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# THE DIABETIC FOOT

## ASSESSMENT AND ASSISTIVE DEVICES

ULLA HELLSTRAND TANG

AVDELNINGEN FÖR ORTOPEDI, INSTITUTIONEN FÖR KLINISKA  
VETENSKAPER, SAHLGRENSKA AKADEMEN VID GÖTEBORGS UNIVERSITET



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# THE DIABETIC FOOT

## ASSESSMENT AND ASSISTIVE DEVICES

ULLA HELLSTRAND TANG

HUVUDHANDLEDARE: JON KARLSSON  
BIHANDEDARE: KERSTIN HAGBERG OCH ROY TRANBERG



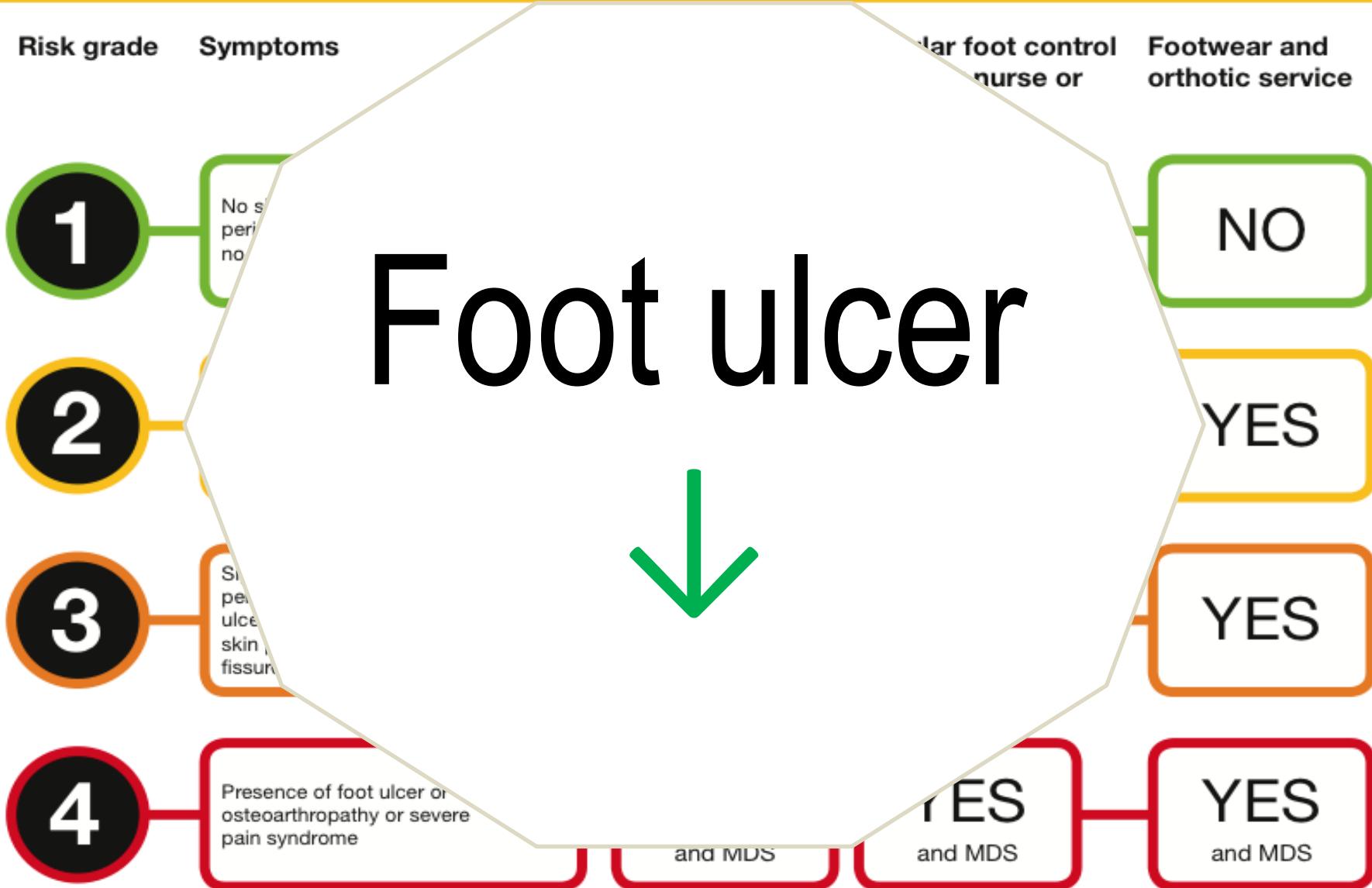
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# THE DIABETIC FOOT

## ASSESSMENT AND ASSISTIVE DEVICES

A FOOT THAT BELONGS TO A PERSON  
WITH DIABETES

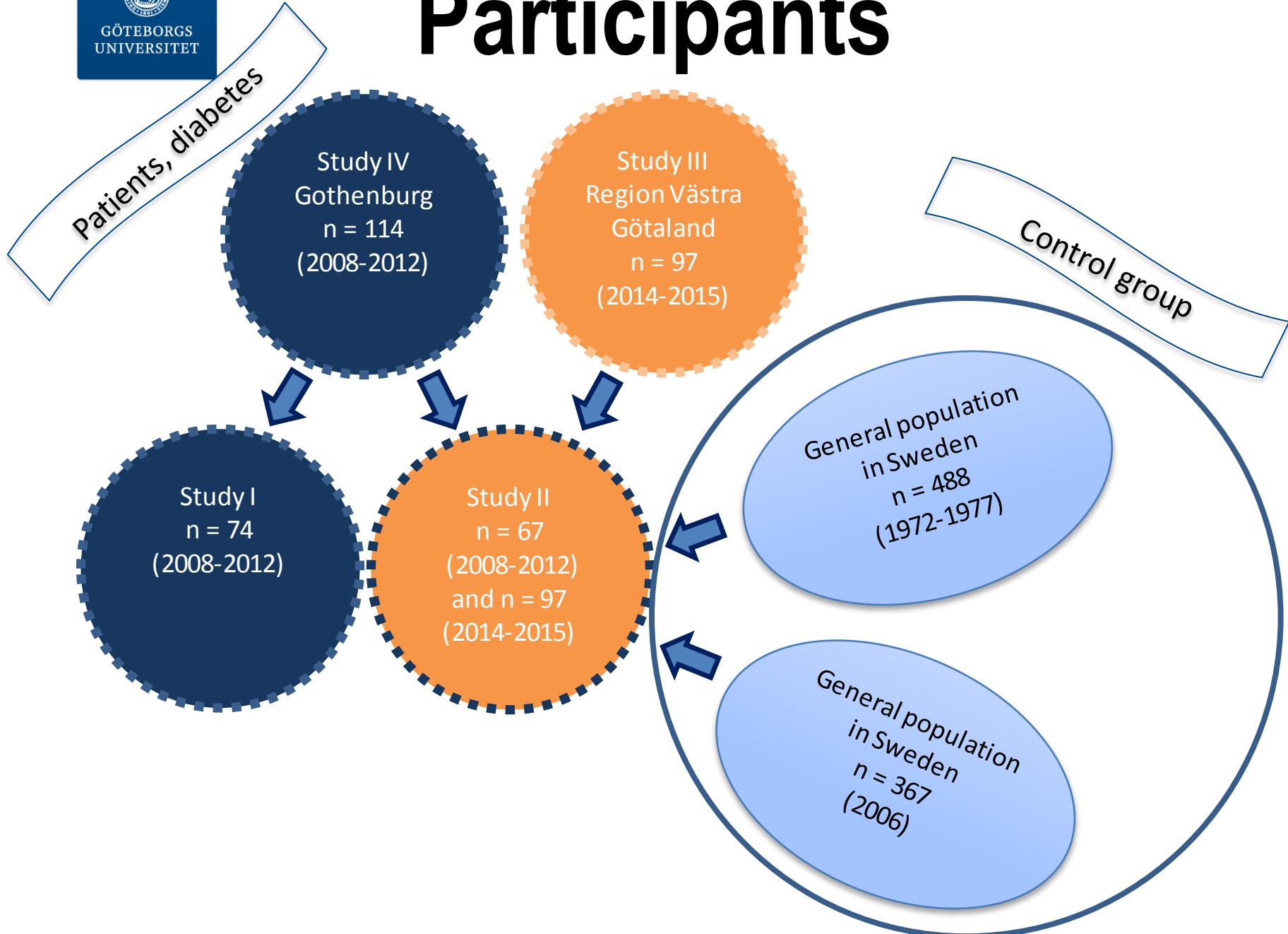
## Prevention - and multidisciplinary service (MDS) - of foot complications in diabetes



# Study I-IV

N	Titel	Theme
I	Foot deformities, function in the lower extremities, and plantar pressure in patients with diabetes at high risk to develop foot ulcers.	Risk factors
II	Foot anthropometrics in individuals with diabetes compared with the general Swedish population - implications for shoe design.	Foot form
III	The D-Foot, an eHealth tool useful in risk classification and foot assessment in diabetes – construction and reliability.	D-Foot
IV	Comparison of plantar pressure in three types of insole given to patients with diabetes at risk of developing foot ulcers – A two-year, randomized trial.	Insoles

# Participants



# Inclusion criteria

diabetes

being referred to a department of prosthetic & orthotics (DPO)

> 18 år

understand the Swedish language

**exklusionskriterier (Study IV)**

foot ulcer

have previously visited the DPO

use walking aids



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# Method

Clinical tests...

# Study I

**Foot deformities, function in the lower extremities, and plantar pressure in patients with diabetes at high risk to develop foot ulcers**

Ulla Hellstrand Tang, Roland Zügner, Vera Lisovskaja, Jon Karlsson, Kerstin Hagberg och Roy Tranberg.  
**Diabetic Foot & Ankle, 2015.**

# Aim

To describe the presence of risk factors for the development of foot ulcers,  
to explore the possible association between these risk factors and plantar pressure and finally,  
to describe the health – related quality of life.



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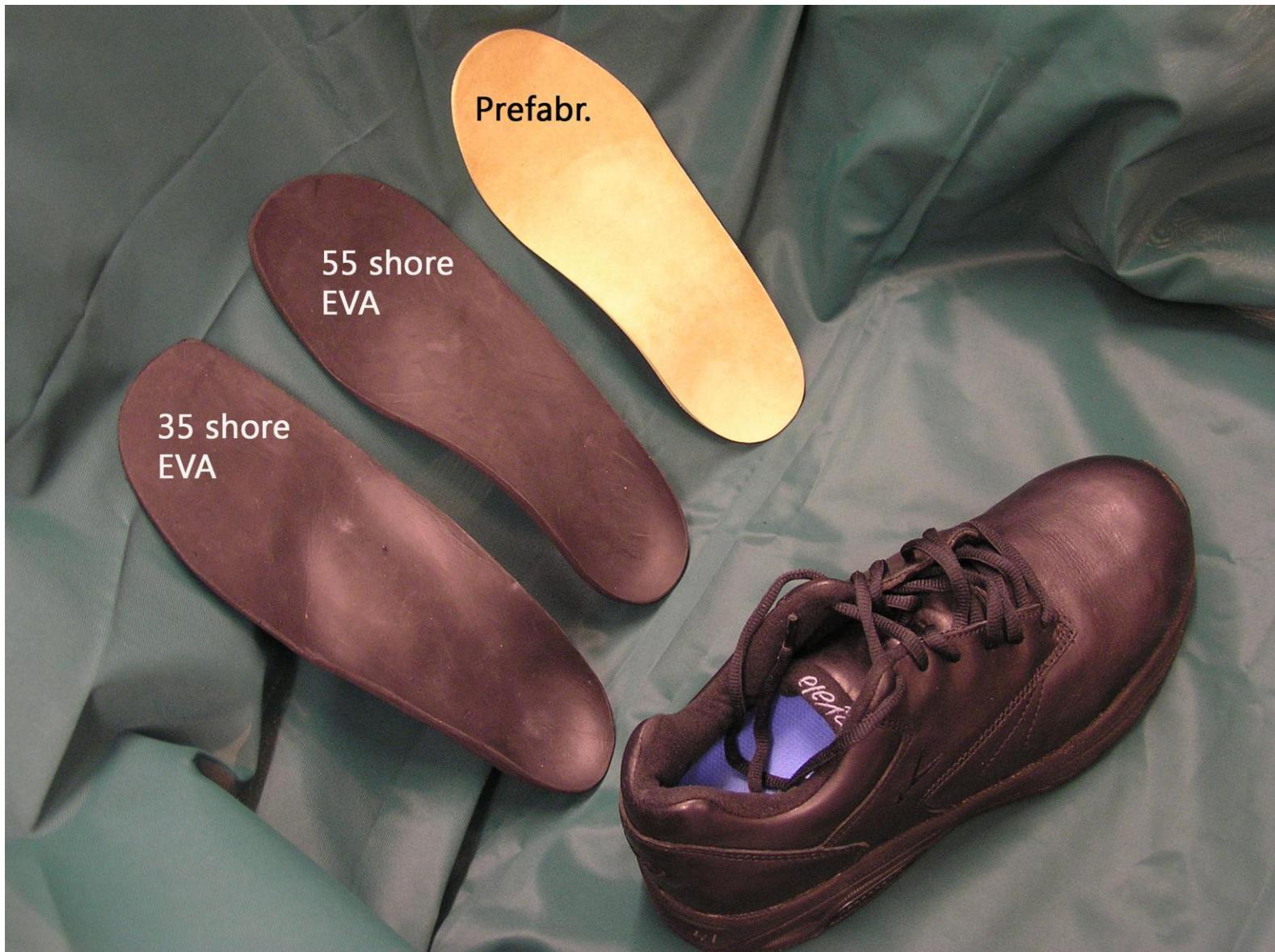
# Method F-Scan™

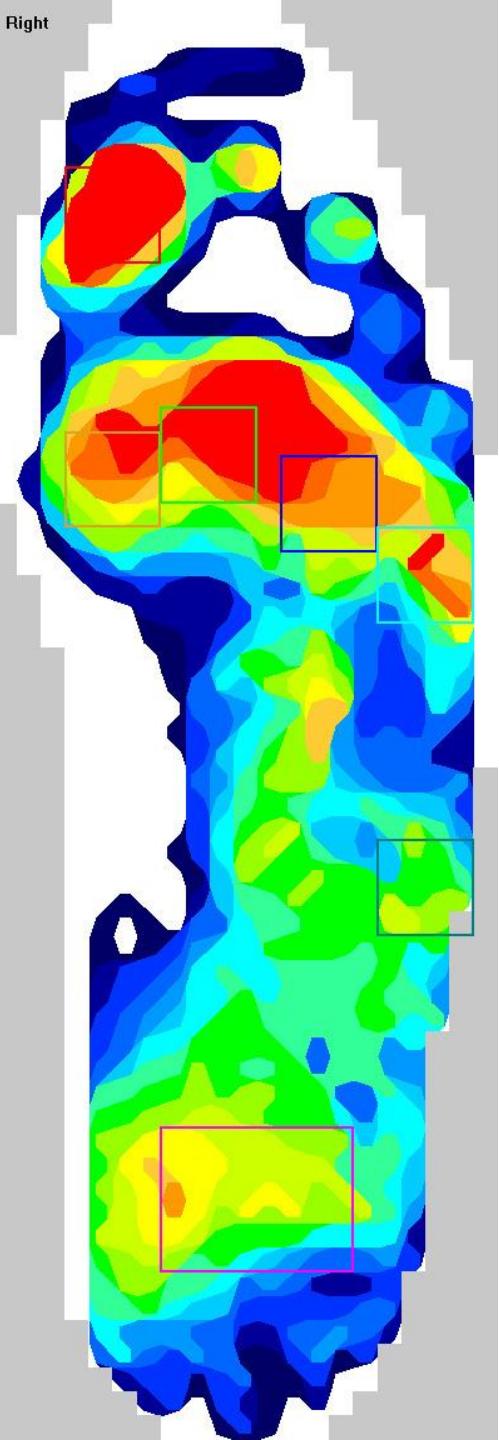
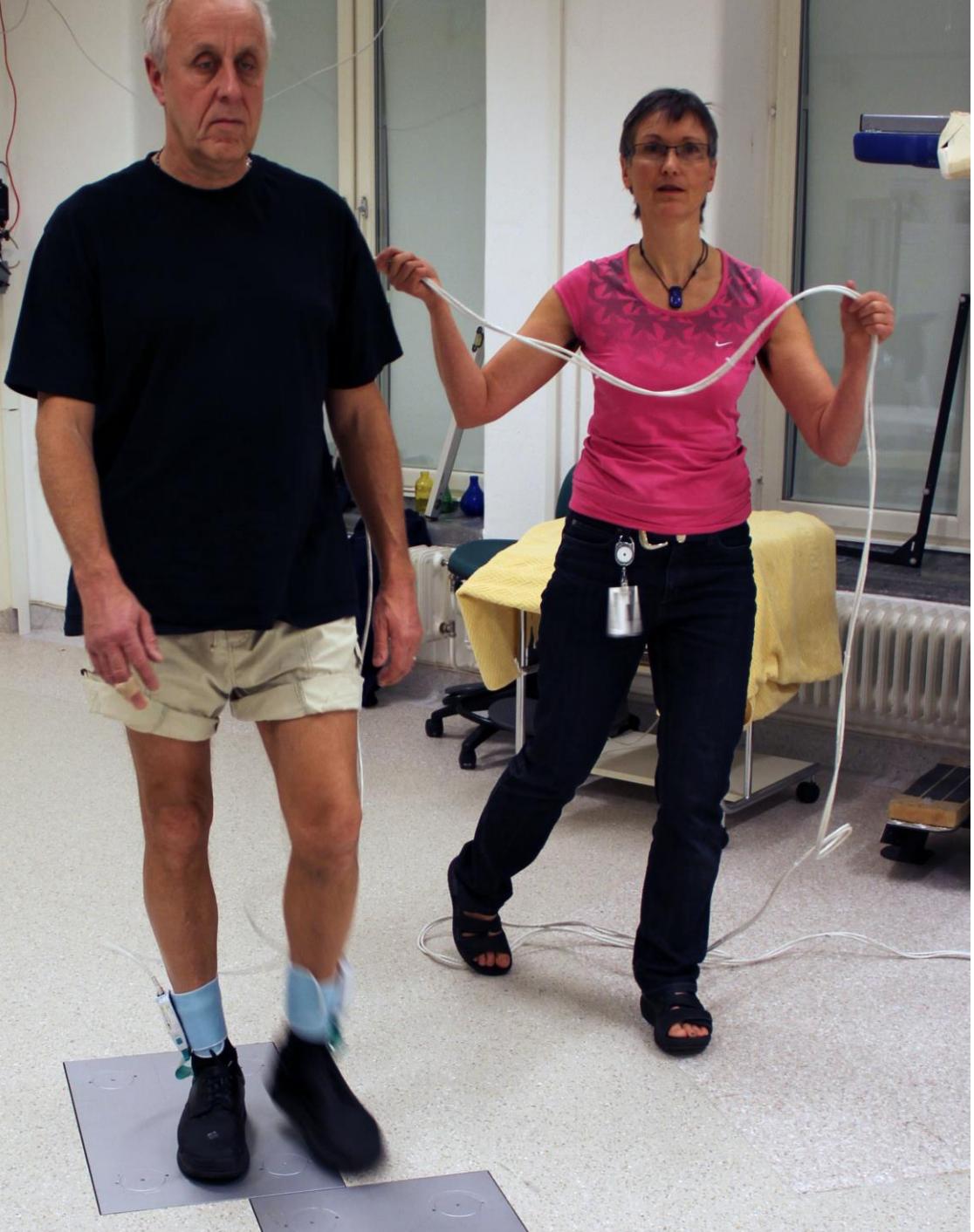




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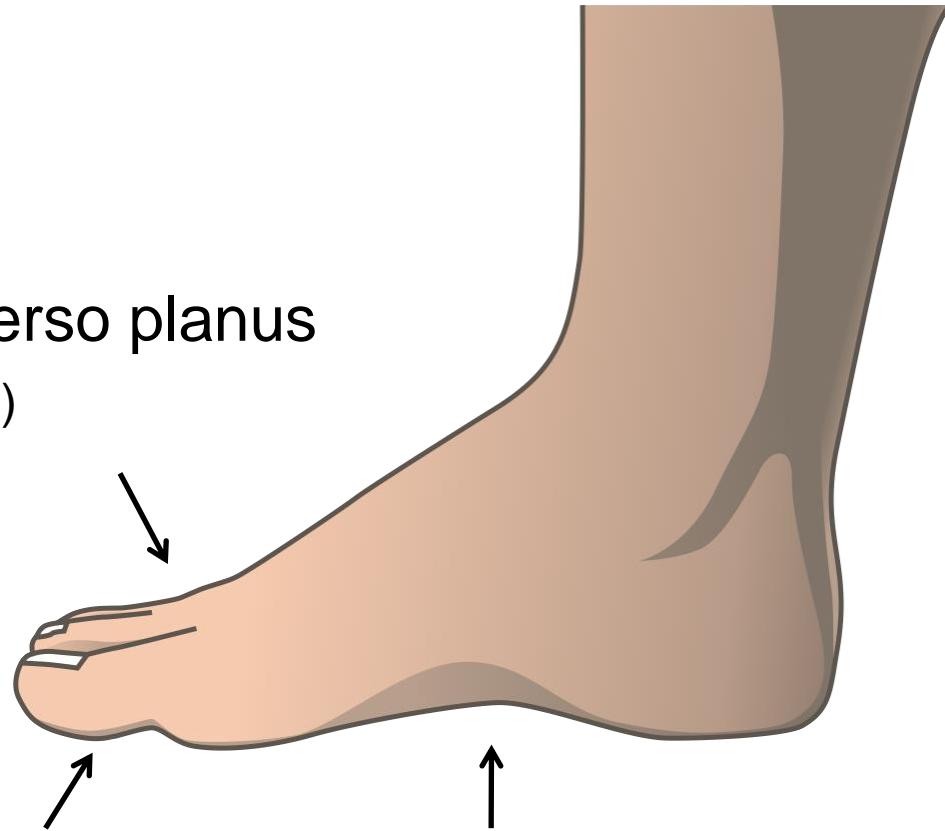
# Method F-Scan™





Pes transverso planus

77% (57/68)



Hallus rigidus

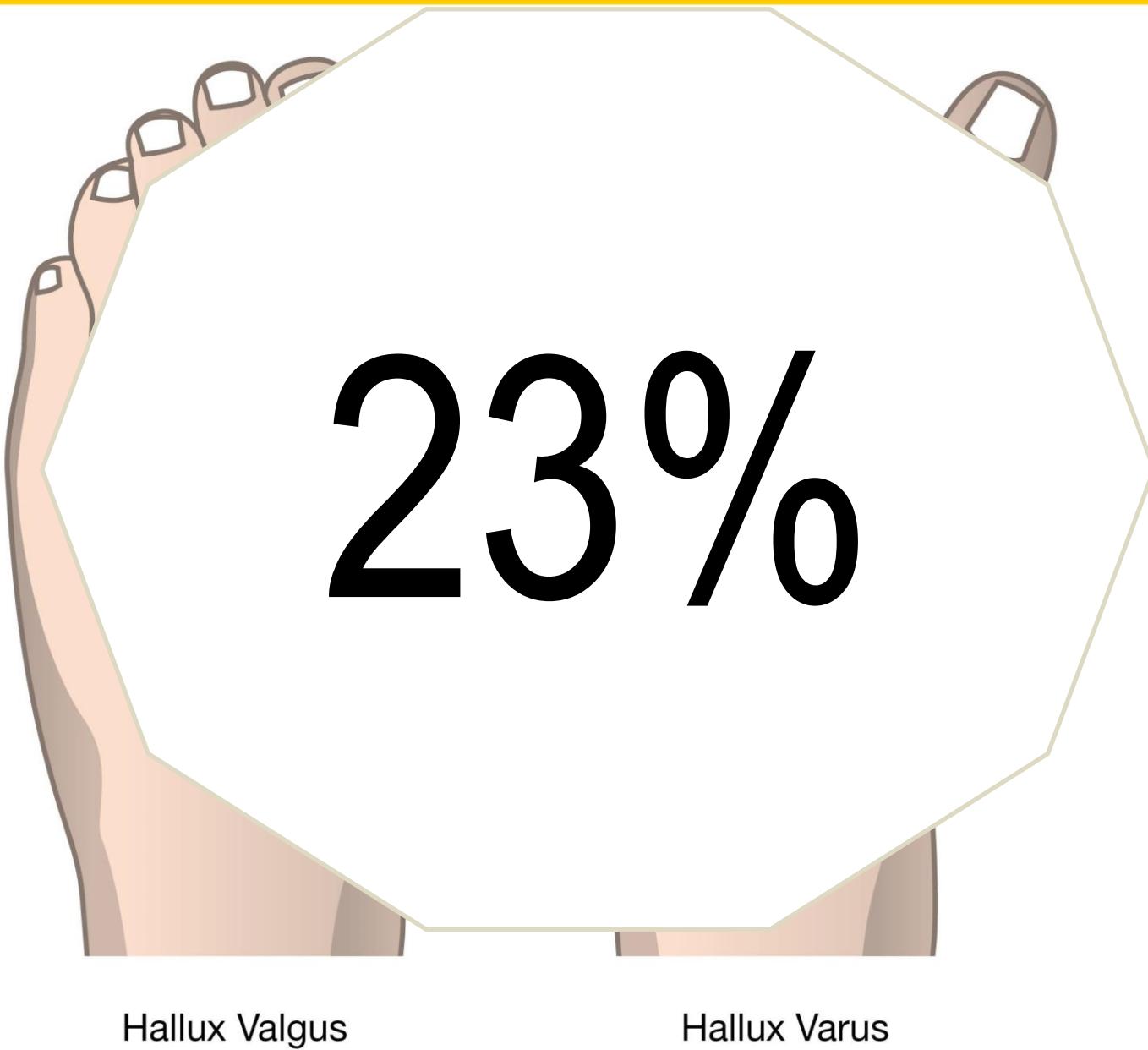
13% (18/69)

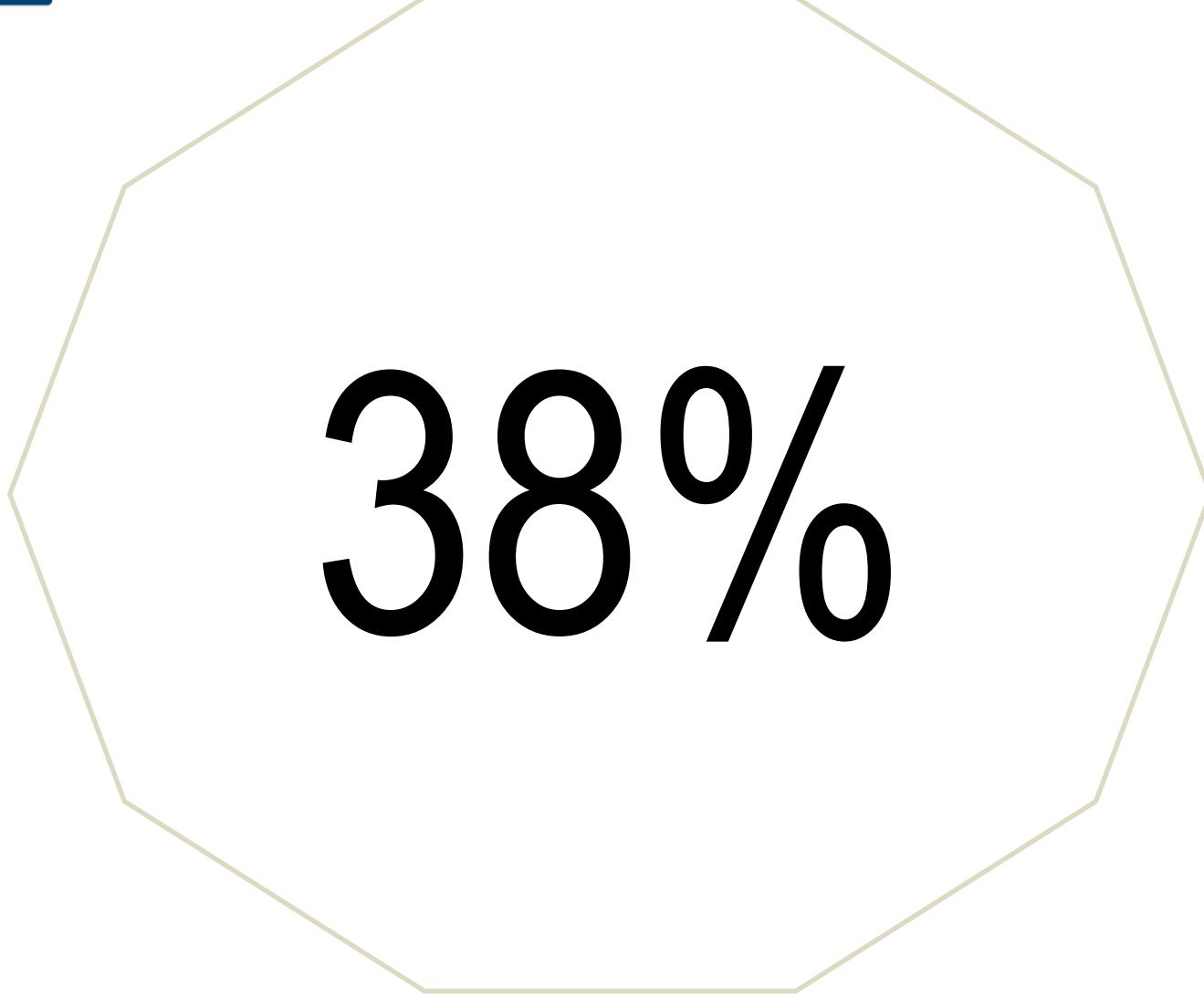
Pes planus 34% (25/68)

Pes cavus 10% (7/68)

# 9 Hallux Valgus/Varus

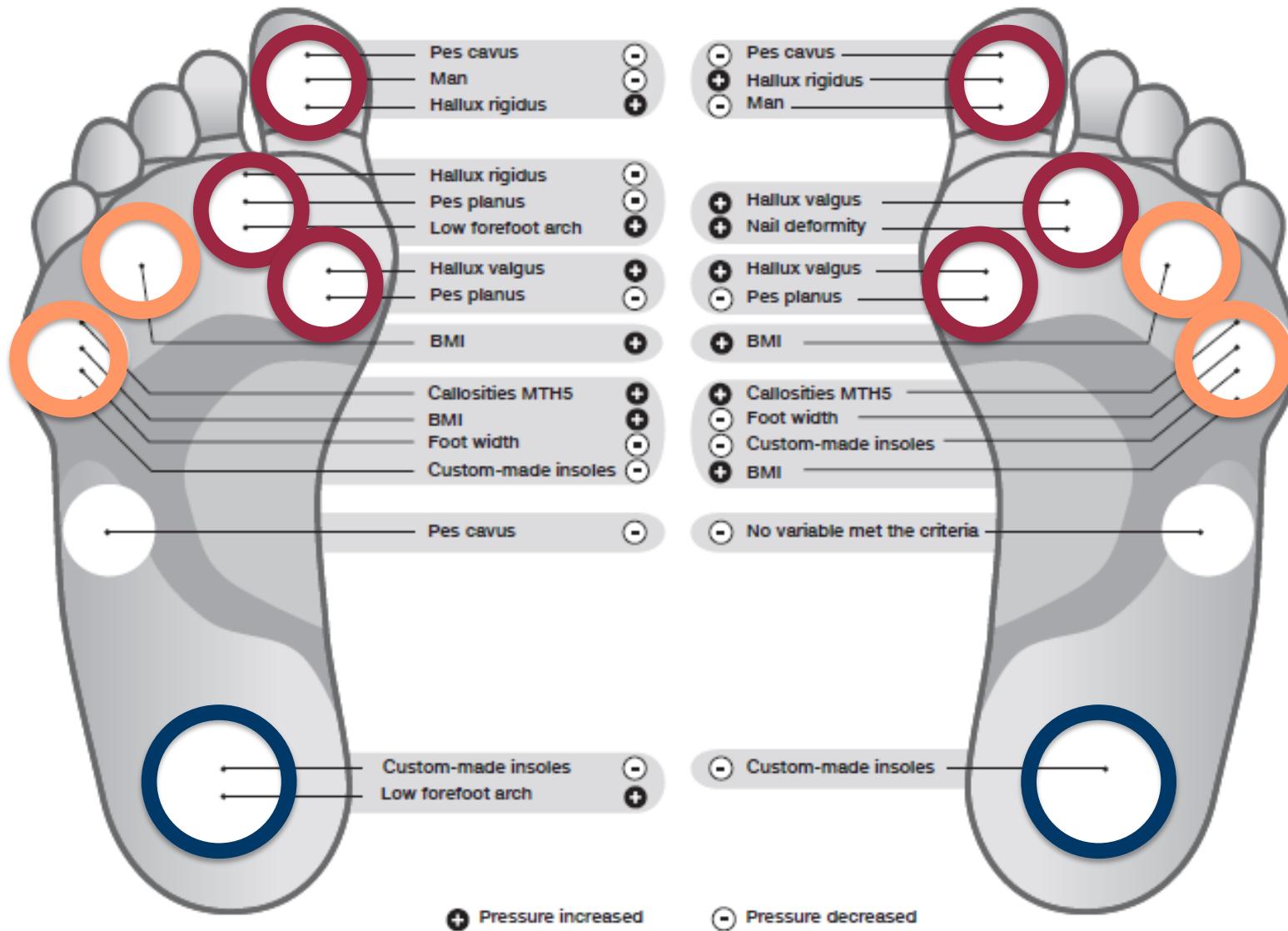
STUDIE I



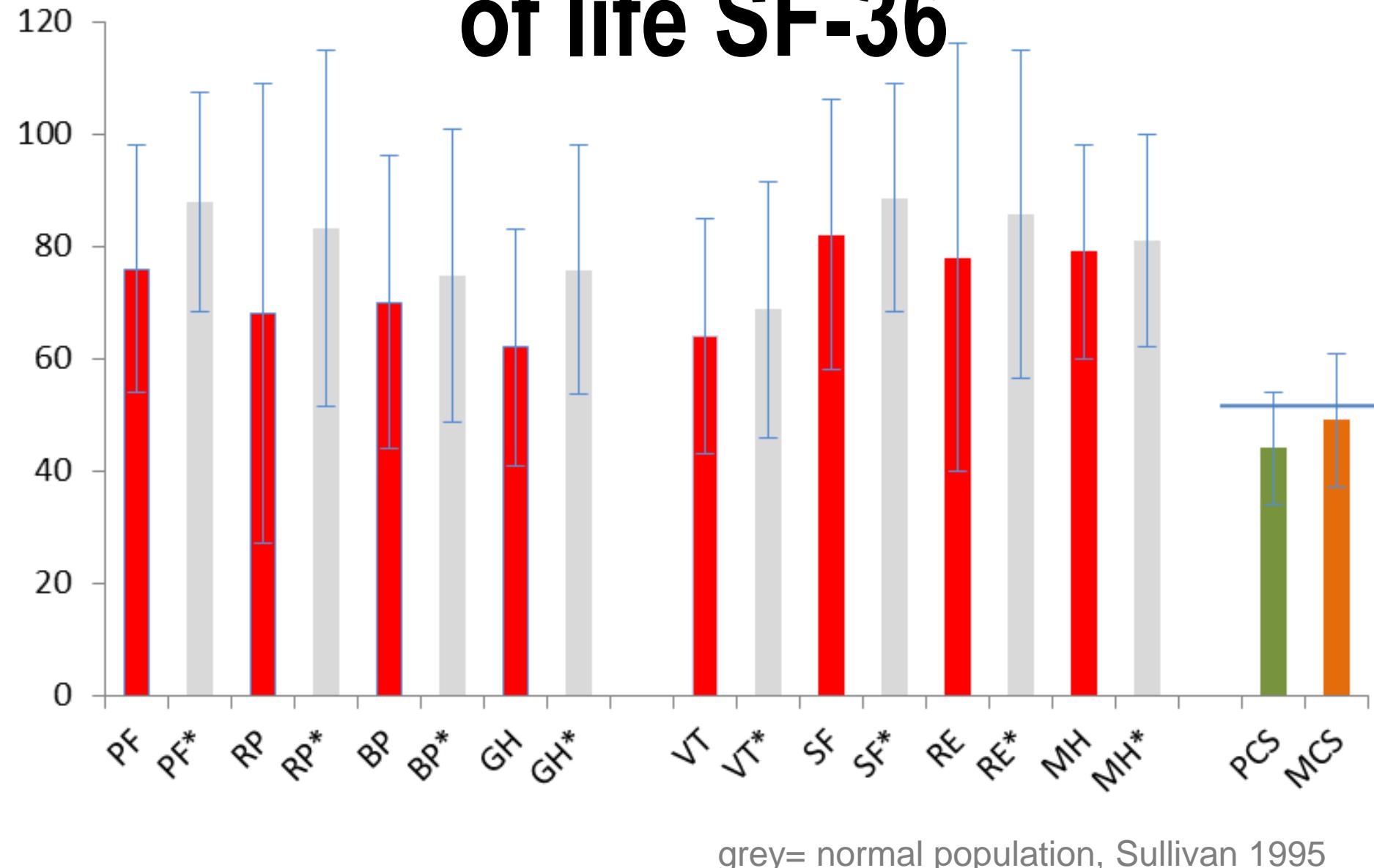


**38%**

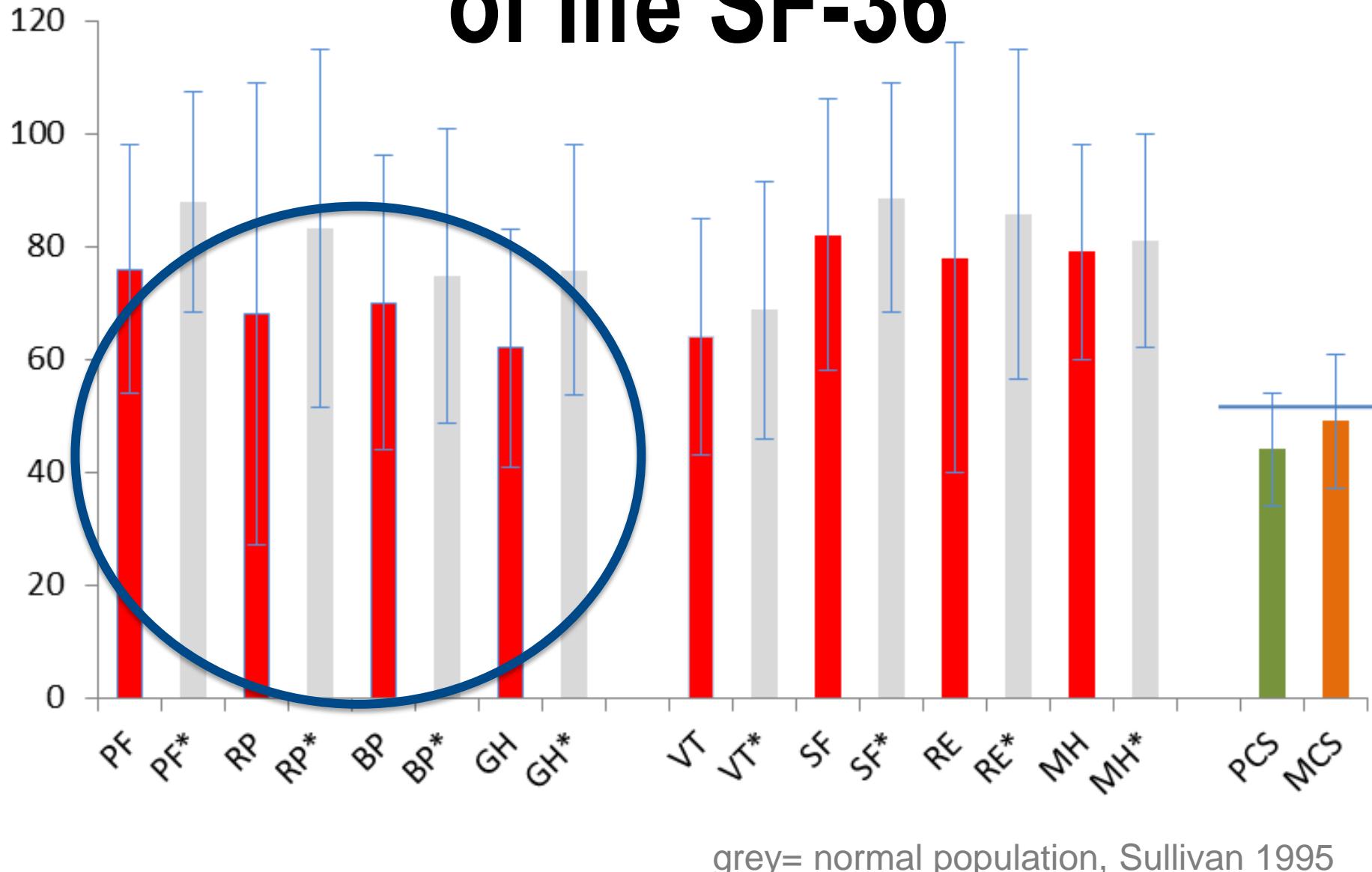
# Results



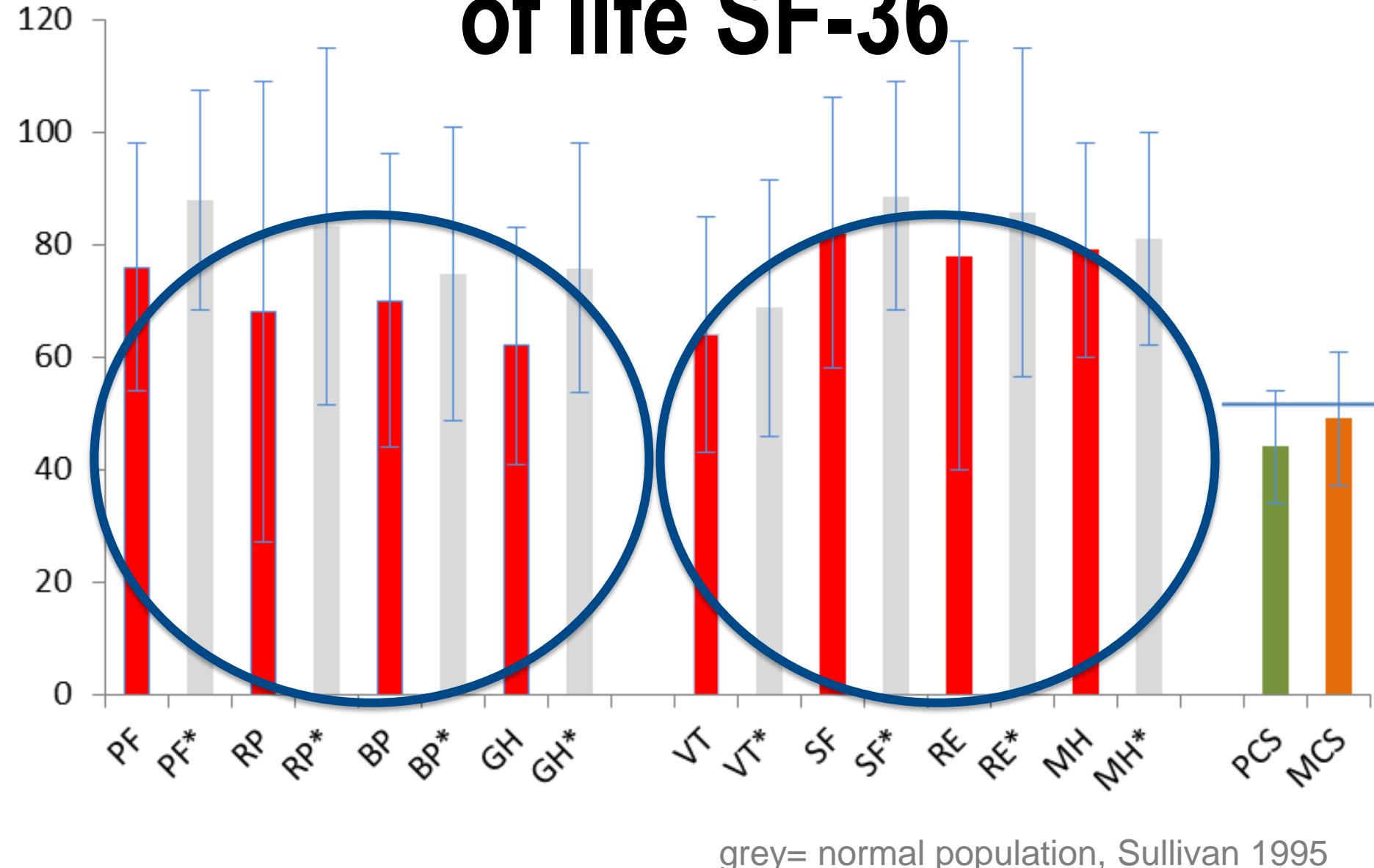
# Health related quality of life SF-36



# Health related quality of life SF-36

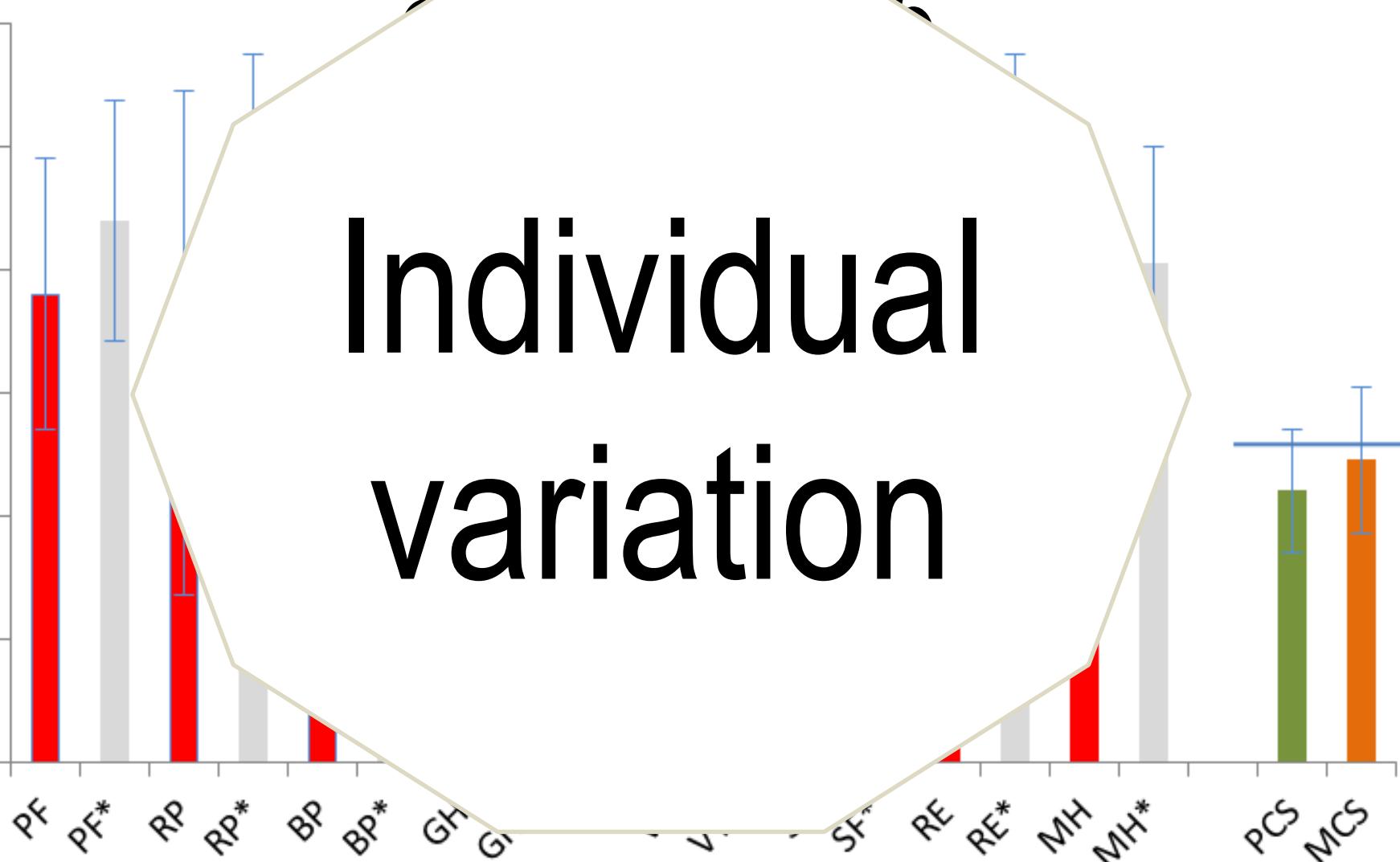


# Health related quality of life SF-36



# Health related quality

Individual  
variation



grey= normal population, Sullivan 1995

# Study II

## Foot anthropometrics in individuals with diabetes compared with the general Swedish population – implications for shoe design

Ulla Hellstrand Tang, Jacqueline Siegenthaler, Kerstin Hagberg, Jon Karlsson och Roy Tranberg.  
**The Foot and Ankle Online Journal 10 (3): 1**

# Aim

To describe and compare the foot anthropometrics in patients with diabetes compared with the anthropometrics of the general population.

# Control

## Diabetes

## Control

Diabetes  
(Group D)  
n= 164

Group D<sub>N</sub>  
n=102  
2008-2015

Group D<sub>D</sub>  
n=62  
2008-2015

♀  
n=42

♂  
n= 60

♀  
n= 31

♂  
n= 31

Control  
(Group C)  
n= 855

Group C<sub>1</sub>  
n= 488  
1972-1977

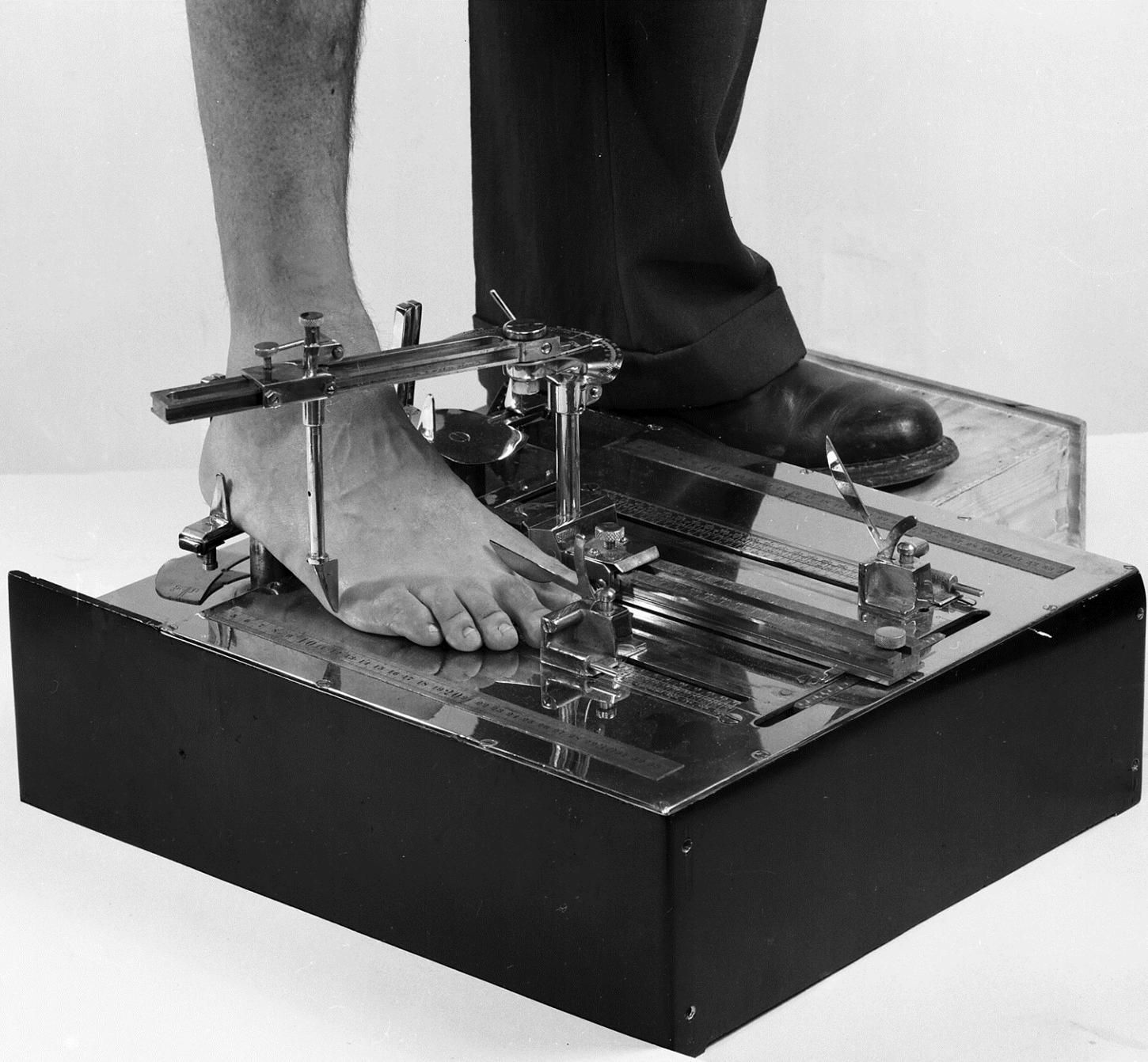
Group C<sub>2</sub>  
n= 367  
2006

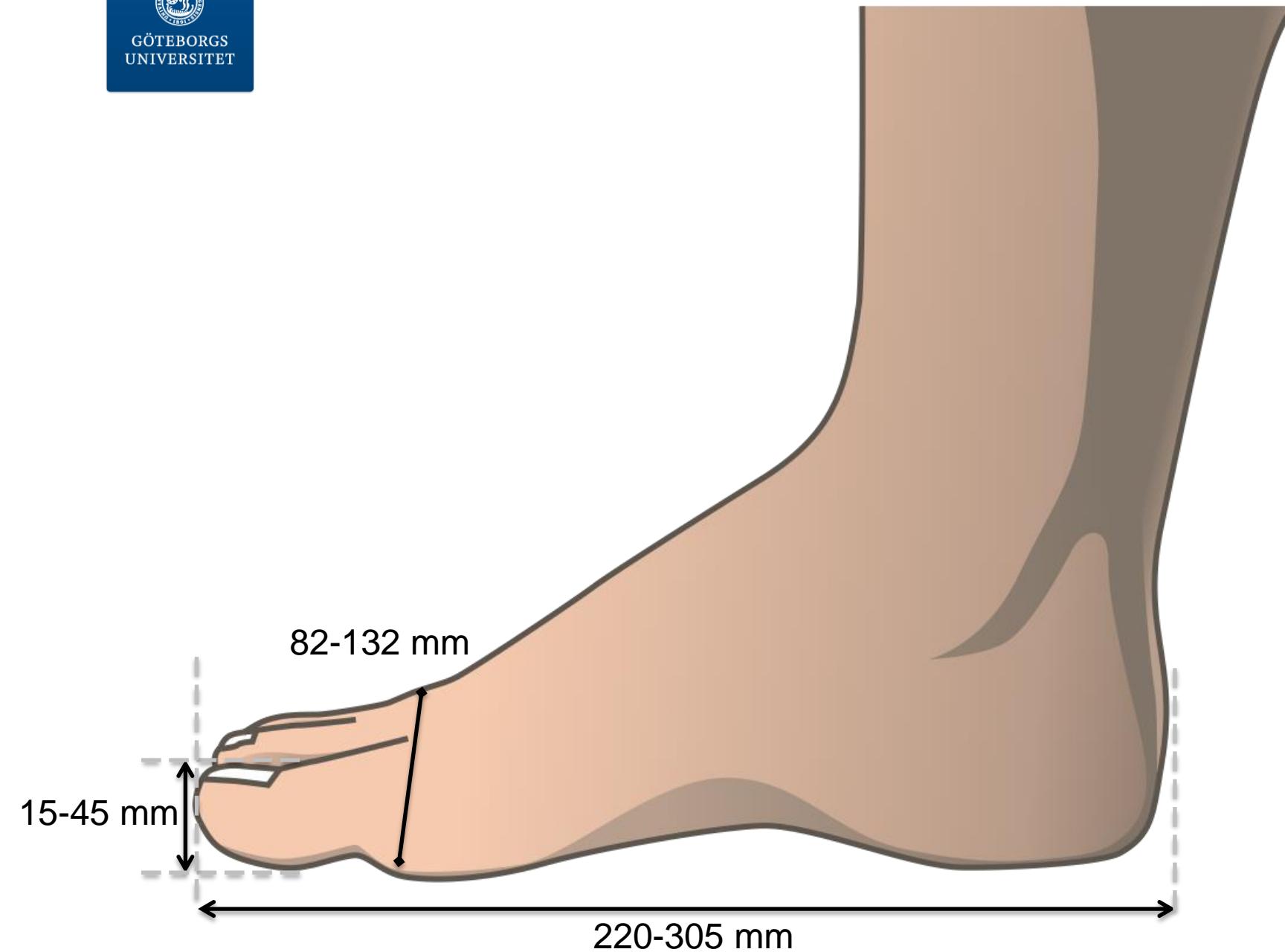
♀  
n= 253

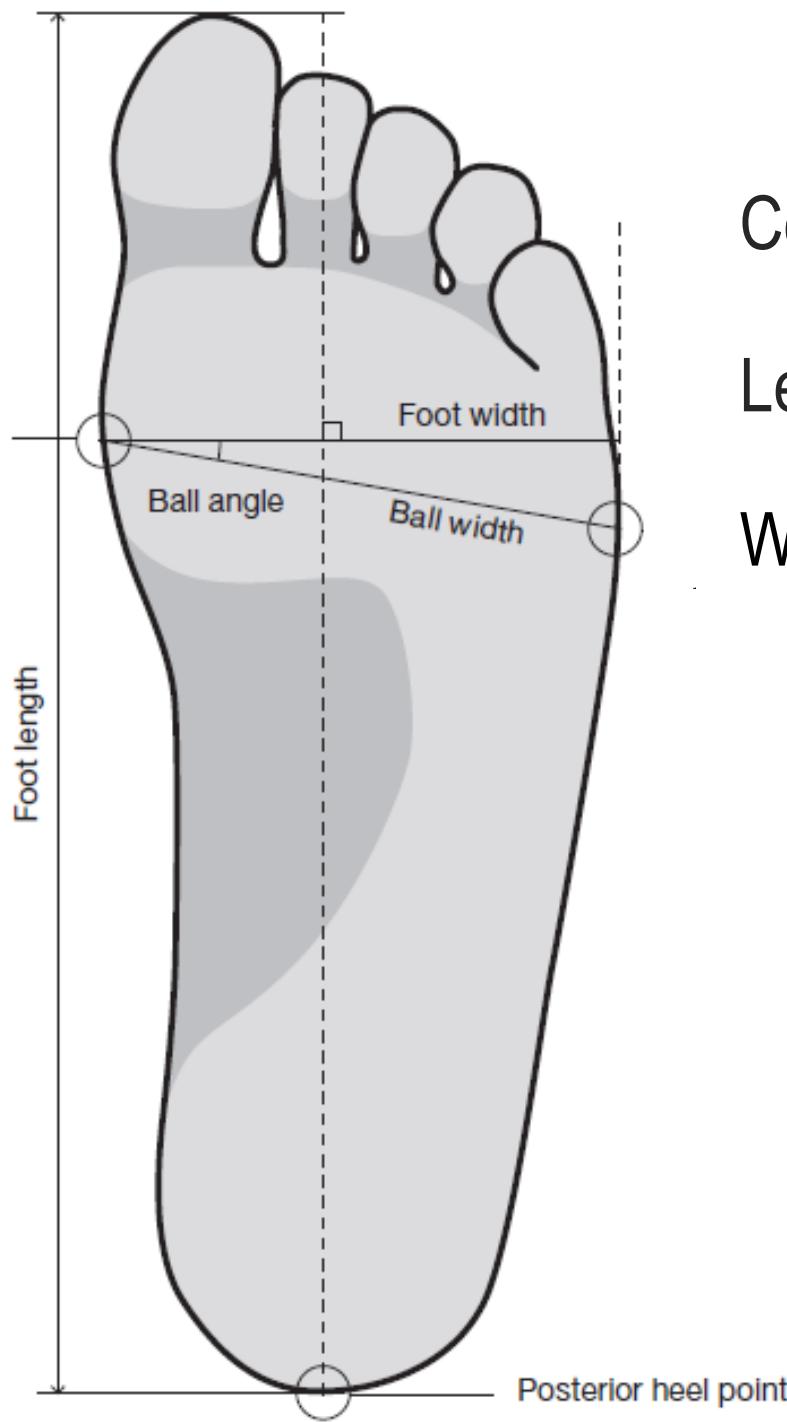
♂  
n= 235

♀  
n= 262

♂  
n= 105



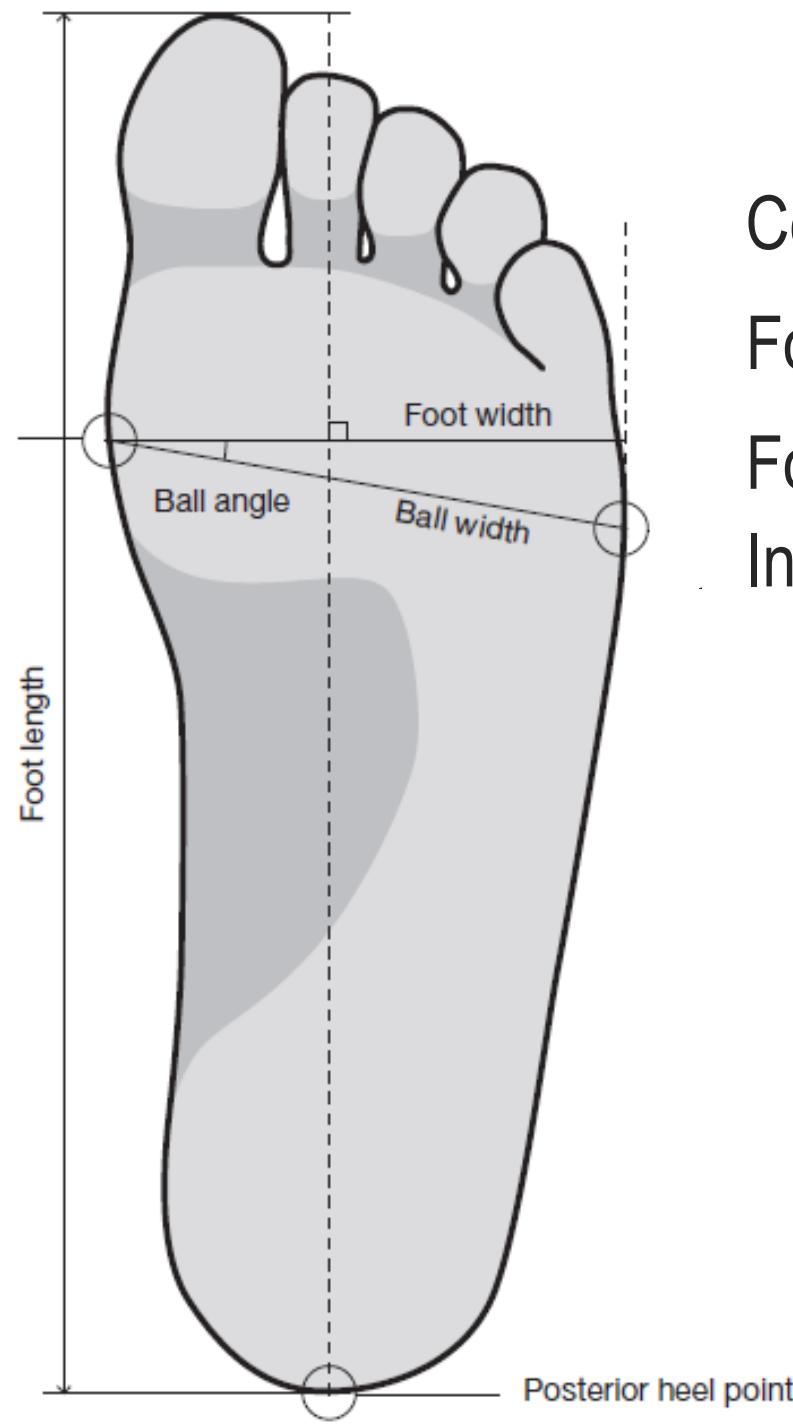




Covariates: age, gender

Length + 23.6 mm for ♂

Width + 9.0 mm for ♂



Covariates: age, gender, and BMI

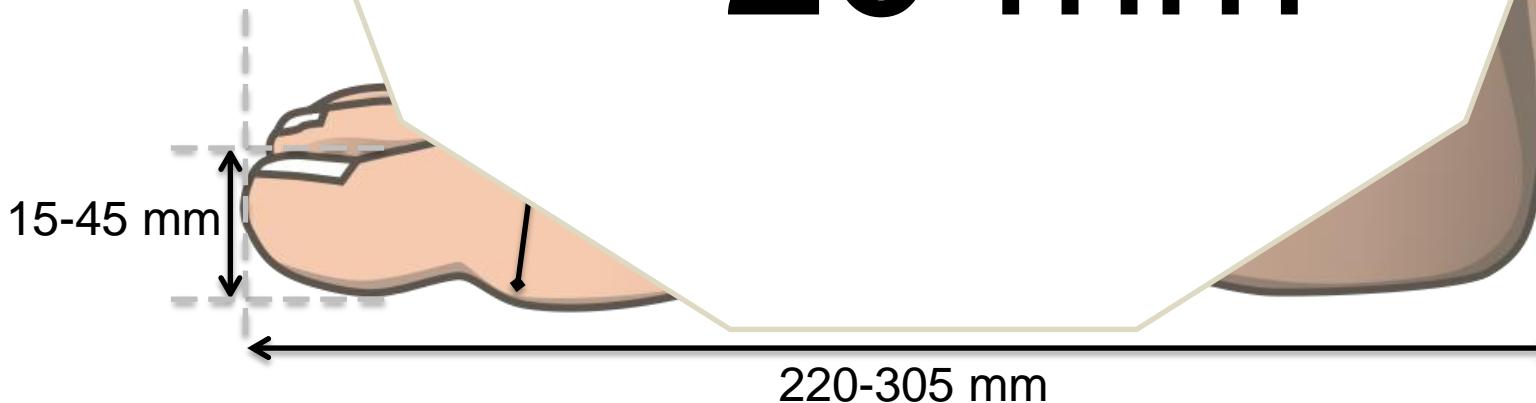
Foot length ns

Foot width  $D_N - C_2$  (1.6 mm, p=0.047)

Index<sub>FL/FB</sub>  $D_D - C_2$  (-0.05 mm, p=0.018)



# Toe height $> 25 \text{ mm}$



# Study III

## The D-Foot, an eHealth tool useful in risk classification and foot assessment in diabetes – construction and reliability

Ulla Hellstrand Tang, Roy Tranberg, Roland Zügner, Jon Karlsson, Vera Lisovskaja, Jacqueline Siegenthaler och Kerstin Hagberg.

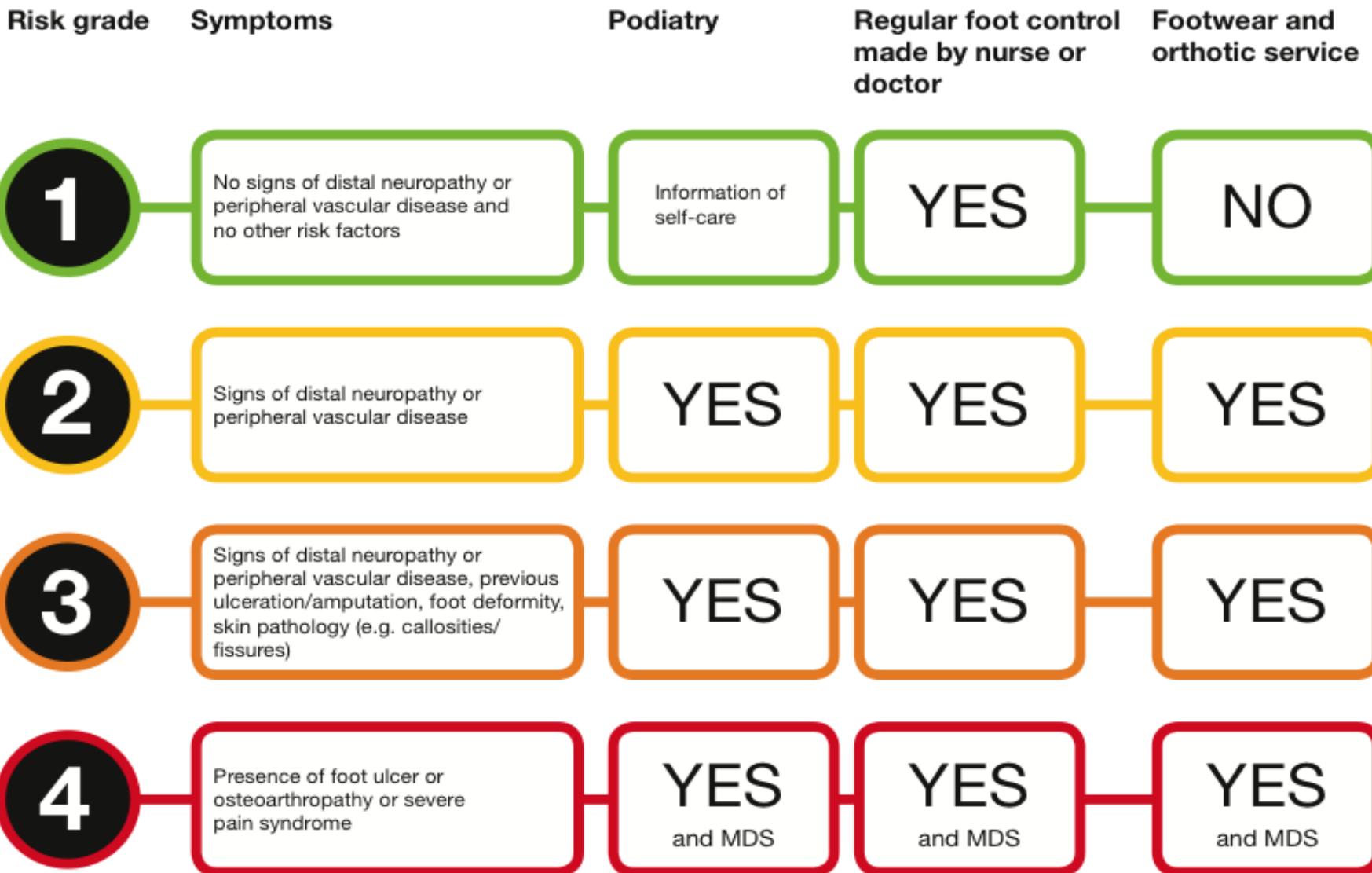
The Foot and Ankle Online Journal 10 (2): 4

# Aim

To evaluate the reliability of the web application D-Foot, constructed to detect risk factors to develop diabetic foot ulcers.



# Prevention - and multidisciplinary service (MDS) - of foot complications in diabetes



## 1. Känseltest på tår med The Ipswich Touch Test

Använd dina fingertoppar för att göra test av känsel.

Förklaring

Ja Nej

## 2. Passiv rörlighet i stortåleden

Höger:

Grader

/änster:

Grader

Använd goniometer och mät passiv rörlighet i stortåleden.  
(Svara i grader)

Förklaring

## 3. Plantart ytliga ben och ledstrukturer

Höger:

Ja Nej

Palpation.

/änster:

Ja Nej

## 4. Uttalade tryckområden med callus

Höger:

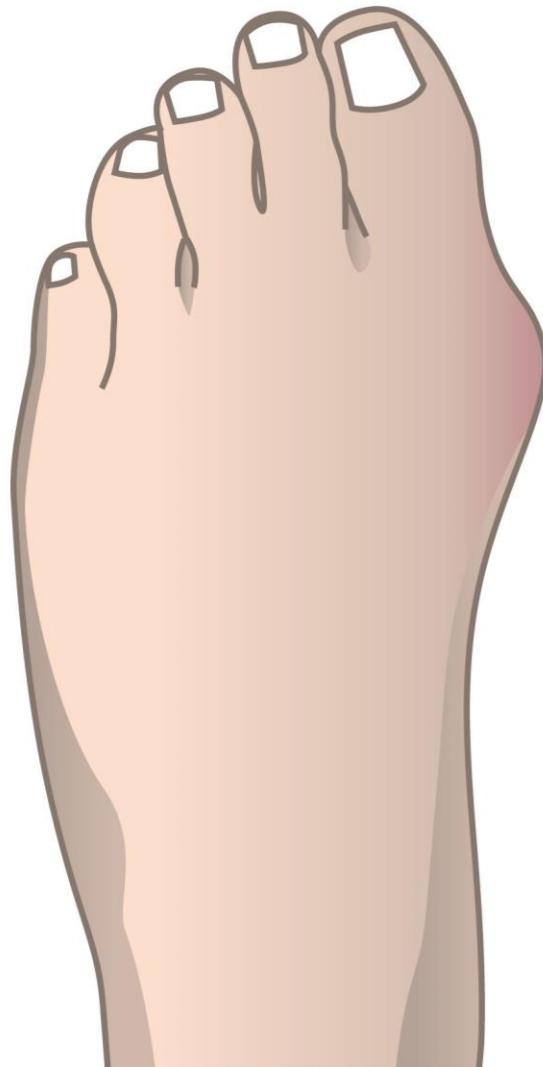
Ja Nej

Visuell inspektion av förhårdnader.

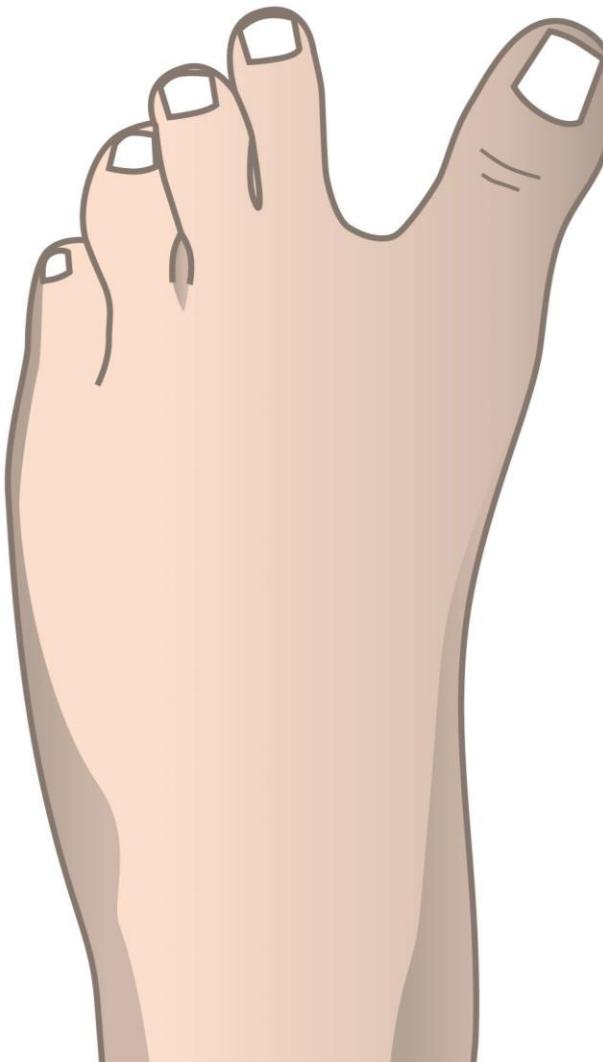
/änster:

Ja Nej

# 9 Hallux Valgus/Varus



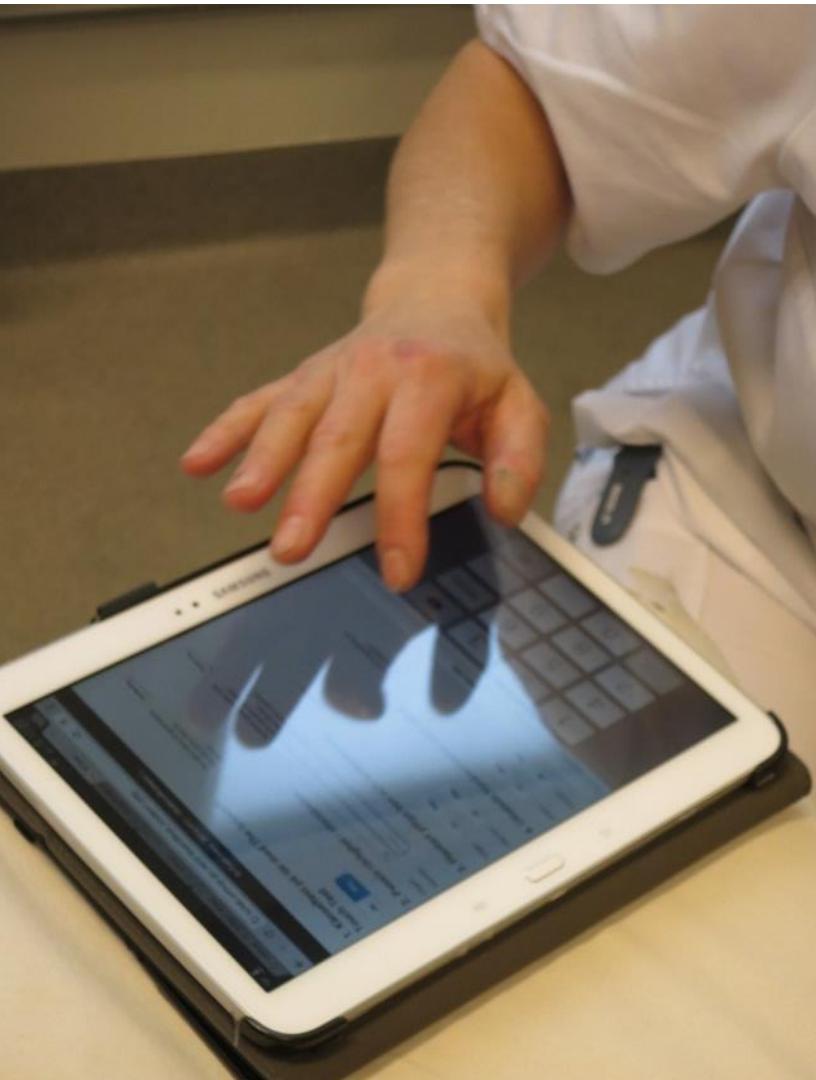
Hallux Valgus



Hallux Varus



# Construction D-Foot Reliability



Inter

Intra

N = 102 patients





# Reliability

Agreement between observers for  
Yes/No questions

Correlation between observers for the  
continuous measurements



# Results

Type of risk factor	Inter-reliability (between)			
	Prevalence	Agreement		Kappa
	(%)	proportion	± CI	Pooled
<b><u>Neuropathy</u></b>				
Positiv Ipswich Touch Test	50	0.79	0.08	0.56
<b><u>Foot deformity</u></b>				
Amputation	0	<b>1.00</b>	0.00	<b>1.00</b>
Charcot deformity	1	<b>1.00</b>	0.20	<b>0.76</b>
Hallux valgus/varus	26	<b>0.86</b>	0.07	0.59
Calcaneus valgus/varus	33	0.75	0.09	0.26
Abduction/adduktion of the forefoot	35	0.74	0.09	0.10
Prominent bony structure	35	0.75	0.09	0.44
Gait deviation, drop foot	10	<b>0.88</b>	0.07	0.23
Collapsed heel counter medial/lateral	29	0.74	0.09	0.32
Excessively worn-out sole	28	0.72	0.09	0.29

# Results...continued

Type of risk factor	Inter-reliability (between)			
	Prevalence	Agreement		Kappa
	(%)	proportion	± CI	Pooled
<b><u>Skin</u></b>				
Areas of excessive pressure with callosities	45	0.77	0.08	0.42
Callosities	45	0.73	0.09	0.32
Ulcer	11	<b>0.92</b>	0.06	0.31
<b><u>Risk grad</u></b>				
Risk grade 1	1	<b>0.94</b>	0.05	
Risk grade 2	1	<b>1.00</b>	0.00	
Risk grade 3	84	<b>0.83</b>	0.08	
Risk grade 4	14	<b>0.89</b>	0.06	
Risk grade total	100	<b>0.82</b>	0.08	0.31
<b><u>Clinical assessments (potential risk factors)</u></b>				
Inappropriate footwear	31	0.74	0.09	0.44

# Results...continued

Type of risk factor	Inter-reliability (between)			
	Prevalence	Agreement		Kappa
	(%)	proportion	± CI	Pooled
<u>Clinical assessments (potential risk factors)</u>				
Insufficient function of the toes and metatarsal phalangeal joints	34	0.59	0.10	0.08
Gait deviation, affected from hip/knee right and left respectively	36	0.68	0.37	0.28

# Results

Type of risk factor			Inter-reliability (between)	
	Mean	Diff.	Pearsons <i>r</i>	ICC
<b><u>Foot deformity</u></b>				
Toe height (mm)	27	0.5	0.57	0.56
Passive dorsal flexion at hallux joint (degree)	54	0.4	<b>0.61</b>	<b>0.62</b>
Maximal dorsal flexion at ankle joint (degree)	22	1.3	<b>0.72</b>	<b>0.66</b>
Navicular drop test (mm)	8	0.6	0.33	0.32



# Results

Agreement between observers (inter) > 0.80 (good)

- Risk classification
- Amputation
- Charcot deformity
- Foot ulcer
- Gait deviation
- Hallux valgus/hallux varus

# Study IV

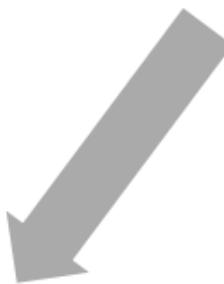
**Comparison of plantar pressure in three types of insole given to patients with diabetes at risk of developing foot ulcers - A two-year, randomized trial**

Ulla Hellstrand Tang, Roland Zügner, Vera Lisovskaja, Jon Karlsson, Kerstin Hagberg och Roy Tranberg  
**Journal of Clinical & Translational Endocrinology, 2014.**

# Aim

To compare the plantar pressure between three types of commonly used insoles.

**Patients (n=235)**



**Included (114)**

**Not included (121)**



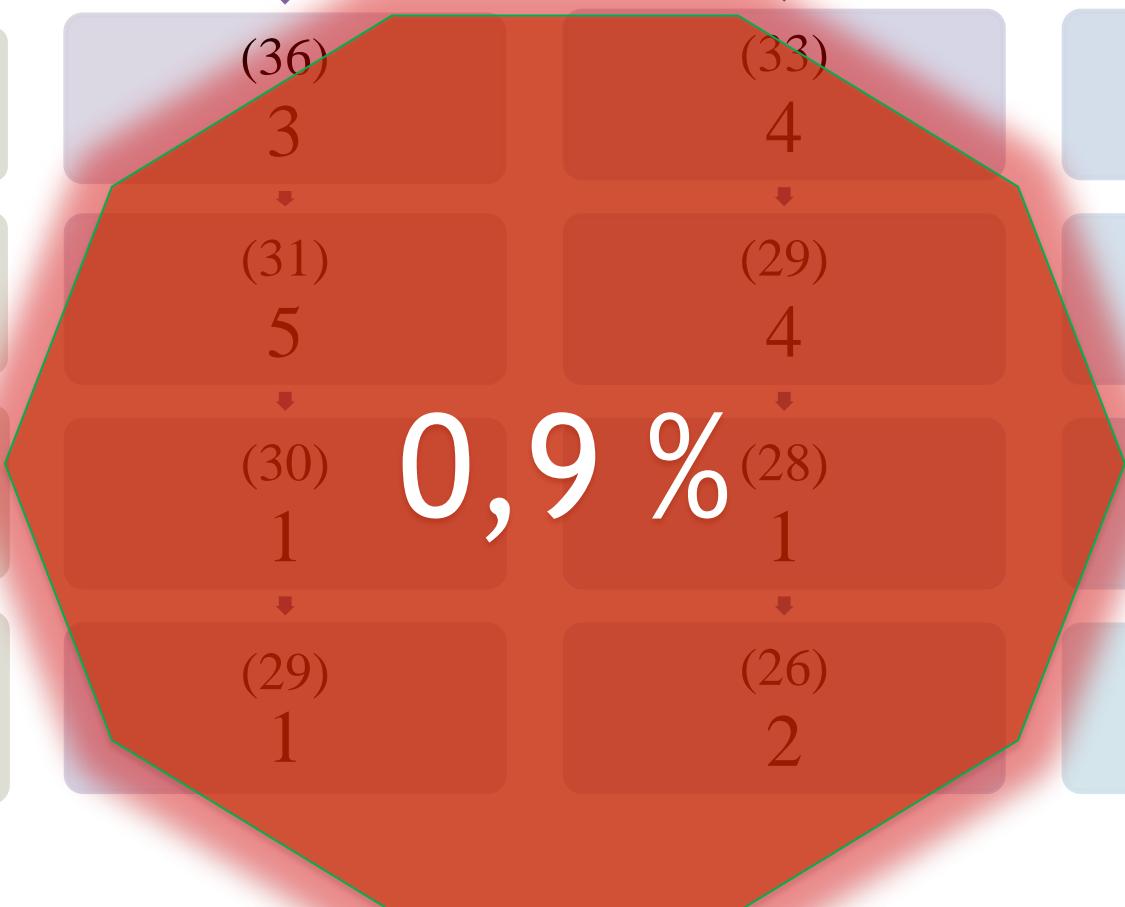
**Randomization**



**35 EVA insoles**  
(39)

**55 EVA insoles**  
(37)

**Prefab. insoles**  
(38)



**0,9 %**

Peak plantar pressure (kPa)				
	Value	Std. Err.	DF	p-value
Hallux				
Prefabricated	249	17	323	
Diff. 35 EVA	-39	22	111	0,08
Diff. 55 EVA	10	23	111	0,66
Age, insole	0	0	323	0,93
Metatarsal head 1				
Prefabricated	242	15	323	
Diff. 35 EVA	-40	20	111	0,05* 
Diff. 55 EVA	-15	20	111	0,45
Age, insole	-0	0	323	0,07
Metatarsal head 2				
Prefabricated	291	15	323	
Diff. 35 EVA	-42	20	111	0,04* 
Diff. 55 EVA	-29	20	111	0,16
Age, insole	-0	0	323	0,58

Peak plantar pressure (kPa)				
	Value	Std. Err.	DF	p-value
Metatarsal head4				
Prefabricated	202	11	323	
Diff. 35 EVA	-10	15	111	0.50
Diff. 55 EVA	-11	15	111	0.49
Age, insole	0	0	323	0.80
Metatarsal head 5				
Prefabricated	156	11	323	
Diff. 35 EVA	-21	15	111	0.16
Diff. 55 EVA	-35	15	111	0.02* 
Age, insole	0	0	323	0.06
Midfoot				
Prefabricated	96	7	323	
Diff. 35 EVA	-1	10	111	0.96
Diff. 55 EVA	-6	10	111	0.57
Age, insole	0	0	323	0.20

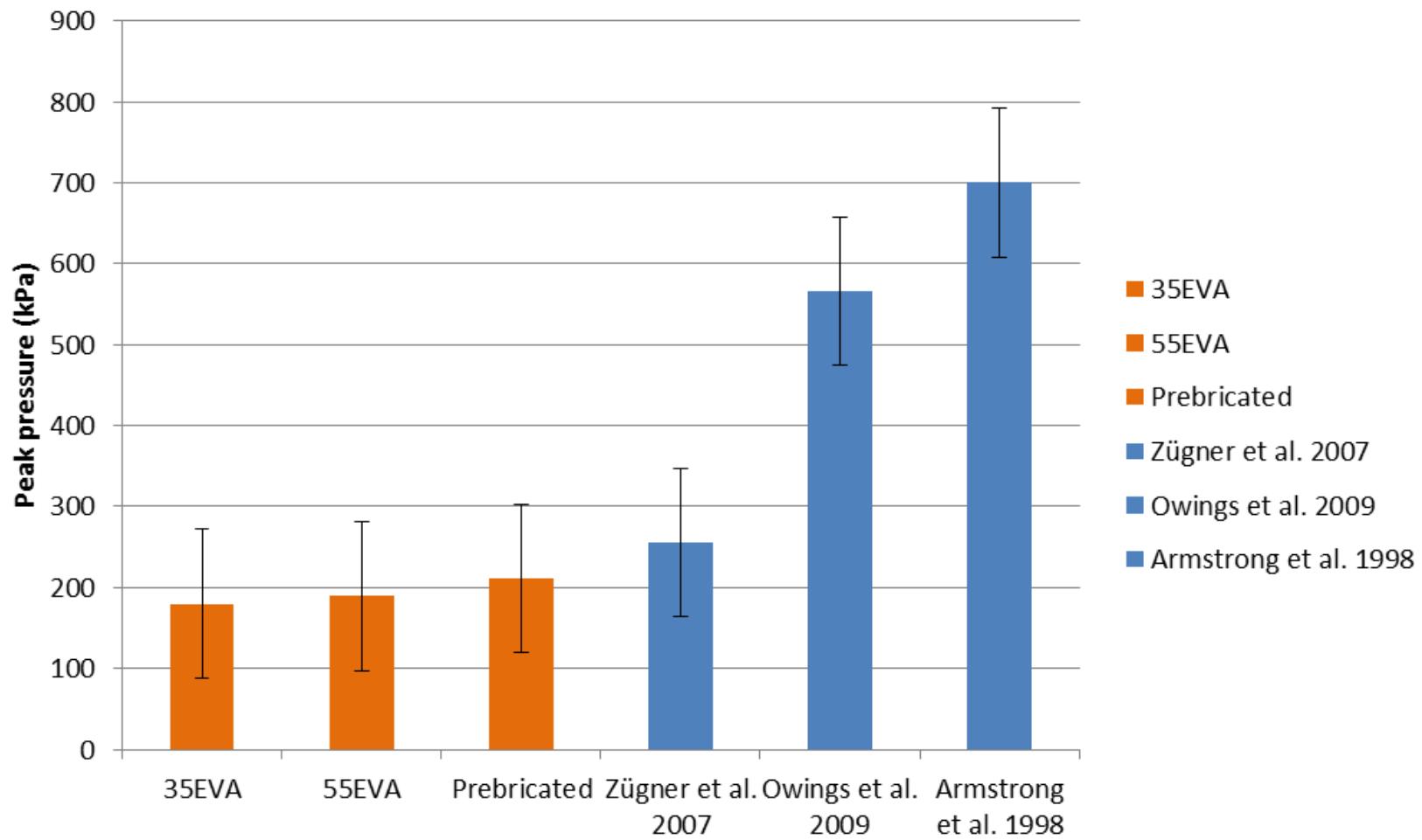


### Peak plantar pressure (kPa)

	Value	Std. Err.	DF	p-value
Heel				
Prefabricated	234	10	323	
Diff. 35 EVA	-64	13	111	0.00***
Diff. 55 EVA	-73	13	111	0.00***
Age, insole	0	0	323	0.01*



## Peak pressure (kPa)



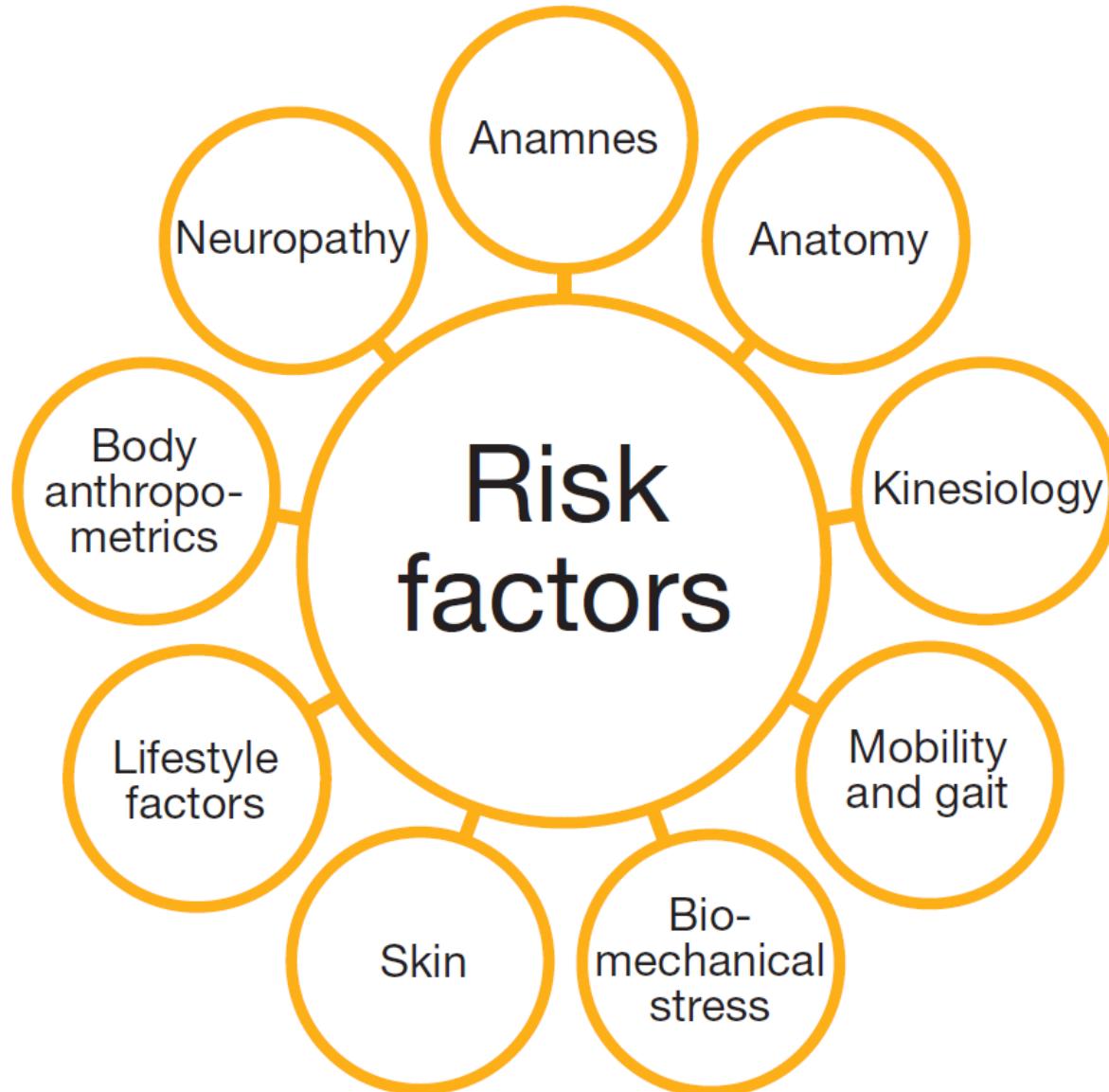
# Discussion

Study



I	Participants no foot ulcer.	No barefoot measure. Lack of control group. Clinical method- not validated.
II	Historical, new foot data.	Different techniques and time points.
III	D-Foot identifies risk factors.	Reliability - variation Not yet included- blood circulation
IV	2 years follow up	No barefoot measure.

# Discussion



# Conclusion

## Assessments

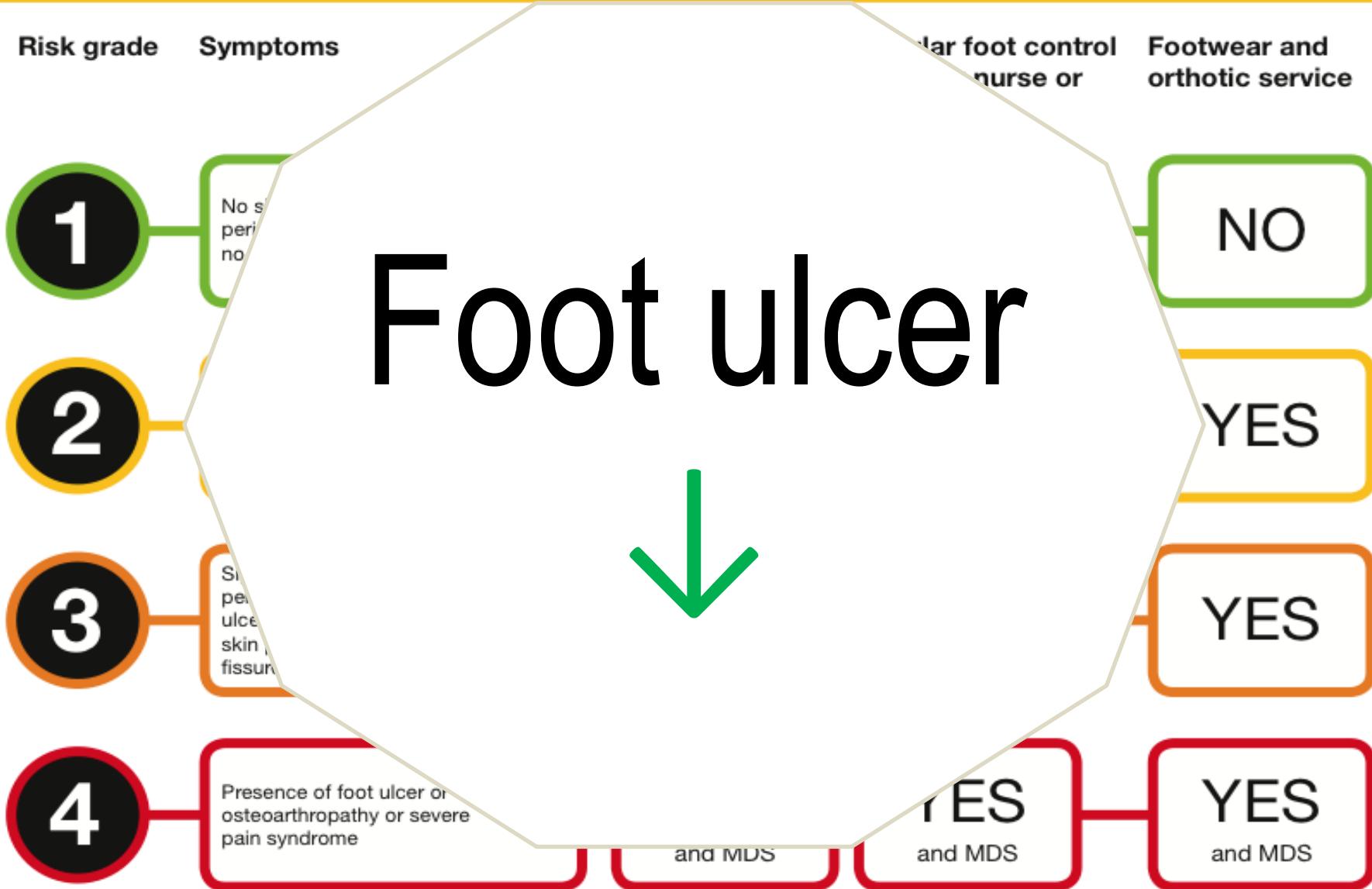
- D-Foot
- Foto measures
- Plantar pressure measurements
- Identifies risk factors
- Study of patients experience when the feet are evaluated with D-Foot. Listen to Åsa Edlunds presentation on Saturday

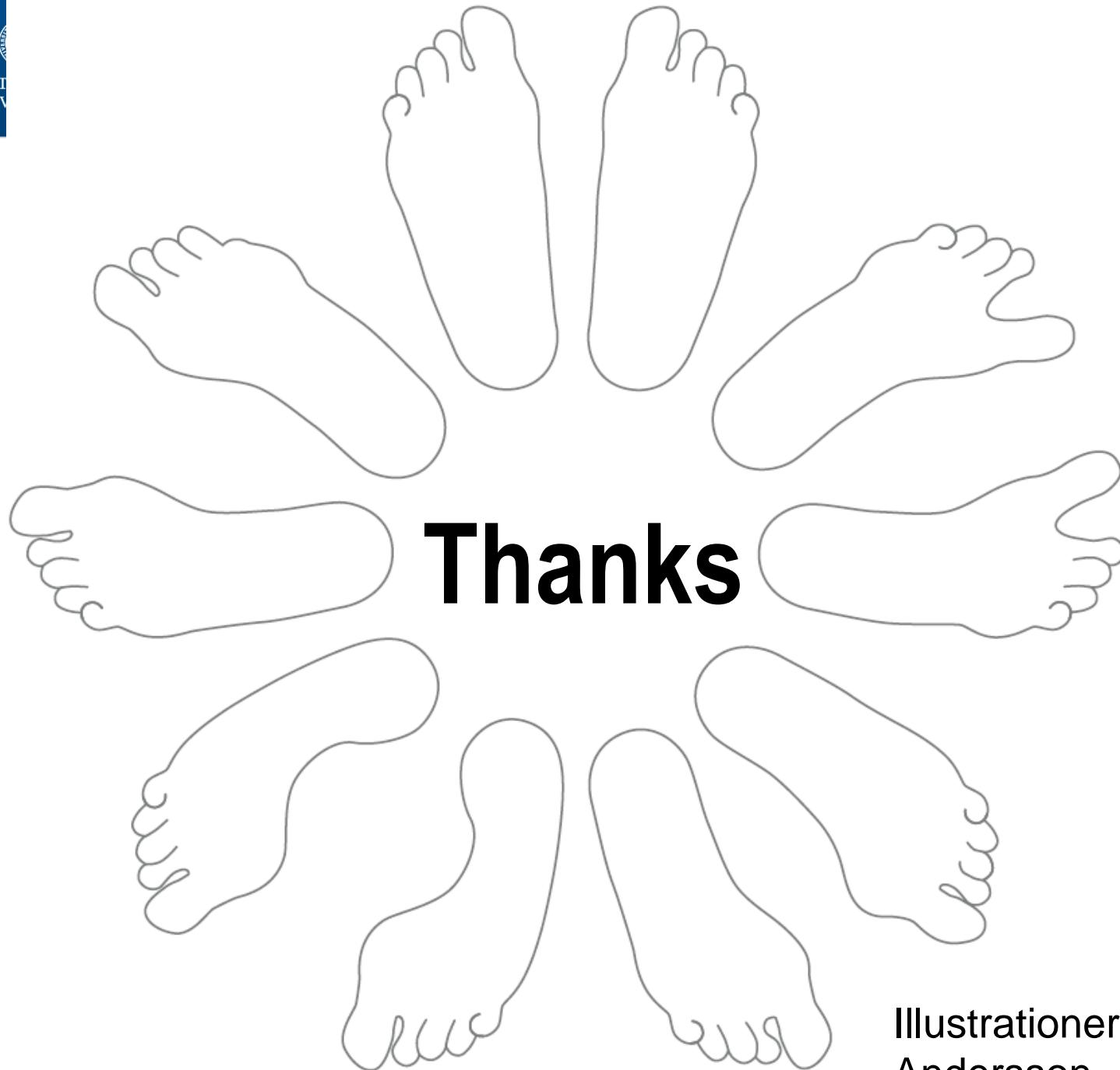
# Conclusion

## Assistive devices

- For each patient: consider the individual variation
- Customised insoles to ↓ pressure at heel
- Prefabricated insole – an alternative

# Prevention - and multidisciplinary service (MDS) - of foot complications in diabetes





Illustrationer: Pontus  
Andersson