Leipziger Forschungszentrum für Zivilisationserkrankungen

imise.

UNIVERSITÄT LEIPZIG

Medizinische Fakultät

Reliability of 3D laser-based Anthropometry and Comparison with Classical Anthropometry

Andreas Kühnapfel

Prof. Dr. Markus Scholz

Europäische Union

Europa fördert Sachsen.
ESF
Europäischer Sozialfonds

Epidemiology

Anthropometric quantities as possible confounders, risk factors, or outcomes

Children: assess growth kinetics as indicator of proper development

Adults: observed associations with health risks, morbidity, and mortality

- **Body mass index identified as risk factor for cardiovascular diseases, diabetes, and different neoplastic diseases**
- **Abdominal fat (operationalized as waist-to-hip ratio) likely associated with coronary heart disease**
- **Assess obesity**

SECA 201

SECA 701

SECA 220

Figure SECA 701: https://www.kpzwaagen.ch/_images/prodbig/saeulenwaage701.jpg

Figure SECA 201: https://www.sellesmedical.co.uk/system/images/data/000/022/669/original/seca_201_with_band_RGB.jpg?1401015436

Figure SECA 220: http://www.protec-medical-supplies.co.uk/images/Upload/Products/Height_Measurement/Seca_220_2.jpg?scale=both&width=330&height=330

Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds

Body Scanner

Vitus Smart XXL
Human Solutions
Kaiserslautern, Germany

Optical triangulation
8 lasers (class 1)
10 seconds

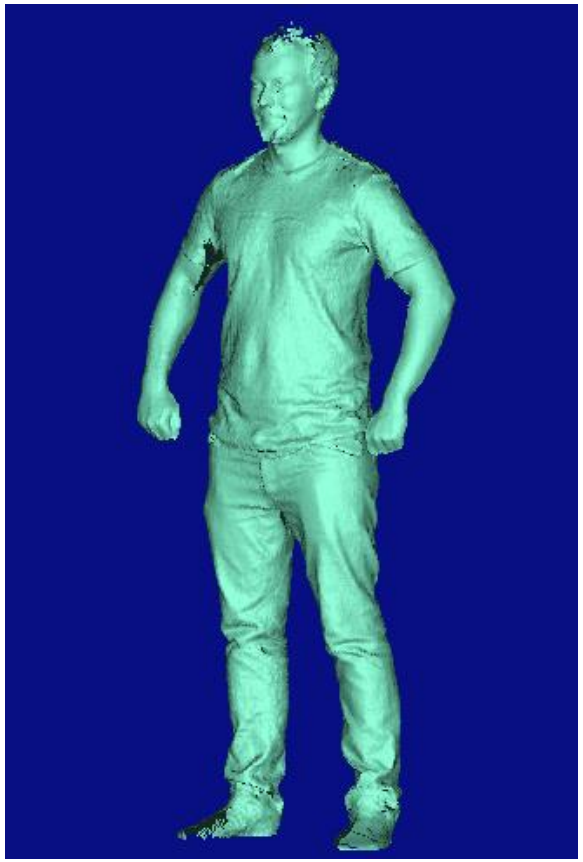
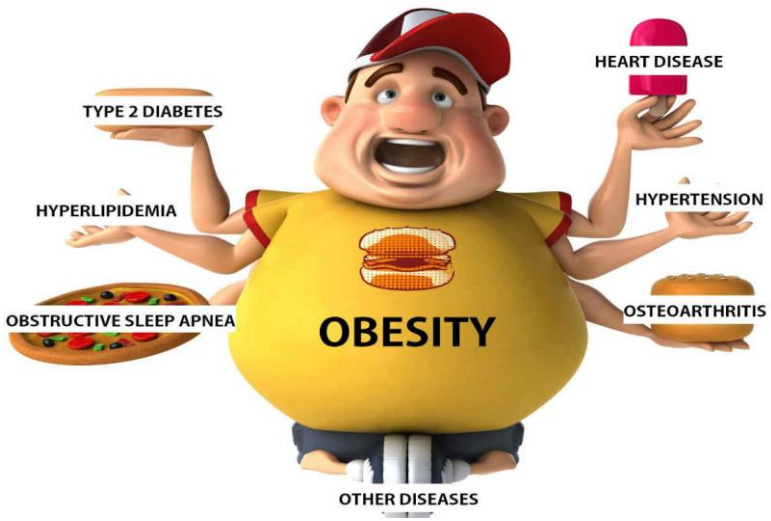


Figure Body scanner: https://scientificservices.eu/item/959/image/picture324.jpg

Aims



Time and **satisfaction** of probands

Intra-/inter-rater reliability of classical anthropometry (CA) and body scanner measurement (BS) and comparison

Comparison of CA measurements and corresponding BS measurements

Effect of obesity on validity and reliability of CA and BS

Figure Stopwatch: https://pimage.sport-thieme.de/detail-fillscale/hanhart-stoppuhr-amigo/130-3403

Figure Obesity: https://2o42f91vxth73xagf92zhot2-wpengine.netdna-ssl.com/blog/wp-content/uploads/sites/4/2016/11/effects-of-obesity.jpg

Europäische Union

Europa fördert Sachsen. ESF Europäischer Sozialfonds

Methods

Study sample

108 probands in preparation of LIFE-Adult (convenience sample)

- 39 males / 69 females
- 31.5% < 60 years
- 34.3% BMI >= 30

9 CA measurements

154 BS measurements

Measure of agreement

Overall Concordance Correlation Coefficient (OCCC)

$$\mathrm{OCCC} = \frac{2\sum_{j=1}^{J-1}\sum_{k=j+1}^{J}\mathrm{Cov}(M_j, M_k)}{(J-1)\sum_{j=1}^{J}\mathrm{Var}(M_j) + \sum_{j=1}^{J-1}\sum_{k=j+1}^{J}[\mathrm{E}(M_j) - \mathrm{E}(M_k)]^2}$$

Figure R: https://upload.wikimedia.org/wikipedia/commons/thumb/1/1b/R_logo.svg/2000px-R_logo.svg.png

Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds

Results: Feasibility

Time from instruction until documentation

Ø(CA) = **3.10** (± 0.97) min
Min(CA) = 1 min
Max(CA) = 8 min

Ø(BS) = **4.08** (± 1.43) min
Min(BS) = 1 min
Max(BS) = 9 min

Ø(BS) **>** Ø(CA) ($p < 0.001$)

Satisfaction by Likert scale (5 = ☺, …, 1 = ☹)

CA(5 & 4) = **86.5%**

BS(5 & 4) = **92.3%**

Satisfaction(BS) **>** Satisfaction(CA) ($p = 0.0029$)

Figure Scale: https://c.vergleich.org/image/upload/s--8ohcOWOZ--/c_pad,dpr_1.0,f_auto,h_223,q_auto,w_300/v1/product/sites/2528/waage.png

Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds

Results: CA Measurements

Trait	Intra			Inter		
	OCCC	95%-CI of OCCC		OCCC	95%-CI of OCCC	
Body height	0.998	0.995	0.999	0.998	0.996	0.999
Body weight	1.000	1.000	1.000	0.999	0.999	0.999
Upper arm length	0.989	0.971	0.996	0.924	0.873	0.955
Upper arm girth	0.997	0.993	0.998	0.978	0.943	0.991
Waist girth	0.996	0.991	0.998	0.993	0.988	0.995
Hip girth	0.991	0.873	0.999	0.996	0.989	0.998
Thigh length	0.959	0.895	0.985	0.819	0.686	0.899
Thigh girth	0.994	0.991	0.996	0.974	0.935	0.989
Calf girth	0.995	0.991	0.997	0.992	0.983	0.996

Figure Thumb up: http://www.baumundzeit.de/fileadmin/user_upload/Daumen_gr%C3%BCn.JPG

Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds

Results: BS Measurements

Intra

Trait	OCCC	95%-CI of OCCC	
Calf girth	0.999	0.998	0.999
Neck height	0.998	0.997	0.999
Minimum leg girth	0.997	0.993	0.998
Body height	0.997	0.990	0.999
Scapula height	0.997	0.989	0.999
…	…	…	…
Distance waistband high hip back	0.683	0.462	0.825
Across front width	0.674	0.478	0.806
Shoulder angle	0.628	0.392	0.786
Side upper torso length	0.559	0.315	0.734
Shoulder width	0.353	0.035	0.605

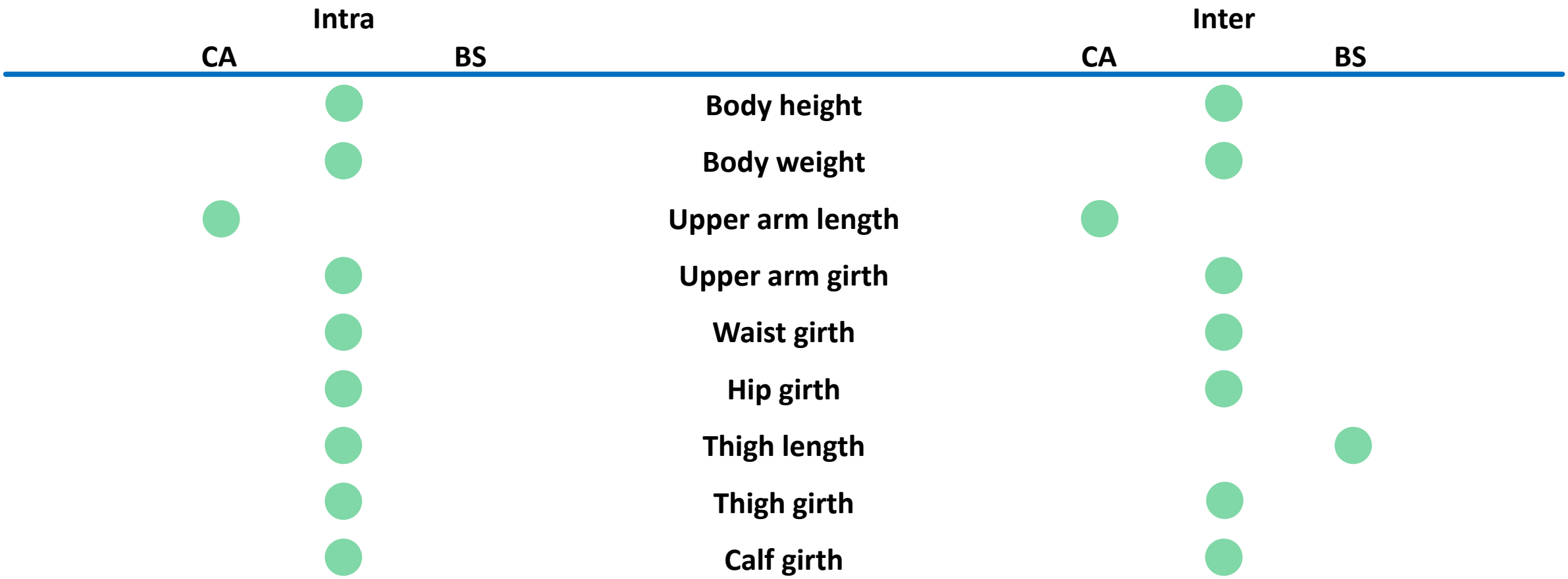
Inter

Trait	OCCC	95%-CI of OCCC	
Calf girth	0.999	0.998	0.999
Buttock girth	0.999	0.997	0.999
Neck height	0.998	0.997	0.999
Body height	0.998	0.996	0.999
Scapula height	0.998	0.996	0.999
…	…	…	…
Upper torso torsion	0.695	0.540	0.805
Shoulder angle	0.651	0.451	0.788
Distance buttock to vertical	0.643	0.365	0.816
Shoulder width	0.548	0.128	0.801
Neck height front	0.458	-0.323	0.868

Europäische Union

Europa fördert Sachsen.
ESF
Europäischer Sozialfonds

Results: Comparison of CA and BS Reliabilities



Europäische Union
Europa fördert Sachsen.
ESF
Europäischer Sozialfonds

Results: Validity (One-to-One)

Classical anthropometry	Body scanner	Uncorrected OCCC	Offset	OCCC	95%-CI of OCCC	
Body height	*Body height*	0.995	−0.61	0.997	0.996	0.998
Body weight	*Body weight*	1.000	−0.23	1.000	0.999	1.000
Upper arm length	*Upper arm length*	0.183	+5.73	0.769	0.680	0.835
Upper arm girth	*Upper arm girth*	0.720	+2.18	0.862	0.820	0.894
Thigh girth	*Thigh girth*	0.557	−6.30	0.928	0.894	0.951
Calf girth	*Calf girth*	0.984	−0.30	0.988	0.981	0.992

Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds

Results: Validity (Alternatives)

Classical anthropometry	Body scanner	Uncorrected OCCC	Offset	OCCC	95%-CI of OCCC	
Waist girth	*Waist girth*	0.982	−1.51	0.987	0.981	0.991
	High waist girth	0.984	+1.09	0.986	0.980	0.991
	Waist band	0.924	−2.17	0.935	0.907	0.956
	3D waist band	0.924	−2.16	0.936	0.907	0.956
	Belly circumference	0.929	−4.39	0.973	0.961	0.981
	Maximum belly circumference	0.894	−5.66	0.963	0.944	0.975
Hip girth	*Middle hip girth*	0.910	−0.28	0.910	0.850	0.947
	High hip girth	0.832	+2.76	0.853	0.771	0.908
	Buttock girth	0.969	−2.14	0.986	0.979	0.990
	Hip girth	0.938	−3.19	0.976	0.964	0.984
	Hip/thigh girth	0.510	+7.22	0.659	0.557	0.742

Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds

Results: Validity (Derivatives)

Classical anthropometry	Body scanner	Uncorrected OCCC	Offset	OCCC	95%-CI of OCCC	
Thigh length	*TL1* = Buttock height – Knee height	0.311	+4.70	0.778	0.678	0.849
	TL2 = Hip height – Knee height	0.156	+6.26	0.407	0.252	0.541
	TL3 = Crotch height – Knee height	0.031	+17.77	0.606	0.481	0.706
	TL4 = Inseam length – Knee height	0.035	+16.47	0.580	0.446	0.689
	TL5 = Side seam length – Knee height	0.079	−8.30	0.381	0.218	0.523
	TL6 = (TL1 + TL5) / 2	0.542	−1.80	0.671	0.550	0.764
	TL7 = (TL2 + TL5) / 2	0.528	−1.02	0.565	0.409	0.689

Europäische Union

Europa fördert Sachsen.
ESF
Europäischer Sozialfonds

Conclusion

BS assessment feasible: slightly more time consuming but better accepted

BS yields 17 times as much measurements as CA within almost the same time

BS reliability generally excellent/good with few exceptions

BS proxies for all CA measurements (offset correction)

BS and CA reliabilities comparable

Reliabilities slightly reduced in obese subgroup

Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds

Europäische Union

Europa fördert Sachsen.
ESF
Europäischer Sozialfonds