Supplementary Material

1 SUPPLEMENTARY DATA

Table S1: **Different types of foot measurements.** V-visual, G-geometrical, A-anthropometric measurements used for different orthotic and footwear applications. Occurrence in the reported studies: $> 10\%$*, $> 20\%$**, $> 30\%$***, $> 40\%$****. Foot variability (i.e., study of the main shape variations of the foot), subject features (i.e., study of the relationship between different foot measurements), subject behaviour or health condition (i.e., study of influence of behaviour or health on the shape of the foot), custom products (i.e., study to improve footwear products), definition of product sizes (i.e., study to improve the footwear sizes), new measurement system (i.e., study to improve the measuring system of feet.) Note that due to the wide range of studies and the variety of foot measurements, the occurrence of any single specific foot measurement never exceeded 50%.

	Foot variability	**Subject features**	**Subject behaviour or health condition**	**Custom products**	**Definition of product sizes**	**New measure. system**	**Other**
Footprint (G) *	(1; 2)	(3; 4; 5), (6; 2)		(7; 8)	(9)	(10)	(11)
Footprint angle (A)					(12)		
Footprint index (A)					(12)		
3D foot shape (G) **	(13; 14; 15), (16; 17; 18)	(19; 20)	(21; 7; 22)	(23; 24; 25)	(20; 26; 27), (28)	(29; 30)	
Foot length (A) ****	(31; 32; 1), (16; 33; 17)	(34; 35; 36), (37; 38; 39), (40; 41; 30), (42)	(43; 30; 44), (45; 21)	(23; 43; 46), (7)	(12; 47)	(29; 48; 28)	(11; 30)
Foot width (A) **	(1; 16; 17), (31)	(34; 37; 32), (36; 49; 50), (41)	(44; 43)	(7; 43; 46)	(12)	(29; 28)	(30)
Foot circumf. (A)	(31)						
Ball angle (A) *		(51; 52; 37), (38; 53)	(21)		(12)		(11)
Ball circumf. (A) ****	(16; 54; 33)	(34), (35; 36), (55; 39; 40), (56; 53; 32), (49; 57; 42)	(43; 58; 59), (45; 21)	(46; 43; 7)	(12)	(29; 48)	(11; 30)

Ball height (A) *		(34; 55; 39), (56; 49; 57), (42)	(58; 59; 21)				
Ball length (A) *		(52; 39; 53), (49)	(21)	(46)			(11)
Ball-to-heel length (A)		(49)					(11)
Ball width (A) **	(54; 33)	(34; 35; 42), (52; 55; 40), (56; 53; 57)	(58; 59; 21)		(12)	(48)	(11)
Height of top of ball circumf. (A)		(49)		(43)			
Instep circumf. (A) **	(54)	(35; 36; 55), (39; 56; 49), (57; 42)	(58; 59; 45; 21)	(43; 46; 7)	(12)	(29; 48)	
Instep height (A) **	(31; 54; 33)	(36; 42; 34), (35; 52; 37), (55; 38; 39), (53)	(45; 59; 21)	(43; 46)	(47)	(48)	
Instep length (A) *		(34; 36; 52), (37; 38; 49)	(43)	(43)	(47)		(30)
Instep size (A)							(11)
Instep width (A)		(53; 42; 31)					
Plantar circumf. (A)				(23)			
Medial metatarsal length (A) *		(34; 51; 37), (55; 38; 36)		(43)	(12)	(29)	(30)
Lateral metatarsal length (A) *		(34; 51; 37), (55; 38; 36), (52; 49)	(43)	(43)	(12; 47)	(29)	(30)
Heel circumf. (A) *		(34; 36; 40), (49)	(59)	(7)			(11)
Heel length (A)					(12)		
Heel width (A) ***	(16)	(34; 35; 51), (52; 37; 55), (38; 56; 53), (42; 36; 49)	(59; 45; 21), (43)	(43; 46)	(12)	(29)	(11; 48)
Arch angle (A)	(1)	(51)	(60)				
Arch circumf. (A)		(40)			(12)		

Arch height (A) *	(1)	(4; 51; 49) (61; 62)	(58; 59)	(46)	(12)	(63; 28)	
Arch index (A) *	(1)	(4; 51; 56), (5; 57)	(58; 59; 64)			(63)	
Arch length (A)	(16; 17)	(34)			(12)	(29; 48)	
Arch width (A)	(16)	(51)			(12)	(63; 28)	(11)
Dorsal arch circumf. (A)					(12)		(11)
Dorsal arch height (A)		(56; 49)	(60)		(12; 47)		(11)
Foot slope (A)							(11)
Navicular height (A) *	(33)	(35; 55)	(60; 64; 65), (45)	(43)	(47)		
Medial malleolus height (A) *	(66)	(37; 55; 53), (49)	(59)			(29)	
Lateral malleolus heigth (A)		(37; 55; 53), (49)				(29)	
Midfoot circumf. (A)					(12)		
Midfoot height (A)						(29)	
Midfoot width (A)	(16)					(29)	
Ankle circumf. (A)		(57)	(59)	(7)	(12)		
Sphyrion height (A)		(36; 37)					
Toe #1 angle (A) *		(35; 36; 55), (56; 57)	(44; 58; 59), (21)	(43)			
Toe #5 angle (A) *		(35; 36; 55), (56; 57)	(58; 21)	(43)		(48)	
Toe #1 height (A) *		(35; 37; 55), (38; 39; 56), (53; 49; 57)	(58; 59)	(46)			
Toe #5 height (A)		(35; 37; 55)					
Toe #1-#5 circumf. (A)		(56; 57)	(58; 59)				
Toe #1-#5 width (A)		(56; 57)	(58; 59)				
Toes height (A)	(54)	(49)					(11)

Truncated foot length (A)	(66)	(35)			(47)		
Foot posture index (V) *		(56; 57)	(58; 59; 67), (64; 65)			(28)	
Hallux valgus index (A)							(68)
Hallux valgus scale (V)						(69)	
Minimal distance between hallux and the interphalangeal joint of the second toes (A)			(44)				

Table S2. Studies that are using different automation levels of measurement procedure related to the number of measured foot shape characteristics (* virtual markers, ’ physical markers).

	Manual	Semi-automatic	Automatic
Foot lengths	(11), (23), (40), (53), (49), (50), (57), (41), (48), (28)	(43)’, (30)*, (35)’, (36)’, (46)’, (51)*, (52)*, (37)’, (55)’, (38)’, (31)’, (39)’, (44)’, (32)’, (1)’, (47)’, (54)’, (45)’, (66)*, (18)’, (21)*, (8)*	(34), (12), (29), (33), (21), (28)
Foot widths	(11), (63), (40), (56), (58), (59), (53), (49), (50), (57), (41), (48), (28)	(43)’, (30)*, (35)’, (36)’, (46)’, (51)*, (52)*, (37)’, (55)’, (38)’, (31)’, (44)’, (32)’, (1)’, (54)’, (45)’, (18)’, (21)*, (8)*	(34), (12), (29), (33), (21), (28)
Foot heights	(11), (4), (63), (56), (58), (59), (53), (61), (62), (49), (57), (60), (64), (65), (48), (28)	(43)’, (35)’, (36)’, (51)*, (52)*, (37)’, (55)’, (38)’, (31)’, (39)’, (1)’, (47)’, (54)’, (45)’, (66)*, (18)’, (21)*, (8)*	(34), (12), (29), (33), (21), (28)
Foot circumferences	(11), (23), (40), (56), (58), (59), (53), (49) (57), (48)	(43)’, (30)*, (35)’, (36)’, (46)’, (55)’, (31)’, (39)’, (32)’, (54)’, (45)’, (18)’, (21)*, (8)*	(34), (12), (29), (33), (21)
Foot angles	(11), (56), (58), (59), (53), (57), (60)	(43)’, (35)’, (36)’, (51)*, (52)*, (37)’, (55)’, (38)’, (44)’, (1)’, (18)’, (21)*, (8)*	(12), (21)
Foot indexes	(4), (63), (56), (58), (59), (67), (57), (60), (64), (65)	(51)*, (1)’	(12), (5), (70)
Plantar surface			(71), (3), (11), (4), (63), (5), (6), (2), (9), (10), (28)
3D foot shape			(13), (15), (23), (19), (14), (24), (20), (16), (29), (72), (25), (27), (17), (21), (22), (28)

Table S3. Foot shape analysis methods for orthotic and footwear applications.

	Foot shape variation	Group studies	Prediction	Classification and clustering
Describe foot variation	(71), (13), (15), (31), (14), (16), (2)	(1)	(32), (17)	(54), (33), (66), (18)
Linking to subject characteristics	(3), (6), (70)	(34), (35), (36), (51), (52), (37), (55), (38), (19), (56), (53), (32), (5), (49), (50), (20), (2), (41), (42), (18)	(4), (40), (19), (49)	(37), (38), (39), (61), (62)
Linking to subject behaviour and health condition		(43), (55), (44), (58), (59), (67), (57), (60), (64), (65), (45), (22)		
Custom products	(8)	(23), (25)	(24)	(43), (46)
Definition of product sizes	(7)	(20)	(47)	(12), (26), (9), (27)
New measurement system	(21)	(63), (29), (72), (10)		(69), (48)

Table S4. List of studies that evaluate foot shape changes due to factors influence.

Technique	Factor	Study
Regression	Age	(13), (40), (70)
	Gender	(3), (13), (70)
	BMI	(3), (13), (51), (40), (70)
	High-heeled shoes	(71)
	Frequency of sport activity	(13)
Principal component regression	Age	(14)
	Gender	(14)
	BMI	(14)

Table S5. List of studies that employ prediction techniques to estimate predictive significance of related subject characteristics.

Technique	Predictor	Study
Regression	Age	(40)
	BMI	(19)
	Arch height	(4)
	Hallux valgus index	(68)
	Foot length	(47)
Principal component regression	Age	(14)
	Gender	(14)
	BMI	(14)
Machine learning	10 foot dimensions	(24)
Allometry	Foot length	(32)

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Table S6. List of studies that employ classification techniques to distinct foot shape groups.

Technique	Classification groups	Study
Achetypoid analysis	The first archetypoid is a very short and narrow foot; the second archetypoid is very wide foot; and the third archetypoid is a very long foot	(54)
Archetype analysis + knn	Normal shape or outlier	(33)
Discriminant analysis	Recreational sprinters and non-habitual exercisers	(43)
	Gender	(49)
Free form deformation method	Four groups: (a) short toes and large leg depth; (b) long toes and small leg depth; (c) low dorsal and plantar arch; (d) high dorsal arch	(26)
Calculation of central tendencies based of 4 plantar shape parameters: foot width, heel width, three-quarters of the length of the foot; the arch height	S, M, L types based on their central tendencies	(9)
Mean and standard deviation of truncated normalized navicular height are used as the limits for group ranges	Arch height (normal, pes cavus, pes planus)	(66)
Visual appraisal	Arch height (normal, pes cavus, pes planus)	(61), (62)
	Hallux valgus (no, mild, moderate, severe)	(69)

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Table S7. List of studies that apply comparison techniques for evaluation of measurement system based on extracted foot measurements.

Technique	Measurement	Application	Study
MSE	Several foot dimensions	Comparison of proposed low cost 3D scanning procedure to the measurement procedure which uses anthropometric data	(23)
	Several foot dimensions	Comparison of scanned and predicted foot shape for the purposes of the shape reconstruction	(29)
	Foot outline, foot profile, several sections	Comparison of scanned and predicted foot shape for the purposes of using low cost scanning	(72)
RMSE	Plantar foot shape	Comparison of 3D foot high resolution scan and low cost 3D foot scan for the purposes of using low cost scanning	(10)
	3D foot shape	Comparison of scanned and predicted foot shape for the purposes of shape reconstruction	(17)
ICC	Several foot dimensions	Comparison of measurements derived from semi-automatic and automatic landmark detection	(21)
Data distribution measurements	Several foot dimensions	Comparison of 3D Fourier descriptor foot model to the homologous model	(30)
Spearman's rank order correlation	Foot parameter (arch index) and arch dimensions	Comparison of estimated results to the ground truth	(63)
Linear regression	Single foot dimension (arch width)	Comparison between two different measurement systems based on the arch width as a common variable for both data sets	(36)
Mean Euclidean distance	3D foot shape	Comparison of scanned and predicted foot shape for the purposes of the shape reconstruction	(29)
Hausdorff distance	3D foot shape	Comparison of scanned and predicted foot shape for the purposes of the shape reconstruction	(17)
Mean shortest distance between shapes	3D foot shape	Comparison of actual scan and predicted foot parameterized using foot length, foot width, foot height, and a measure of foot curvature so that foot shape for the generation of personalized last	(25)

[17]A. Boppana, A. P. Anderson, Dynamic foot morphology explained through 4d scanning and shape modeling, Journal of Biomechanics 122 (2021).

[18]B. Cao, J. Wang, W. Shi, X. Lu, K. Zhou, 3d foot anthropometric measurements under two weight-bearing conditions for ergonomic design of foot-related products, International Journal of Morphology

Table S8. Papers showing which factors influence specific foot regions.

	Age	BMI	Ethnicity	Foot problems	Sex	Others
Toes	(13), (56)		(50)	Hallux valgus- (14); Hallux valgus, Toe deformity, Swollen foot - (55)	(3), (13), (35), (56), (49), (18)	High-heeled shoes - (71); Frequency of sport activity- (13), (43); Different bearing weight- (41); Shod and unshod runners- (44)
Forefoot	(56)	(13), (11), (34), (51), (19)	(36), (46), (50)	Hallux valgus - (14); Hallux valgus, Toe deformity, Swollen foot - (55)	(46), (52), (37), (55), (38), (53), (32), (50), (18)	High-heeled shoes - (71); Geographic region- (20); Frequency of sport activity- (43); Different bearing weight- (41); Shod and unshod runners- (44)
Midfoot	(40), (70)	(71), (3), (11), (34), (51), (40), (19), (70)	(5), (50)	Hallux valgus, Toe deformity- (55); Patellofemoral pain syndrome- (60); Osteoarthritis- (64)	(3), (13), (35), (46), (52), (37), (55), (38), (56), (49), (20), (18), (70)	Frequency of sport activity- (13); Geographic region- (20)
Heel	(13)	(13), (11), (34)	(50)	Swollen foot- (55) Patellofemoral pain syndrome- (60); Arthritis- (57); Osteoarthritis- (64); Diabetic foot- (67)	(13), (46), (56), (20), (18)	
Ankle	(13)	(13), (11)	(50)	Toe deformity, Swollen foot- (55) Patellofemoral pain syndrome- (60); Arthritis- (57); Osteoarthritis- (64); Diabetic foot- (67)	(13), (56), (49), (18)	Frequency of sport activity- (13)

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