The influence of age, sex, bulb position, visual feedback and order of testing on maximum anterior and posterior tongue strength and endurance in healthy Belgian adults.

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Introduction

- Tongue: important role in the oral and pharyngeal phases of swallowing
  - oral preparatory phase (bolus formation, placement, manipulation)
  - oral transit phase (posterior bolus transfer to the pharyngeal cavity)
  - pharyngeal phase (downward bolus propulsion into UES)
- Abnormal tongue function can lead to oral and/or pharyngeal dysphagia
  - negative effect on health status
  - impairing quality of life
- Therefore: identifying (i.e. measuring) tongue function is important to target remediation

Existing literature

- plenty of data on
  - speech and dysarthria
  - swallowing and dysphagia
- mostly using the IOPI (MOST)
- however… European data are lacking!

Our study

- To investigate the influence of
  - age
  - sex
  - bulb position
  - visual feedback
  - order of testing

on maximum anterior and posterior tongue strength and endurance in healthy Belgian adults

- To determine normative data to allow for future use

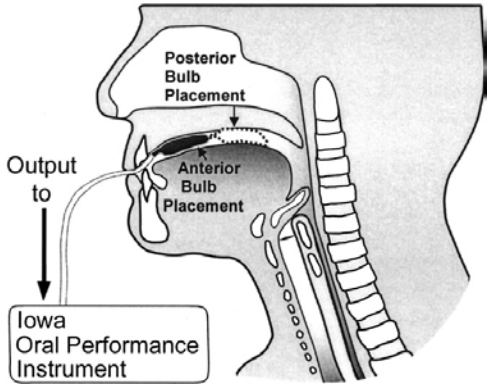
Methods

- subjects:
  - 420 healthy adults (20-95 years old)
  - 7 decades (20-30 / 31-40 / 41-50 / 51-60 / 61-70 / 71-80 / 80+)
  - 30 males and 30 females in each decade
  - in total 210 males and 210 females

- exclusion criteria:
  - a history of dysphagia
  - oral cavity surgery (beyond routine dental surgery)
  - dyspnea (endurance)
  - dysarthria or apraxia
  - playing wind instruments
  - oral motor impairment (tongue structure or function)

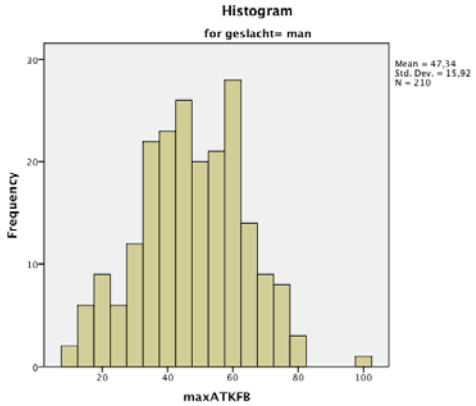
Methods

- materials:
  - IOPI device - tongue force and endurance
- measurements:
  - maximum isometric tongue strength (3 trials)
  - maximum tongue endurance (1 trial)
- conditions
  - bulb position: anterior or posterior tongue
  - visual feedback: yes or no
  - order of testing: anterior vs posterior tongue first

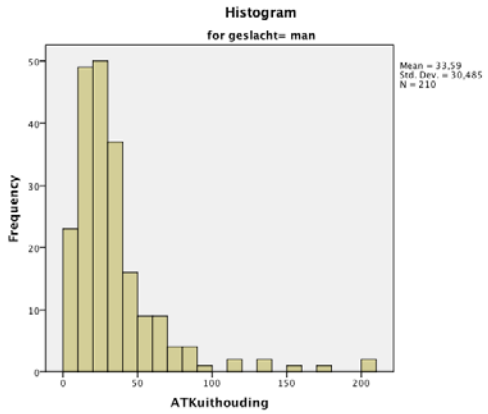


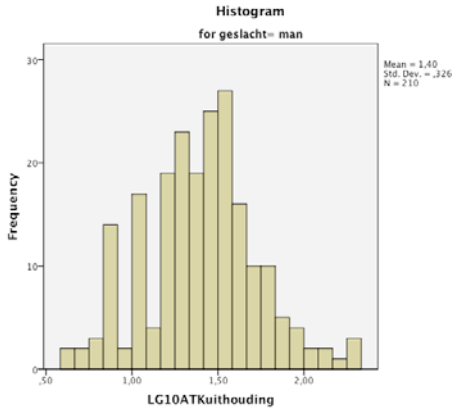
Results - data

- strength: Normal distribution



- endurance: non-Normal distribution → log transform





Results - data

- data

Initial item	Normality?	Final item	Normality?
maxATKFB	yes	maxATKFB	yes
maxPTKFB	yes	maxPTKFB	yes
ATKuith	no →	LG10ATKuith	yes
PTKuith	no →	LG10PTKuith	yes

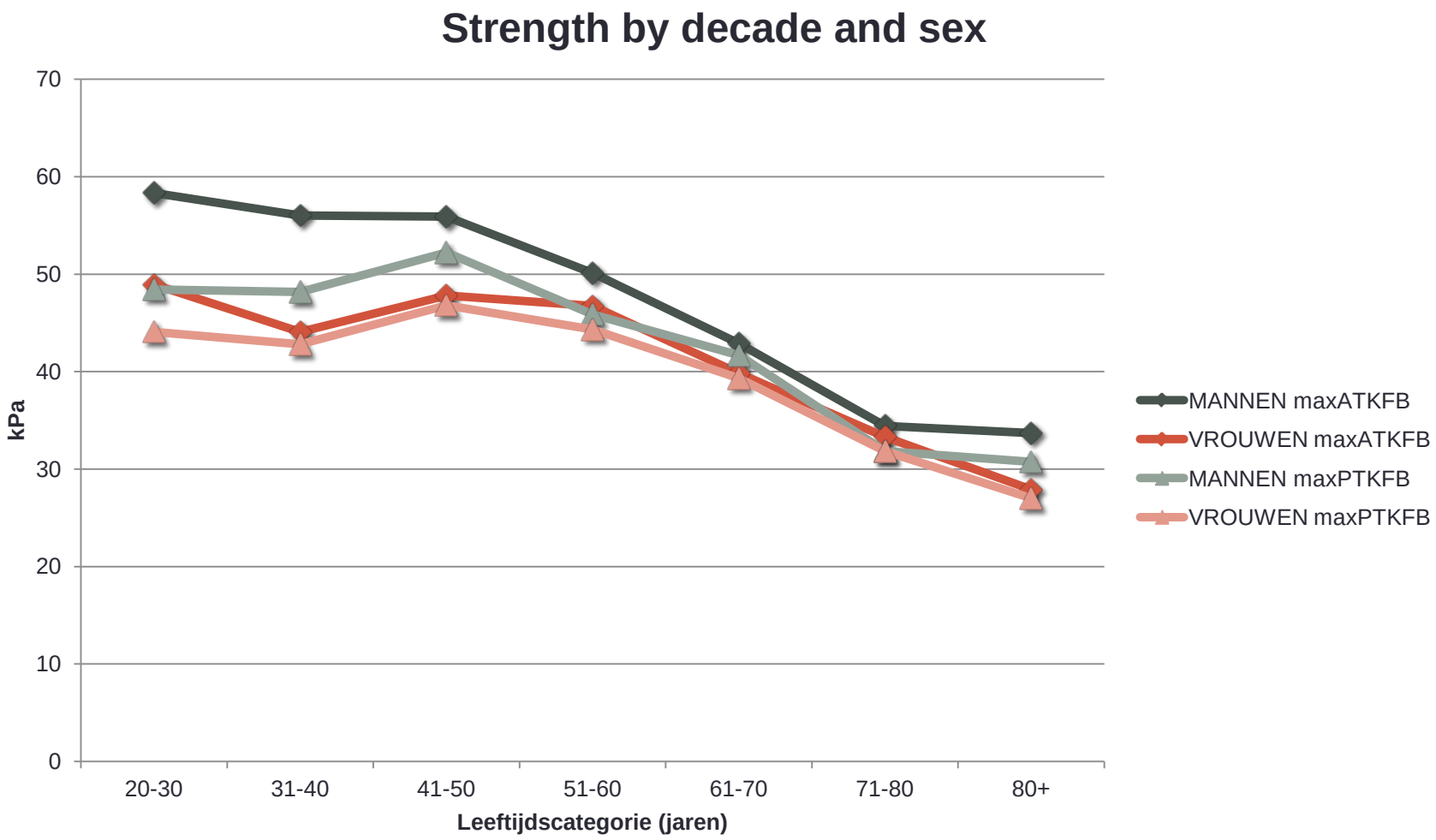
Results – interaction effect sex and age

- MANOVA
  - not significant
  - allows for individual analysis

Tests of Between-Subjects Effects

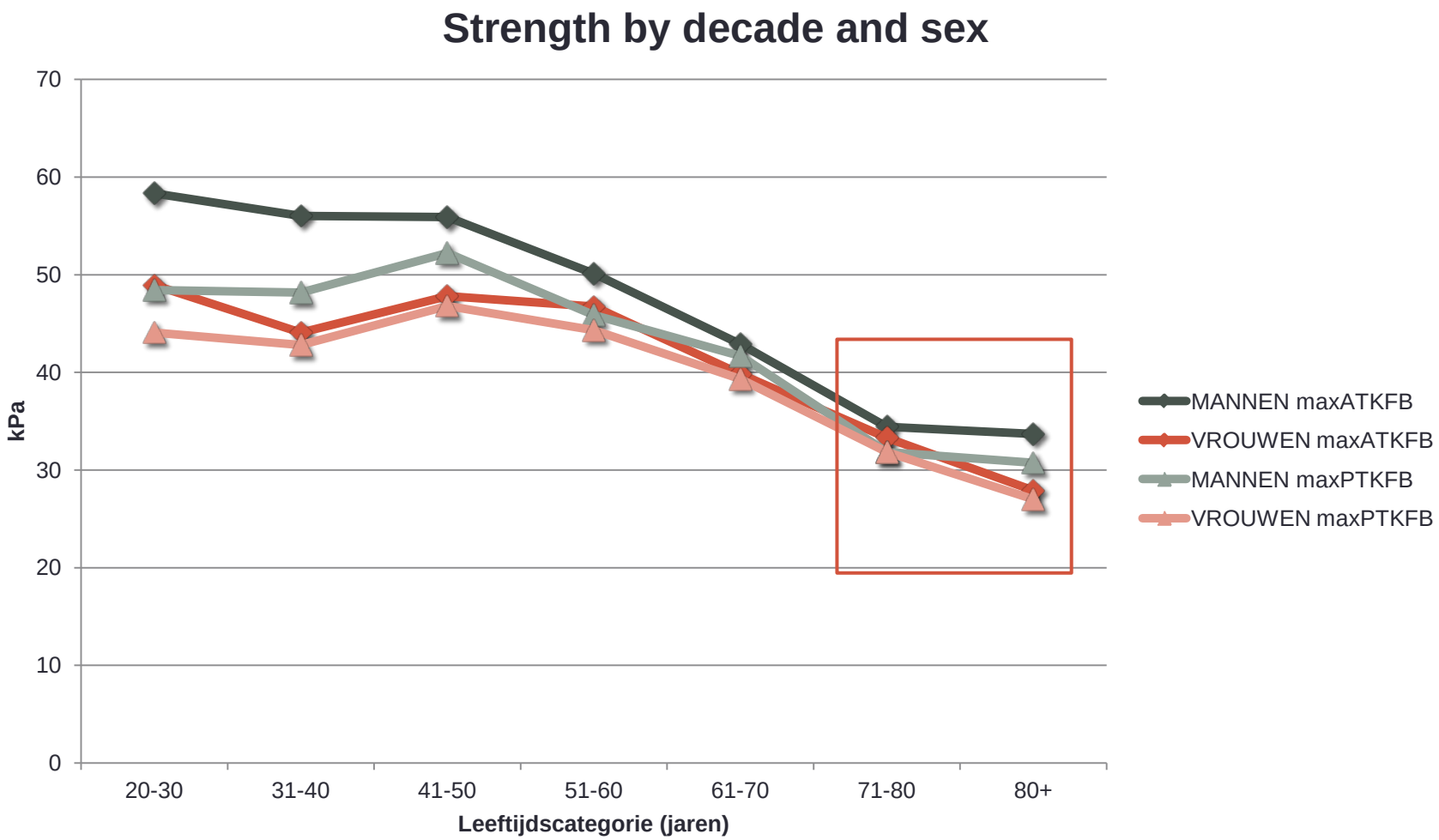
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	maxLKFB	3004,958[a]	13	231,151	2,990	,000	,088	38,864	,994
	LG10LKuith	9,934[c]	13	,764	6,224	,000	,167	80,916	1,000
	maxATKFB	34054,382[d]	13	2619,568	17,686	,000	,363	229,913	1,000
	maxPTKFB	22871,639[e]	13	1759,357	10,781	,000	,258	140,157	1,000
	LG10ATKuithouding	7,820[f]	13	,602	6,190	,000	,166	80,468	1,000
	LG10PTKuithouding	4,906[g]	13	,377	4,727	,000	,132	61,454	1,000
geslacht * leeftijdscategorie	maxLKFB	593,349	6	98,891	1,279	,266	,019	7,674	,503
	LG10LKuith	,402	6	,067	,545	,774	,008	3,271	,220
	maxATKFB	1458,898	6	243,150	1,642	,134	,024	9,850	,628
	maxPTKFB	423,094	6	70,516	,432	,857	,006	2,593	,178
	LG10ATKuithouding	,645	6	,108	1,106	,358	,016	6,639	,438
	LG10PTKuithouding	,697	6	,116	1,455	,192	,021	8,731	,566

Results - age



Anova, p<.05, post-hoc analysis

Results - age



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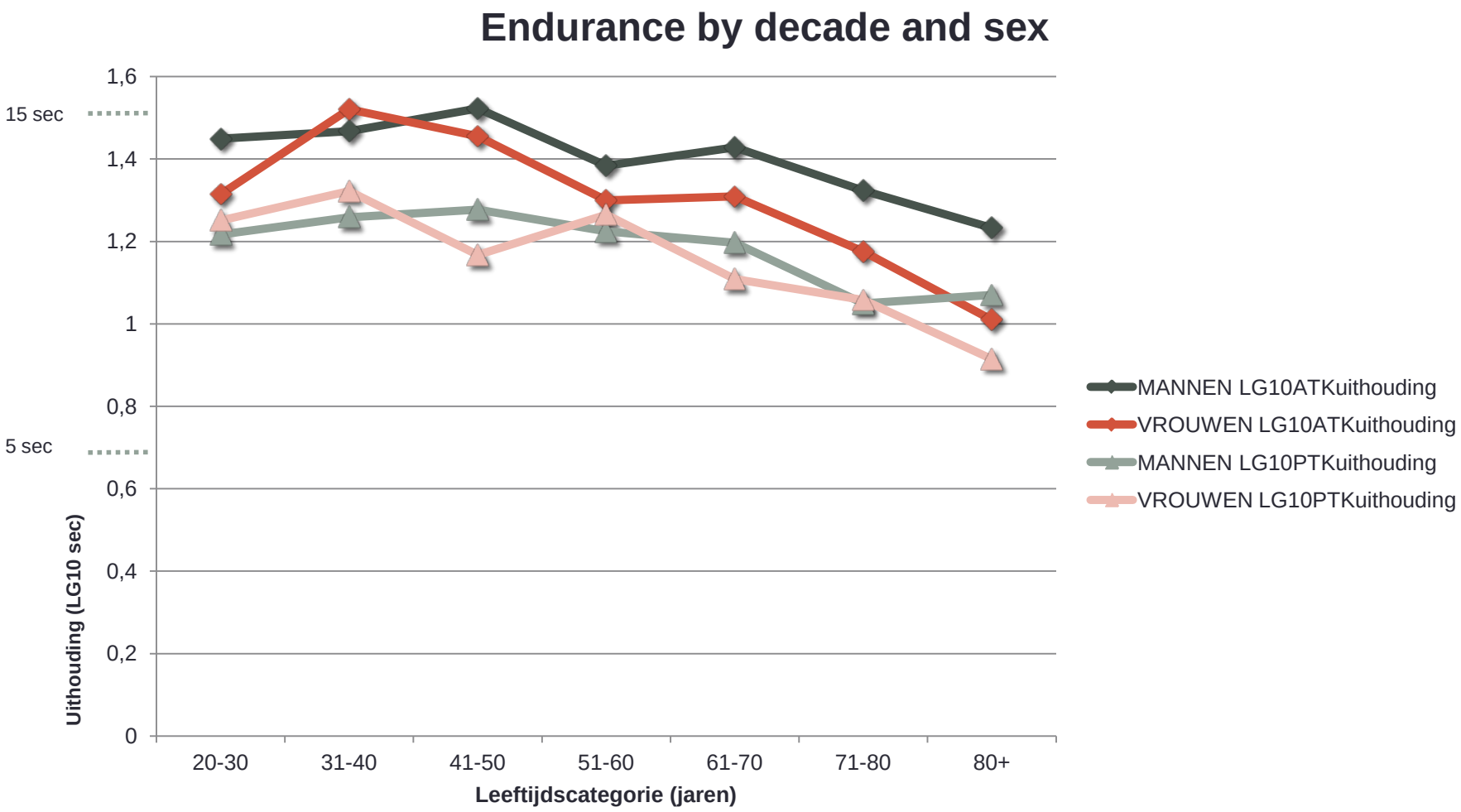
Results - age



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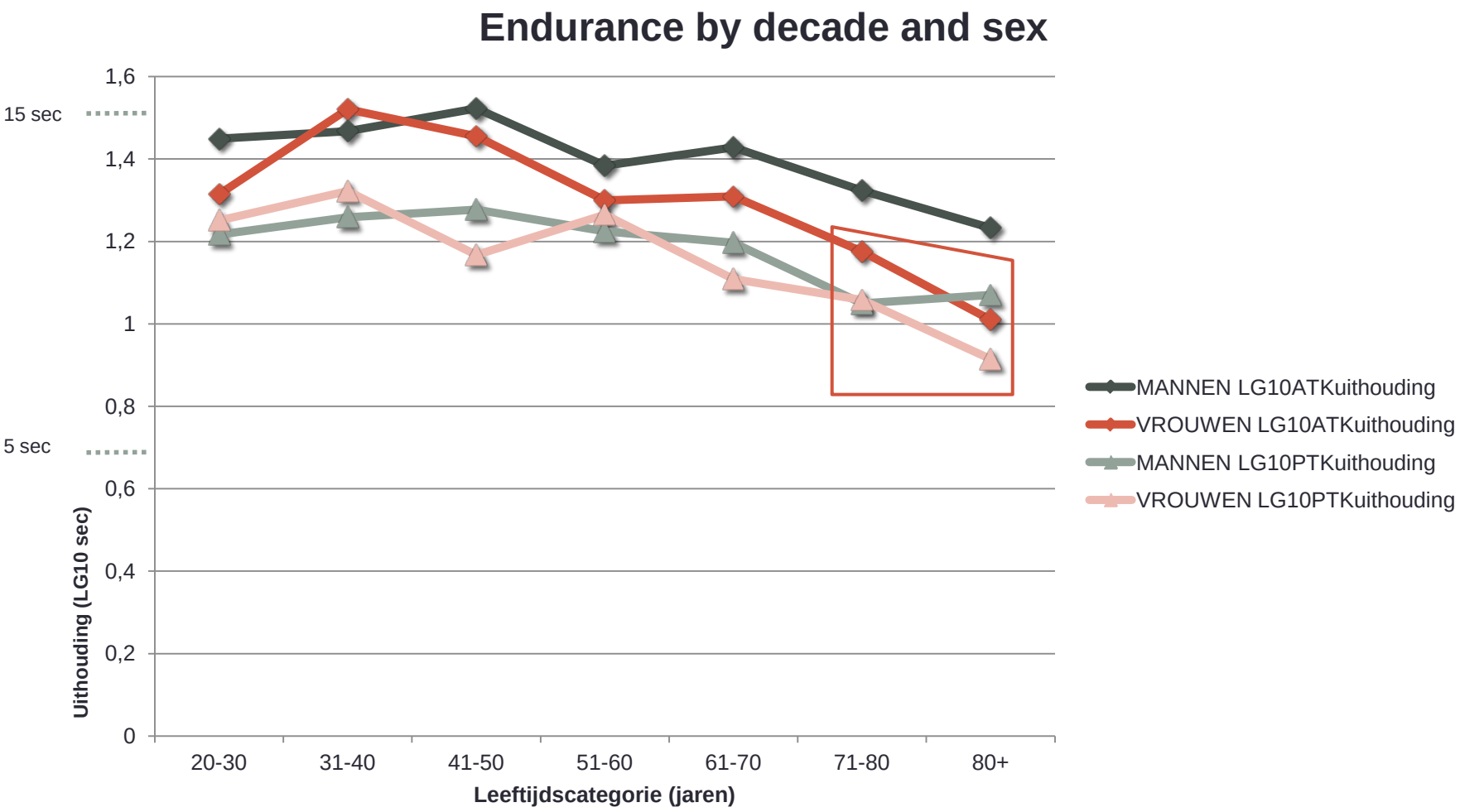
Results - age

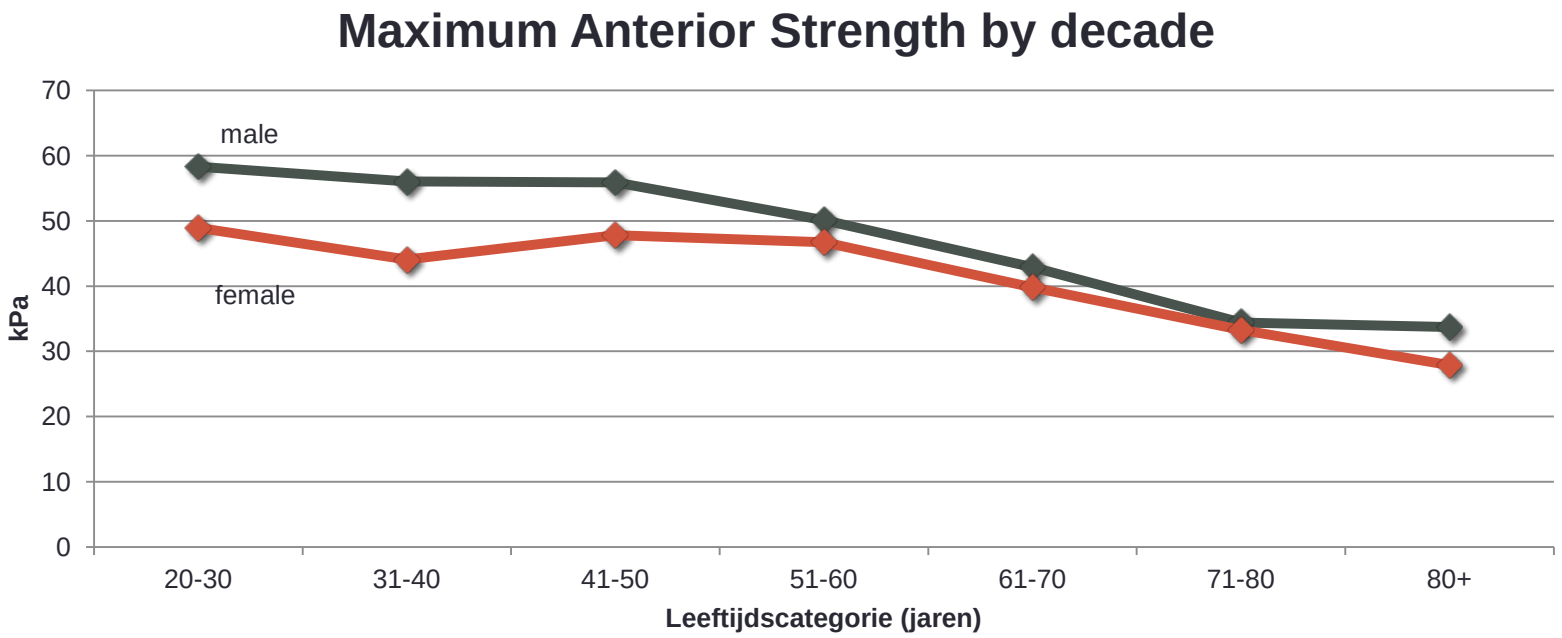


Anova, p<.05, post-hoc analysis

Results – age summary

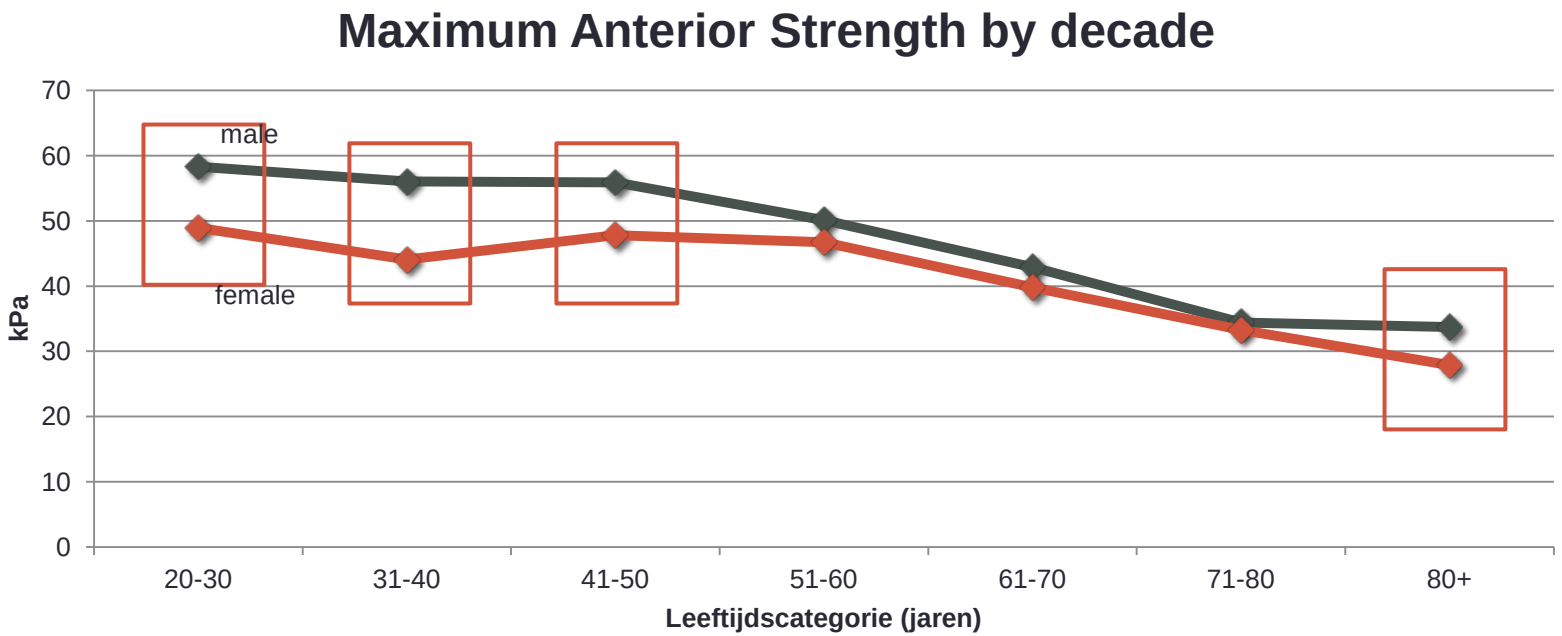
- tongue strength:
  - older people (70+) have less strength both anterior and posterior (males and females)
- tongue endurance:
  - older people (70+) have less endurance both anterior and posterior
  - execption: older males (70+) have intact anterior endurance

Results - sex



Anova, p<.05, post-hoc analysis

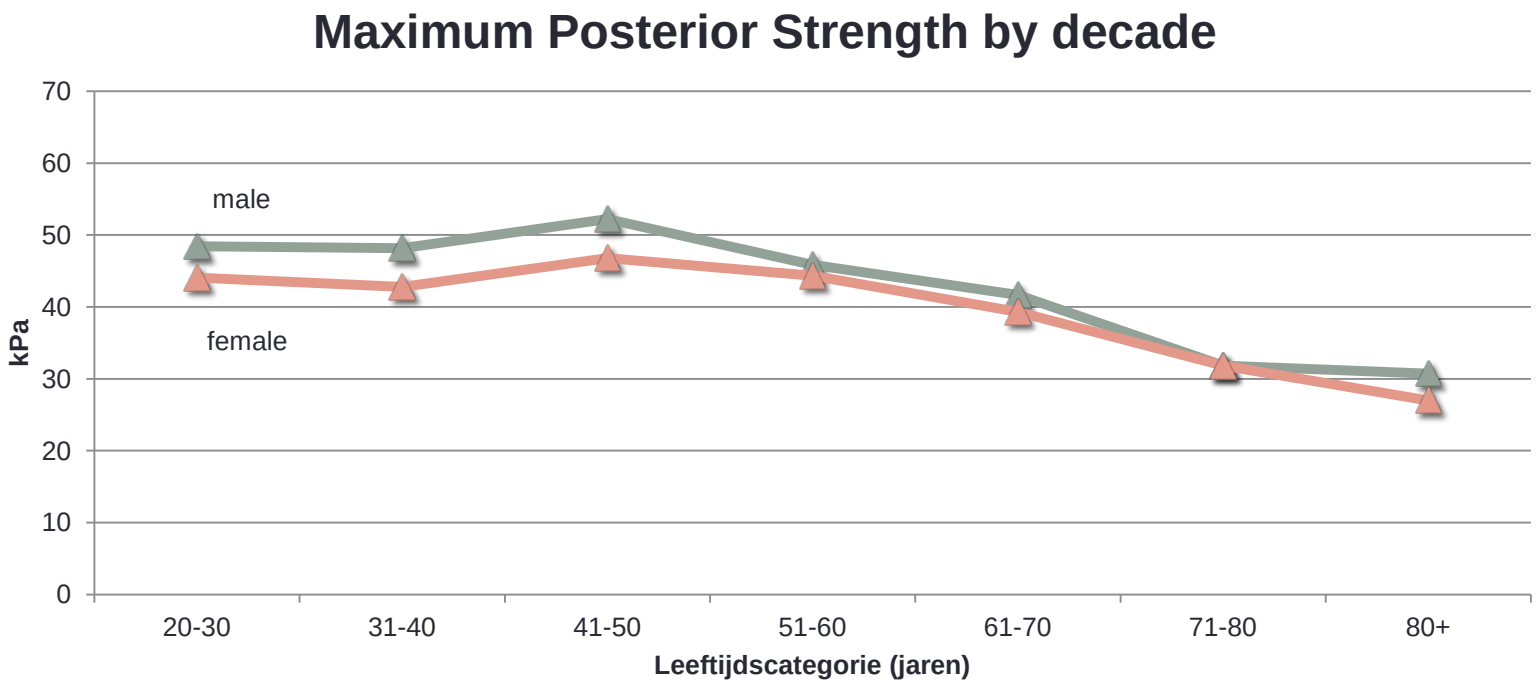
Results - sex



		20-30		31-40		41-50		51-60		61-70		71-80		80+	
		Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.
maxATKFB	man	56,03	0,001	58,33	0,004	55,9	0,011	50,1	0,214	42,9	0,383	34,43	0,744	33,7	0,045
	vrouw	44,07		48,93		47,8		46,73		39,83		33,3		27,9	

Anova, p<.05, post-hoc analysis

Results - sex



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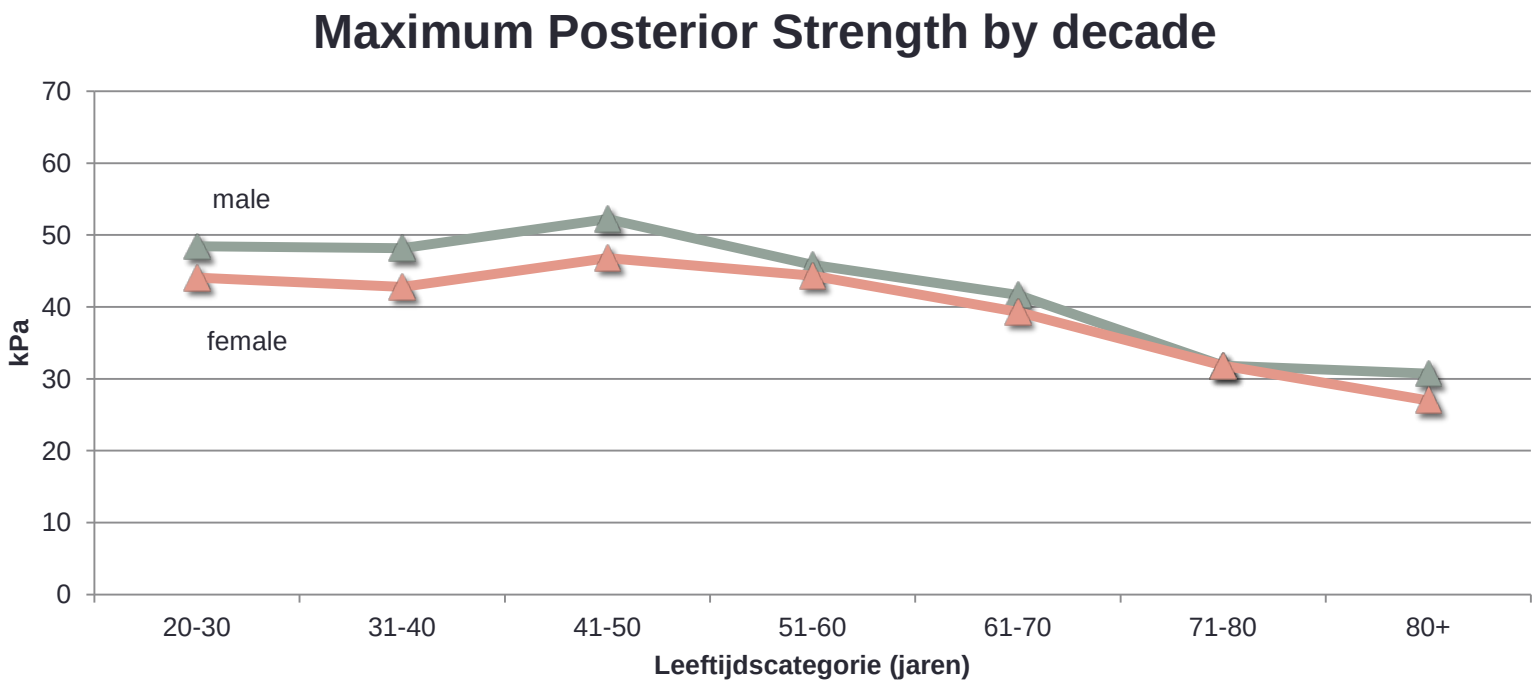
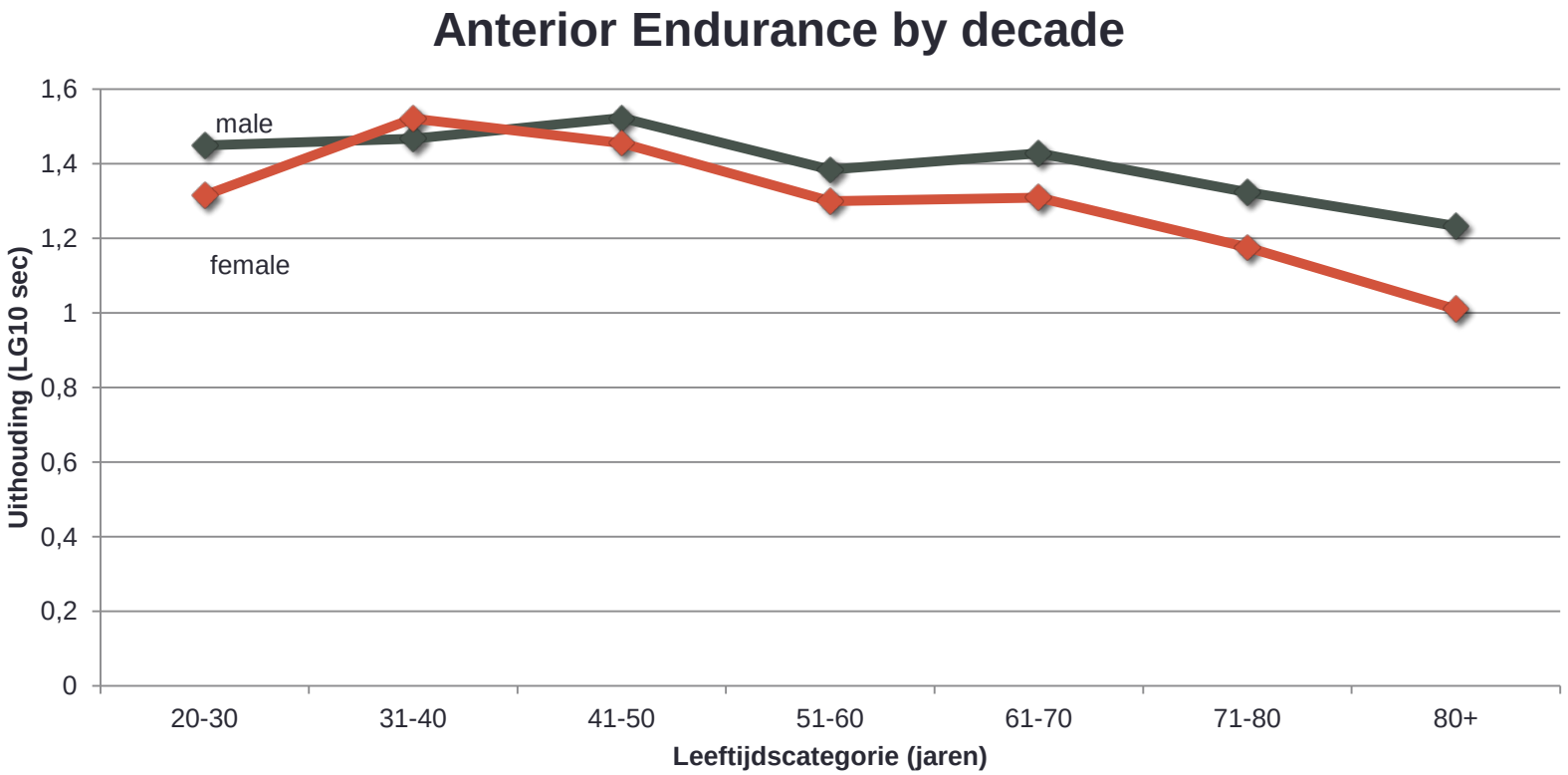
Results - sex



		20-30		31-40		41-50		51-60		61-70		71-80		80+	
		Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.
maxPTKFB	man	48,17	0,122	48,43	0,214	52,23	0,072	45,87	0,58	41,67	0,572	31,83	1	30,73	0,19
	vrouw	42,8		44,07		46,8		44,33		39,33		31,83		27	

Anova, p<.05, post-hoc analysis

Results - sex



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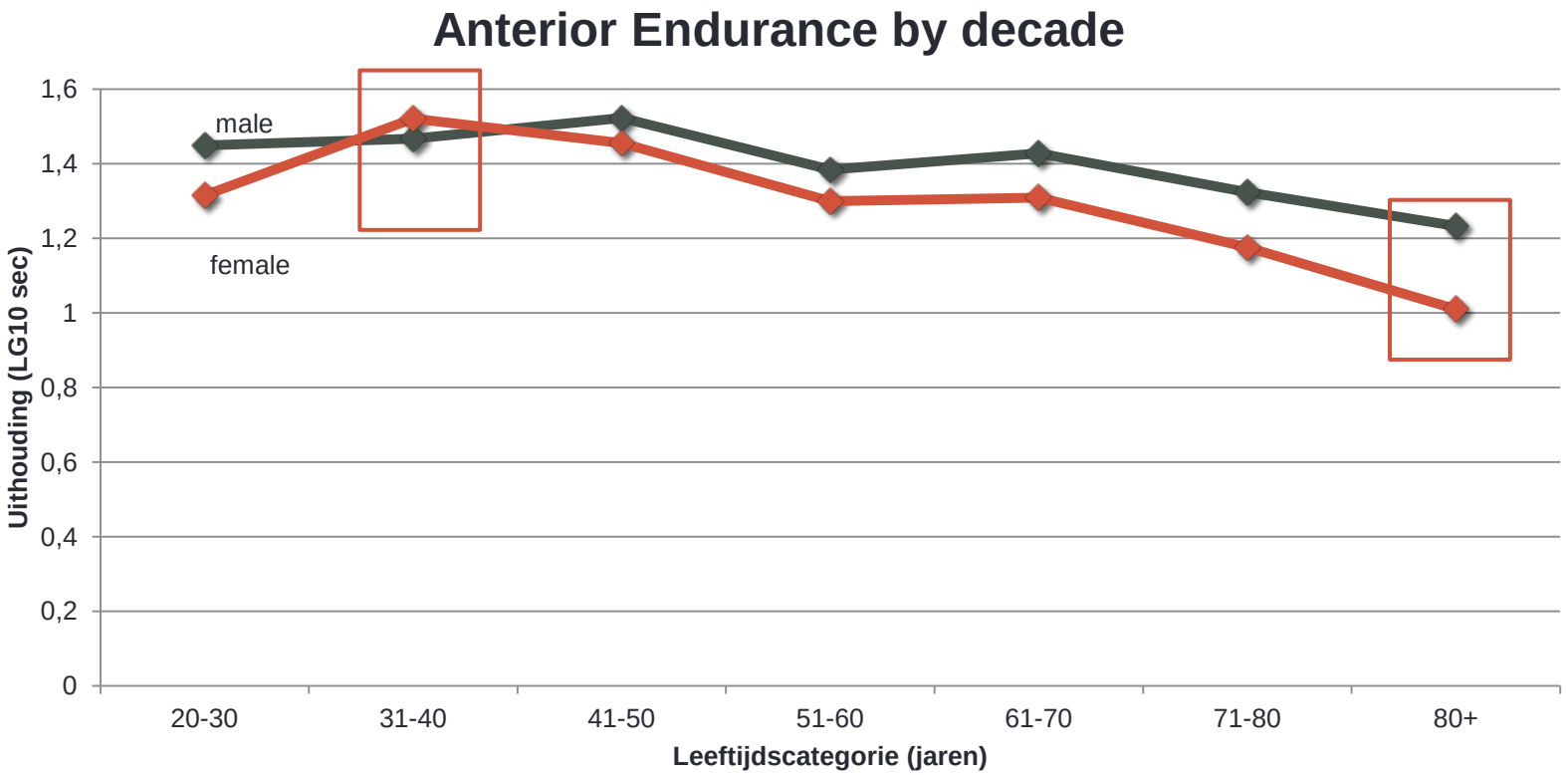
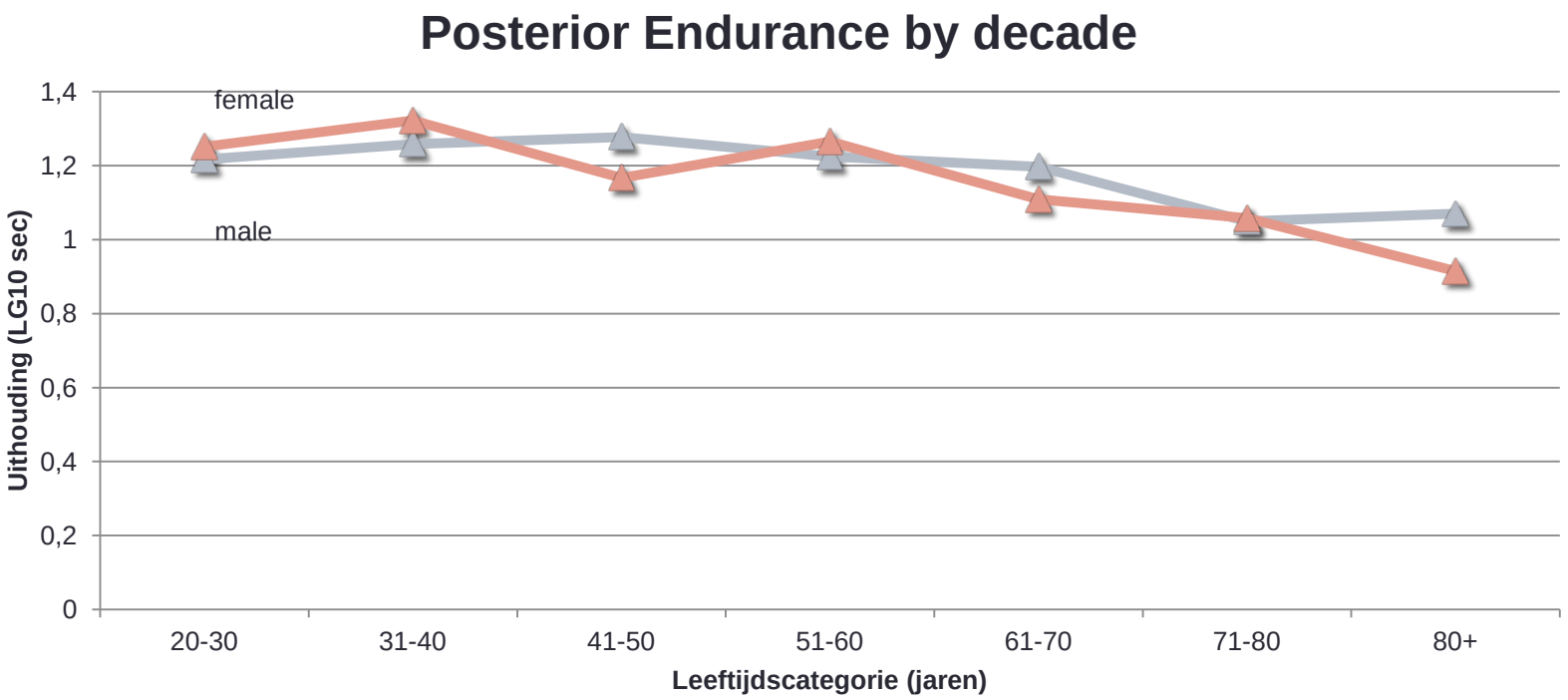
Results - sex



		20-30		31-40		41-50		51-60		61-70		71-80		80+	
		Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.
LG10ATKuith	man	1,4675	0,51	1,4493	0,035	1,5226	0,441	1,3841	0,294	1,4281	0,203	1,3233	0,066	1,233	0,007
	vrouw	1,521		1,3147		1,4555		1,2997		1,3092		1,1757		1,0101	

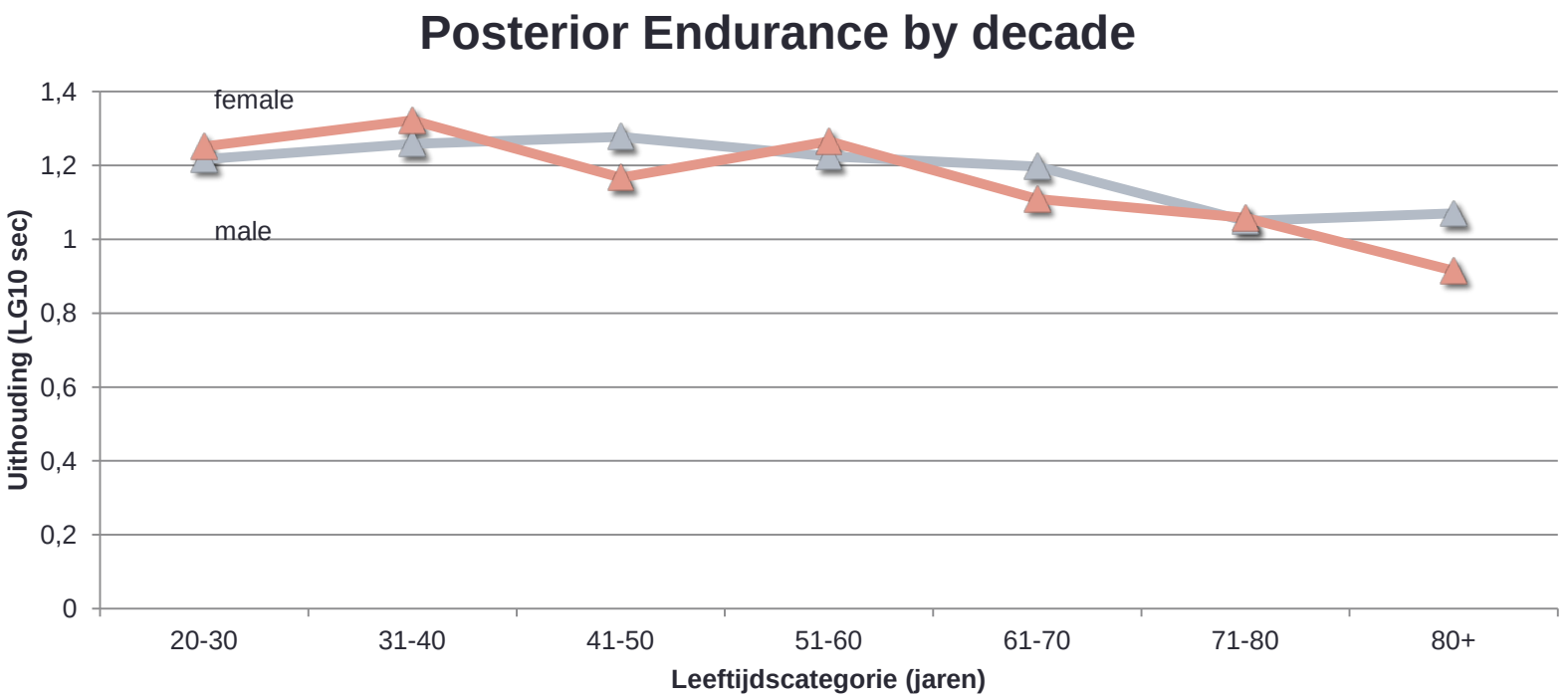
Anova, p<.05, post-hoc analysis

Results - sex



Anova, p<.05, post-hoc analysis

Results - sex



		20-30		31-40		41-50		51-60		61-70		71-80		80+	
		Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.
LG10PTKuith	man	1,2586	0,333	1,2169	0,487	1,2774	0,073	1,2244	0,633	1,1969	0,282	1,0496	0,919	1,0701	0,067
	vrouw	1,3224		1,251		1,1672		1,2651		1,1086		1,0578		0,9147	

Anova, p<.05, post-hoc analysis

Results – sex overview data

		20-30		31-40		41-50		51-60		61-70		71-80		80+	
		Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.	Mean	Sig.
maxATKFB	man	56,03	0,001	58,33	0,004	55,9	0,011	50,1	0,214	42,9	0,383	34,43	0,744	33,7	0,045
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	vrouw	1,3224		1,251		1,1672		1,2651		1,1086		1,0578		0,9147	

Anova, p<.05, post-hoc analysis

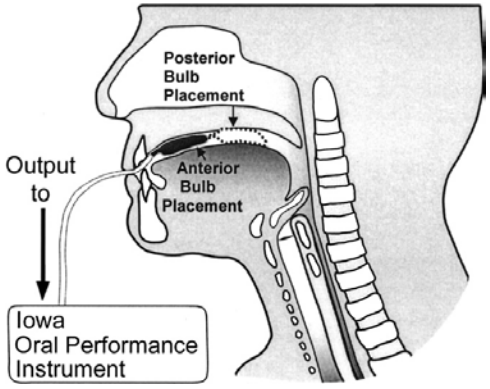
Results – sex summary

- tongue strength:
  - anterior: males in general have more strength than females (4*)
  - posterior: no difference between males and females

- tongue endurance:
  - anterior: males in general have higher endurance than females (2*)
  - posterior: no difference between males and females

Results – bulb position

- anterior vs posterior tongue
- strength and endurance
- paired samples t-test, $p<.05$



Results – bulb position

- anterior vs posterior tongue
- strength and endurance
- paired samples t-test, p<.05

item pair		p-value
maxATKFB+	maxPTKFB+	.000
maxATKFB-	maxPTKFB-	.000
LG10ATKuith	LG10PTKuith	.000

- strength: with and without FB, anterior tongue is stronger
- endurance: greater in anterior tongue

Results – visual feedback

- anterior and posterior maximal strength efforts
- paired samples t-test, $p<.05$

item pair		p-value
maxATKFB	maxATKGFB	.000
maxPTKFB	maxPTKGFB	.000

- when subjects are allowed visual feedback, they reach higher maximal tongue strength

Results – order of testing

- anterior vs posterior tongue first: reciprocal influence?
- independent samples t-test, $p<.05$

parameter	p-value
maxATKFB	.0560
maxPTKFB	.0563
LG10ATKuith	.579
LG10PTKuith	.089

- so no influence of order of testing, meaning no induction of fatigue

Results - conclusion

Q	parameter	answer	implications
1	age*gender	no	separate study is possible
2	age	yes	older = weaker and shorter
3	gender	yes	males = stronger and longer
4	bulb position	yes	anterior tongue = stronger and longer
5	visual feedback	yes	with feedback = stronger
6	order of testing	no	independent muscle systems??

Use and future

- start of Belgian (European) database
- normative data will allow for
  - objective diagnosis of deficit
  - guide rehabilitation tongue/lip weakness
  - monitor results of therapy
- base for future research:
  - comparison between different pathologies
  - impact on function! (swallowing/speech)
  - need for normative data in children, adolescents

Thank you!

Questions?