Wearing patterns of custom-made footwear
a 12-months observational study

Ir. Stein Exterkate
Biomedical Engineer
Voetencentrum Wender

Co-authors: M. Jongebloed-Westra, J.J. van Netten, C. Bode, H. Koffijberg, P.M. ten Klooster, J.G. van Baal and J.E.W.C. van Gemert-Pijnen

voetencentrum wender

voetmax ORTHOPEDIE

UNIVERSITEIT TWENTE.

ZonMw

Problem

Low orthopedic shoe wear by at-risk diabetes patiënt (22 – 36%). *(Bus et al., 2013)*

Objective measurement studies

Waaijman et al., 2013	Ehrman et al., 2018	Lutjeboer et al., 2020
N = 107	**N = 26**	**N = 11**
9.4 ± 4.4 h/day	**4.2 ± 3.6 h/day**	**6.42 h/day**
Period = 7 days	**Period = 133 days**	**Period = 84 days**

Goal 1: Objective long-term measurements

No-clear factors associated with shoe wear using objective measurements *(Jarl et al., 2016)*

Goal 2: Investigate factors associated with orthopedic shoe wear

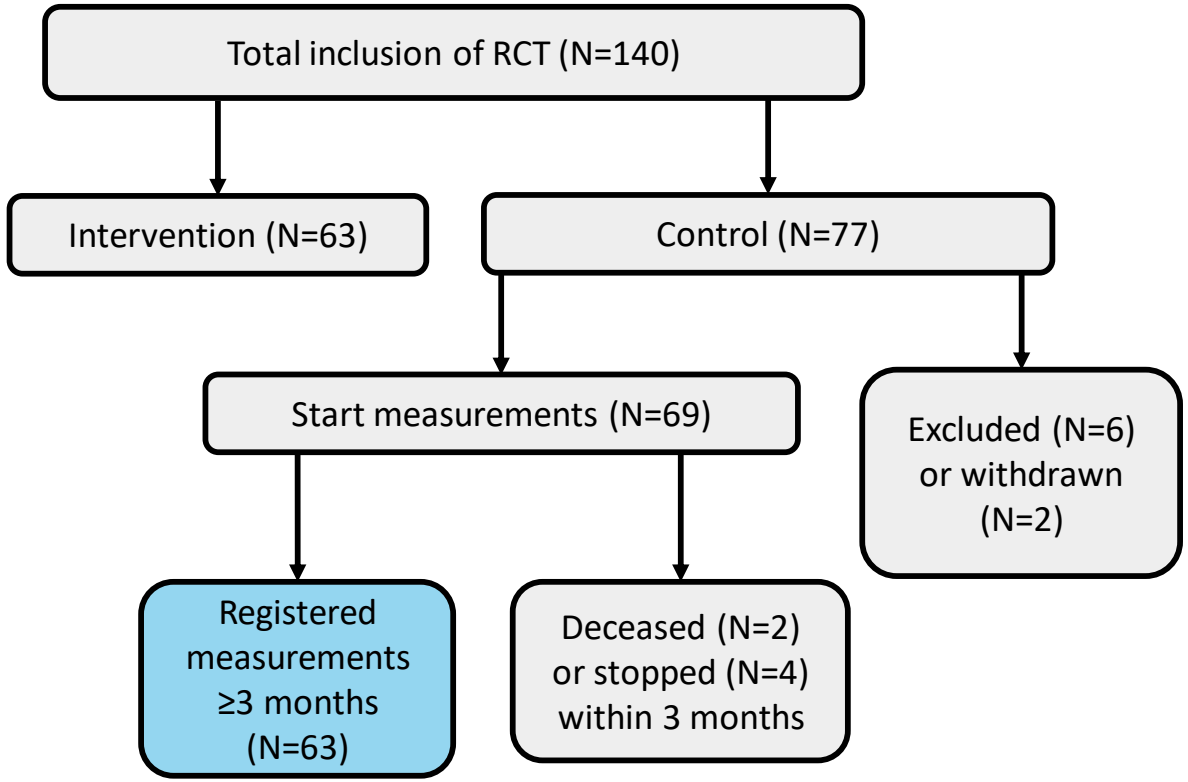
voetencentrum wender

Method

Participants

Inclusion
- Diabetes type 1 or 2
- ≥18 years
- IWGDF 2019 Risk Categories 1-3
- Receiving orthopedic shoes

Exclusion
- Current foot ulcer
- Active Charcot's neuro-arthropathy
- Foot infection
- Unable to walk
- Unable to read or understand study instructions

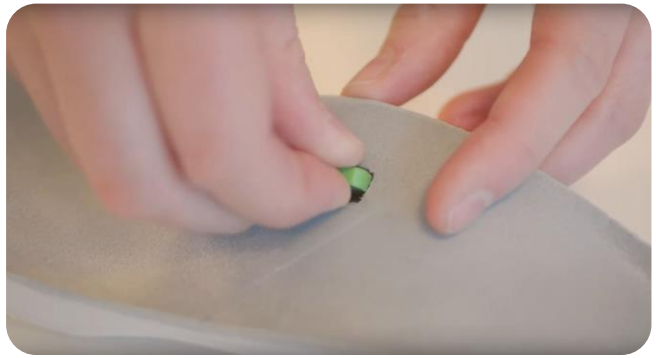


Research protocol (Jongebloed-Westra et al., 2021)

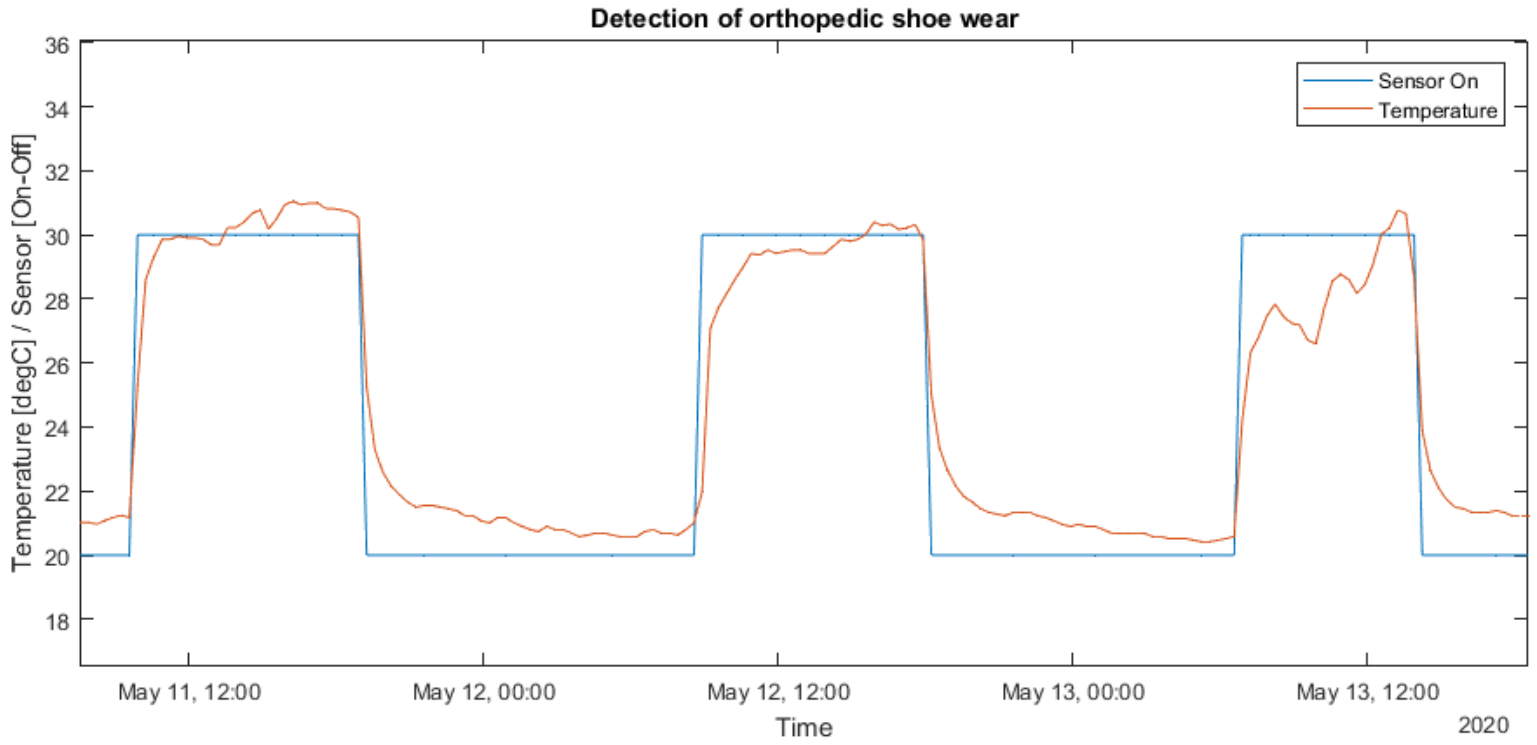
voetencentrum wender

Method

Instrumentation



Orthotimer temperature sensor



Adapted Groningen algorithm (Lutjeboer et al., 2018)

voetencentrum wender

Method

Definitions

Mean wearing time: *Mean hours of orthopedic shoe wear per day*

Adherence: *defined as percentage total steps taken in orthopedic shoes (Waaijman et al., 2013)*

Estimated adherence: *Mean wearing time as a percentage of 16 active hours per day. (Waaijman et al., 2013)*

voetencentrum wender

Results

Objectively measured wearing time

Mean (SD) daily wearing time: **8.06 (6.08) hours/day**

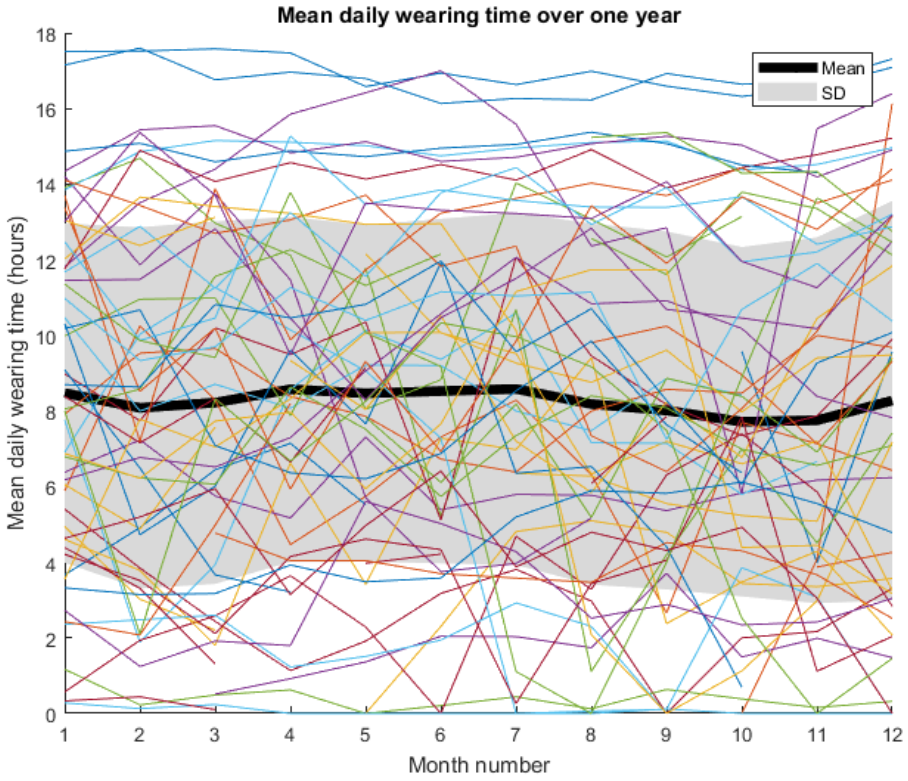
Mean valid days per subject: **334,8 days**

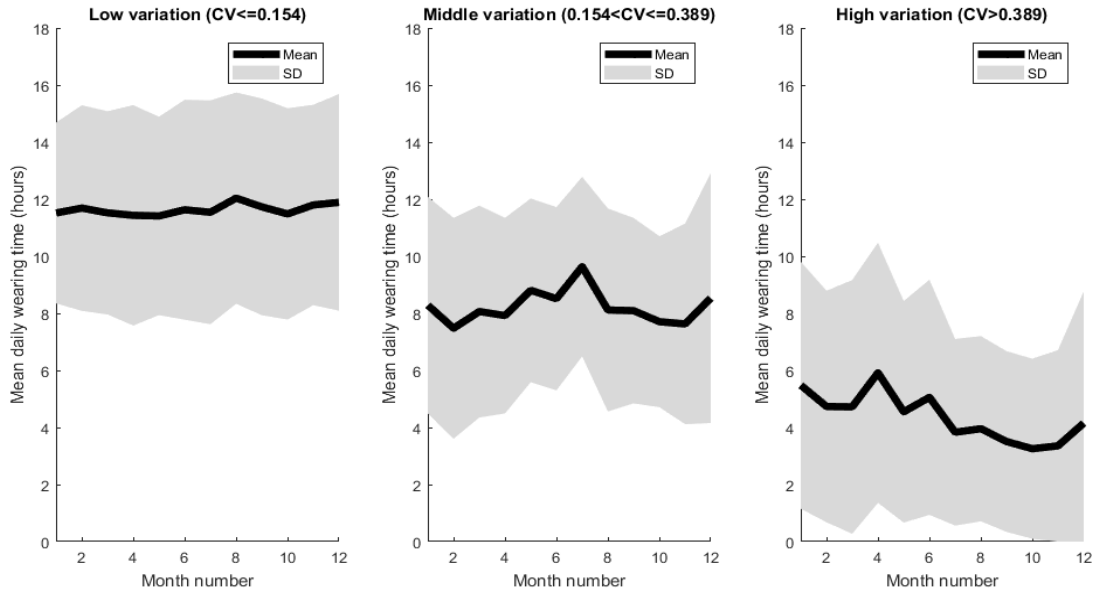
Waaijman et al., 2013	Ehrman et al., 2018	Lutjeboer et al., 2020
N = 107	**N = 26**	**N = 11**
9.4 ± 4.4 h/day	**4.2 ± 3.6 h/day**	**6.42 h/day**
Period = 7 days	**Period = 133 days**	**Period = 84 days**

voetencentrum wender

Results

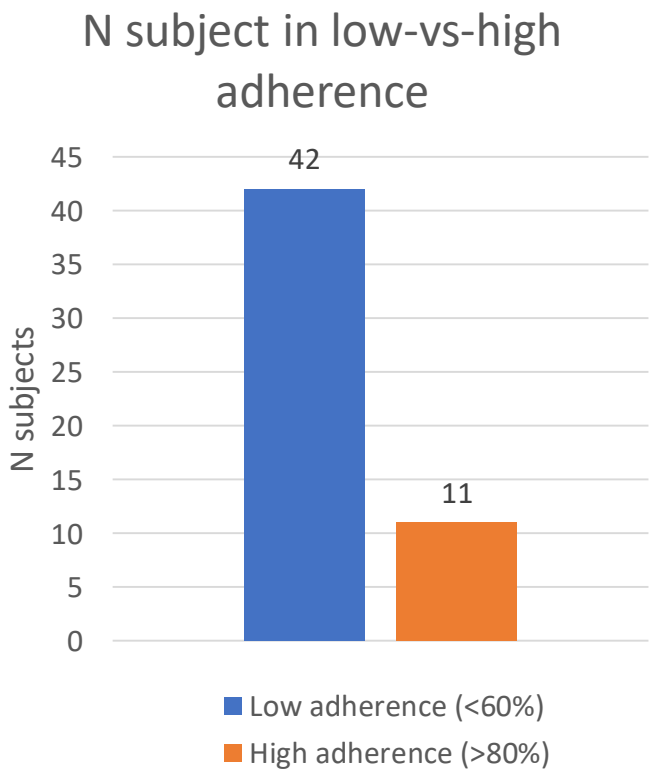
- *Large differences in fluctuation*
- *Subdivision based on variation*
- *Large variation means low wear*

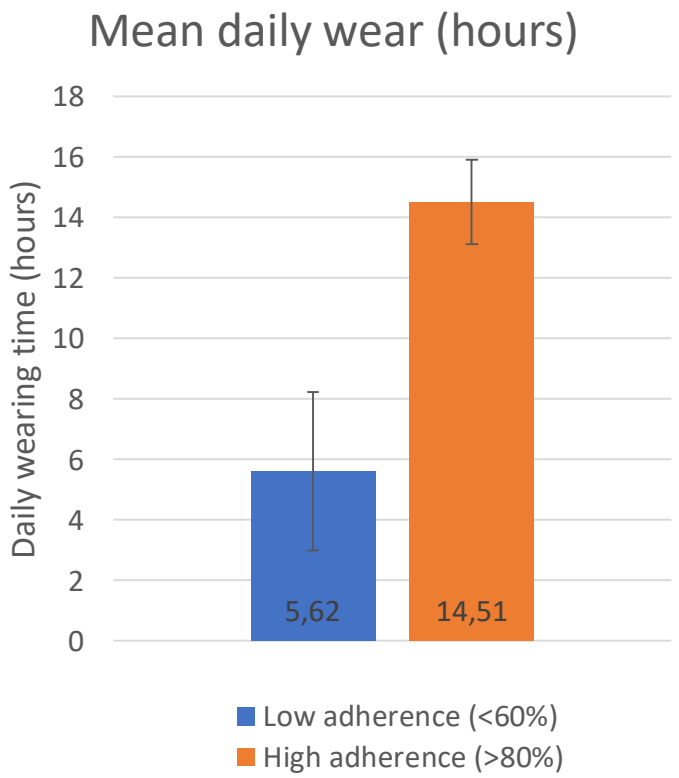


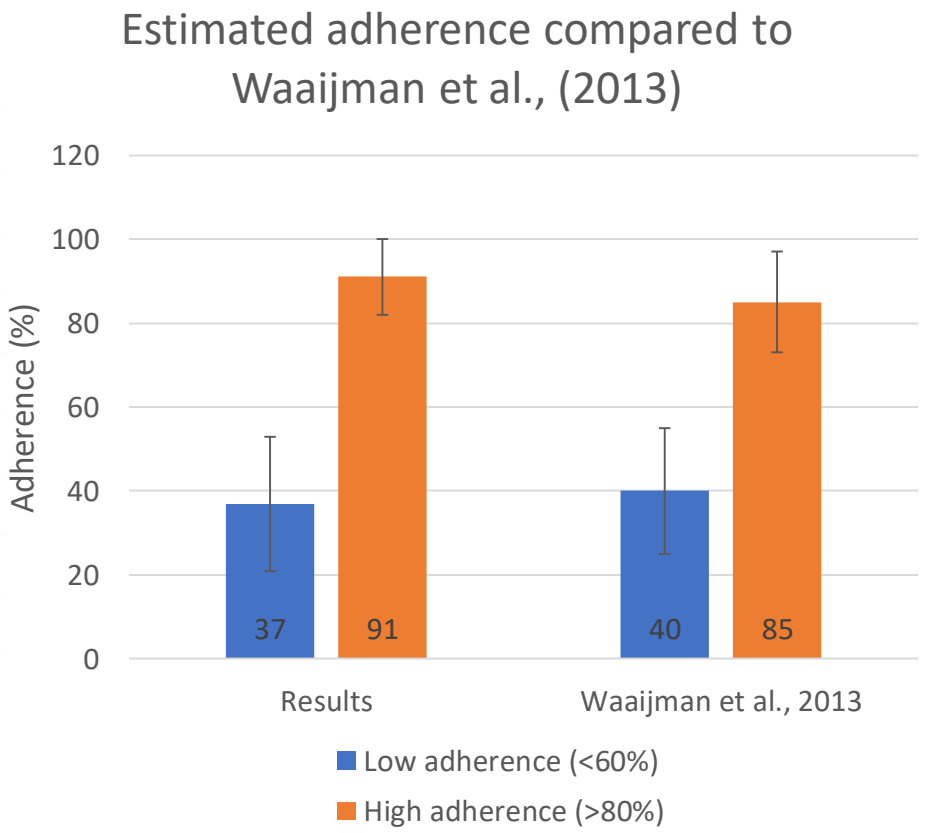


Results

High vs Low wear



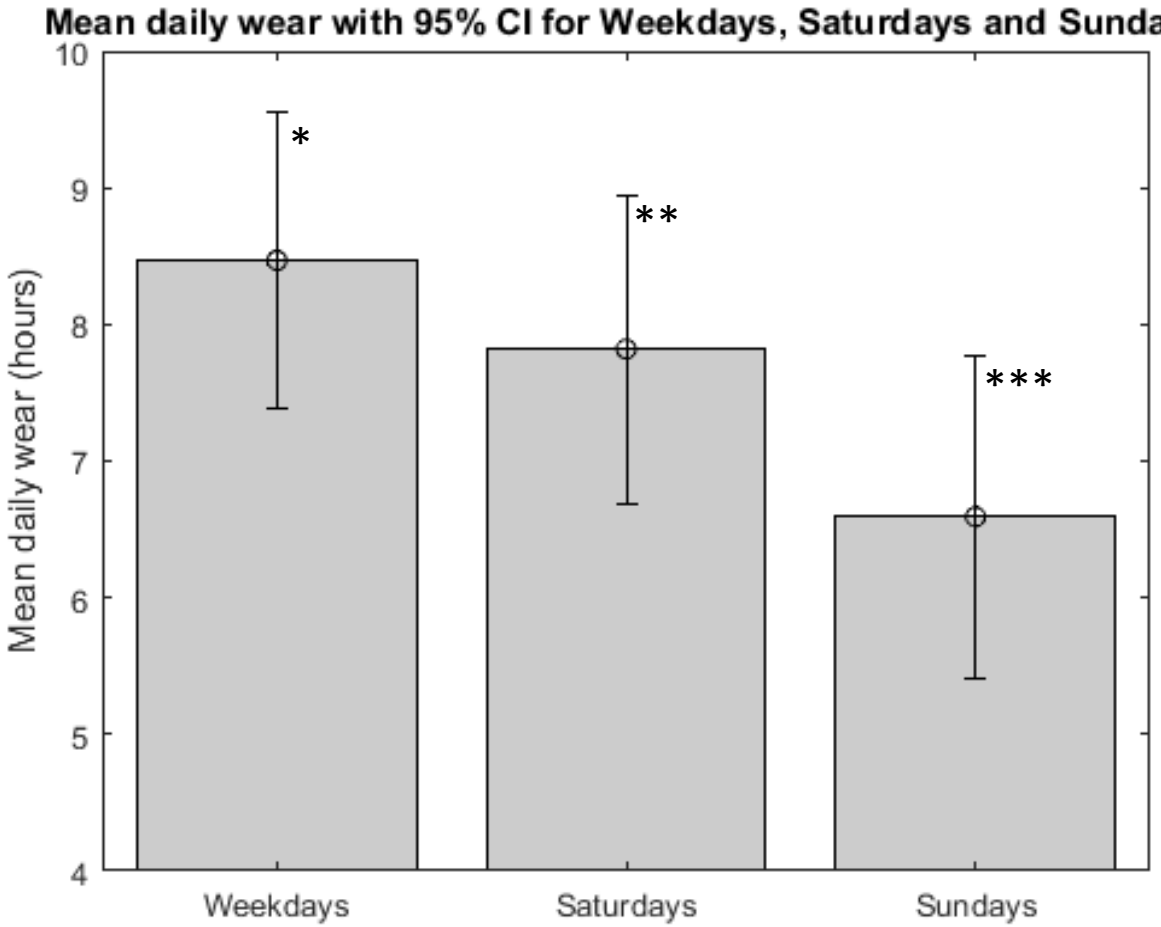




voetencentrum wender

Results

Days of the week



N.B. 95% CI is no gauge of significance in this case.

**significant difference from Saturdays & Sundays (p<0.001)*

*** significant difference from Weekdays & Sundays (p<0.001)*

**** significant difference from Weekdays & Saturdays (p<0.001)*

voetencentrum wender

Results

Univariate + multiple regression

demographics, diabetes-related characteristics & shoe usability

Few factors show significant effects on daily wearing time.

*Only **education level** in multiple regression (p=0.01)*

Demographics & diabetes-related characteristics cannot predict orthopedic shoe wear *(Jarl et al., 2016, Jarl et al., 2020)* $(R^2 = 0.20)$

Shoe usability factors also show limited predictive value $(R^2 = 0.14)$

Conclusion & Discussion

- *Mean daily wear of 8.06 (6.08) hours/day*
- *Large differences between participants*
- *Limited predictive value in studied factors*
- *High fluctuations in wear could predict overal wear time*
- ***Shoe wearing time should be measured objectively and individually***

voetencentrum wender

Further research

- *Objectively measuring adherence*
- *Effect of motivational interviewing on long-term adherence*

Orthotimer

Activity Tracker (MisFit)

voetencentrum wender

voetencentrum wender

voetmax ORTHOPEDIE

UNIVERSITEIT TWENTE.

ZonMw