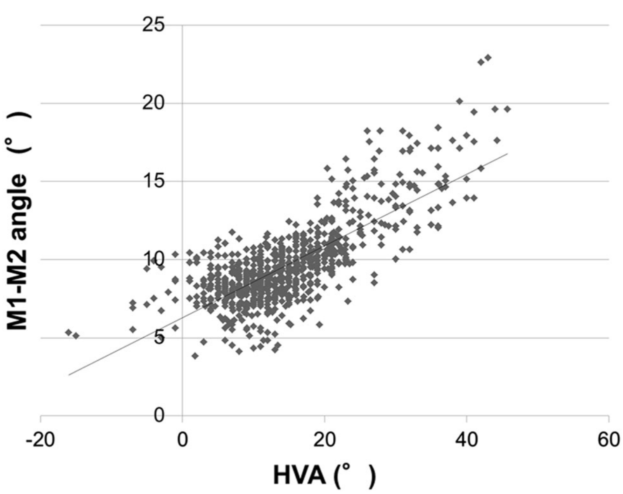

Fig. 1 Relationship between hallux valgus (*HVA*) angle and M1-M2 angle

Table 2 Comparison of individuals with and without radiographic hallux valgus

	HV (n = 120)	No HV (n = 283)	p	95 % CI	OR
Age (years)	76.1 ± 6.9	75.3 ± 6.1	0.66	0.97–1.05	1.01
Gender	M21; F99	M114; F169	0.003*	1.38–4.66	2.54
Obesity	+30/−90	+81/−282	0.23	0.38–1.22	0.73
KOA	+73/−47	+115/−168	0.03†	1.06–2.76	1.71
Osteoporosis	+66/−54	+123/−160	0.80	0.65–1.74	1.07
Heberden's nodes	+67/−53	+118/−165	0.13	0.90–2.27	1.43
Low back pain	+53/−67	+146/−137	0.10	0.44–1.08	0.68

HV hallux valgus, *KOA* knee osteoarthritis, *CI* confidence interval, *OR* odds ratio. Age is shown as mean ± SD. * $p < 0.01$, † $p < 0.05$

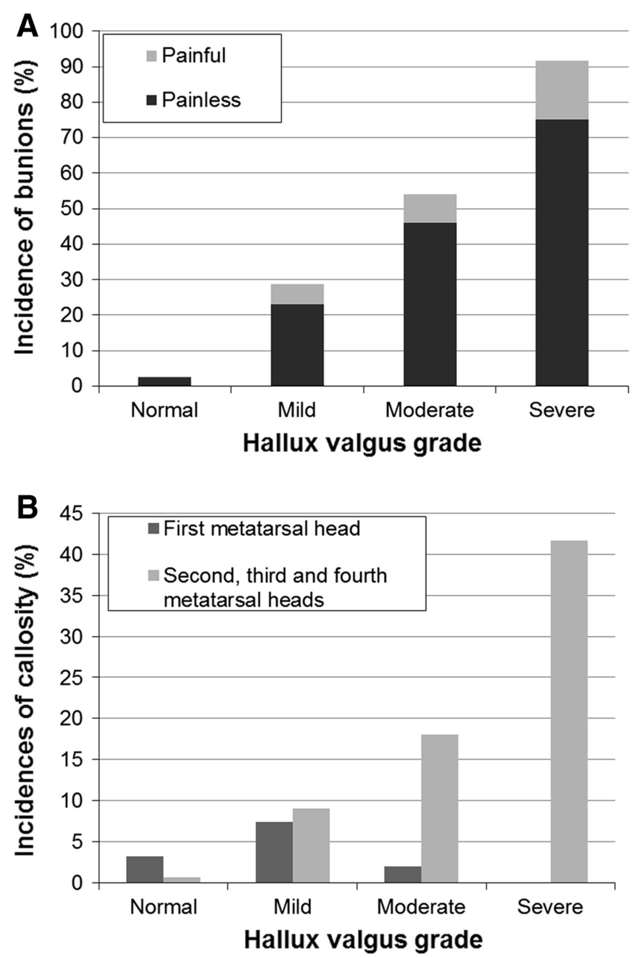

Fig. 2 Incidence of painful (*gray*) and painless (*black*) bunions (**a**) and callosities (**b**)

were 0.6 % (4/622), 9.0 % (11/122), 18.0 % (9/50) and 41.7 % (5/12), respectively (Fig. 2b).

Figure 3 shows that the severity of HV and of KOA significantly correlated ($\rho = 0.228$ and $p < 0.001$).

The EQ-5D utility scores of individuals with normal feet and with mild, moderate and severe HV were 0.855, 0.872, 0.809 and 0.769, respectively, with no significant differences among the groups (Fig. 4).

Discussion

The results of this cross-sectional study indicated a 29.8 % prevalence of radiographic HV among residents in a single village. Roddy et al. [2] reported a 28.4 % prevalence of self-reported HV among 4,249 patients in two general practices. On the other hand, Cho et al. [12] found radiographic HV in 364 (64.7 %) of 563 individuals. The reason for this higher value is their wider definition of radiographic HV as >15°, compared with our definition of >20°. Severe HV (>25°) was also found in 48 (13.2 %) individuals. Given these diagnostic criteria for HV, the prevalence was similar in both studies.

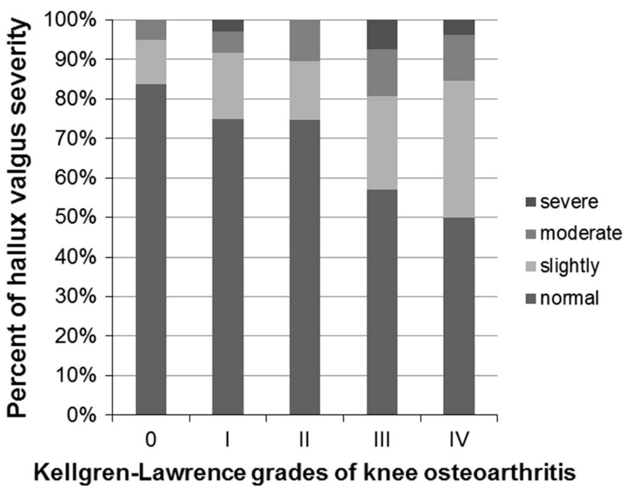

Fig. 3 Relationship between severity of hallux valgus and of knee osteoarthritis

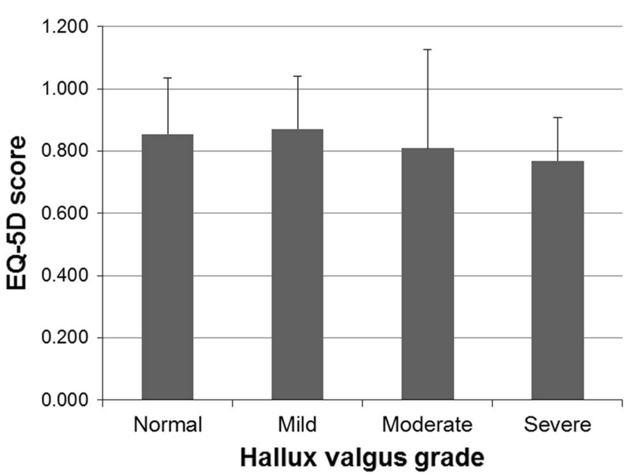

Fig. 4 EQ-5D utility scores of hallux valgus severity. Severity does not significantly differ between groups

Badlissi [11] identified HV in 37.1 % of 784 individuals in a community-based study and found no association with foot pain or function, whereas 9.9 % of individuals studied by Cho et al. [12] reported foot pain. On the other hand, Menz et al. [23] identified foot pain in 20–30 % of community-dwelling elderly individuals. Although foot pain was not assessed in the present study, bunions and callosities, which are the main cause of pain associated with HV, were investigated. The rate of painful bunions on all those with HV in the present study was 6.5 % (12/184), which closely correlated with the severity of HV. The rates of painful bunions and callosities were higher in feet with HV than in normal feet. The locations of callosities changed from the ball of the foot to the second, third and fourth metatarsal heads according to the severity of HV. The likely reason for this is that the load center of the foot moves from the ball of the foot to the second, third and fourth metatarsal heads as HV severity progresses.

Risk factors for HV in some countries have been reported. Our results concurred with the findings of many reports indicating that female sex increases risk for HV [2, 12, 24–26], but contradicted those of Roddy et al. [2], who reported that HV is closely associated with age. However, their study participants were much younger than those in the present study (>30 vs >65 years). Our results suggested that HV is less likely to occur in the elderly. We also found that osteoporosis, which is considered a typical musculoskeletal disease of the elderly, and low back pain, which is associated with osteoporosis, were not associated with HV.

Our results support the notion that HV is associated with knee pain [2, 12, 27], the main cause of which is OA in elderly individuals. Wilder et al. [28] associated radiographically confirmed OA of the first metatarsophalangeal joint with radiographic KOA. Roddy et al. [2] concluded that HV appears to be a component of generalized OA and a likely marker of OA of the first metatarsophalangeal joint. However, the cross-sectional design of their study did not allow confirmation of this relationship ahead of the possibility that HV coexists with OA or that HV is a precursor of OA of the first metatarsophalangeal joint. Other reports [29, 30] show that most patients with HV also have cartilage degeneration of the first metatarsophalangeal joint. Knee OA has a genetic association [34], as well as a phenotypic association with factors such as weight loading (obesity) [12]. A deformity (especially of the varus type) of a person with a genetic background of KOA might proceed gradually, according to weight loading. On the other hand, valgus stress affects the first MTP joint very little when walking barefoot, but the effect is considerable when wearing shoes, especially those with pointed toes or high heels. Not all people who wear such shoes develop HV, so we believe that those who develop HV have internal factors that are related to KOA. On the other hand, Heberden's nodes that are considered hand OA [31] are thought to indicate a systemic predisposition to generalized OA [32]. However, our data showed that HV is related to KOA, but not to Heberden's nodes. Cicuttini et al. [33] found poor agreement between Heberden's nodes and radiological distal interphalangeal osteophytes in the same finger of the same hand. Heberden's nodes were defined in the present study only by inspection and palpation, and such a relationship might be revealed by X-rays of the hand. Further study is needed to clarify this issue.

Cho et al. [12] associated a high BMI with HV, whereas Roddy et al. [2] and Abhishek et al. [35] did not. The present study supports the latter finding, as an association between HV and BMI >25 (obesity) was not identified. Race, lifestyle or socioeconomic background might be involved in this contradiction.

Abhishek et al. [35] suggested that self-reported HV and big toe pain are associated with an impaired QOL, whereas HV alone is not. They also considered that the influence of HV on QOL could be explained by impaired balance [36] and gait [23]. Cho et al. [12] reported that participants with at least moderate HV (HVA >25°) had impaired general functional status on the physical function domain of the SF-36. They also found even lower general functional status among participants who had HV with foot pain than those without. Both moderate and severe HV tended to be a relatively lower EQ-5D score in the present study, but not significantly with QOL (EQ-5D). We considered only HV angle and not foot pain. This could explain the discrepancy between the previous and present results.

The present study has several potential limitations. We did not question participants about the types of shoes they wore when they were young, and so could not clarify the relationship between HV and type of shoes worn in youth. However, many inhabitants were engaged in forestry and/or agriculture because Miyagawa is a mountain village. Thus, most of them probably wore Japanese tabi socks and/or Japanese zori sandals when they were young. Both tabi socks and zori separate the big toe from the other toes and they do not have a heel. Shoes with pointed toes and high heels are risk factors for HV according to the Japanese guidelines [22]. Thus, people who wore tabi and zori in their youth might be less likely to develop HV, and because the younger generations did not wear tabi and zori even when they were young and often wore high-heeled shoes, the prevalence of HV might increase in the near future as they age. Participants who could visit the hospital were generally healthier than non-participants. The statistical significance of the risk factors might be relatively low. The EQ-5D is a standardized instrument used as a measure of health outcome, so it is not foot-specific like the self-administered foot evaluation questionnaire (SAFE-Q) [37], which might reveal significant differences. This study was cross-sectional and not longitudinal. Only two of the 130 participants who participated in both the seventh and eighth Miyagawa studies were free of HV (HVA <20) at the seventh study but had HV by the eighth (data not shown). Thus, a longitudinal study was impossible at this time. Further investigations of more participants over a longer term are planned, as the study will continue every 2 years.

Conclusion

This cross-sectional epidemiological study identified a 22.8 % prevalence of definite radiographic HV in a rural Japanese village. The ratios of mild, moderate and severe HV were 66.3, 27.2 and 6.5 %, respectively, and 15.9 and 13.9 % of participants had bilateral and unilateral HV, respectively. Furthermore, both female sex and KOA were identified as risk factors for radiographic HV.

Conflict of interest The authors declare that they have no conflict of interest.

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