Subjective sleep quality in healthy subjects – What can PSG really tell us?

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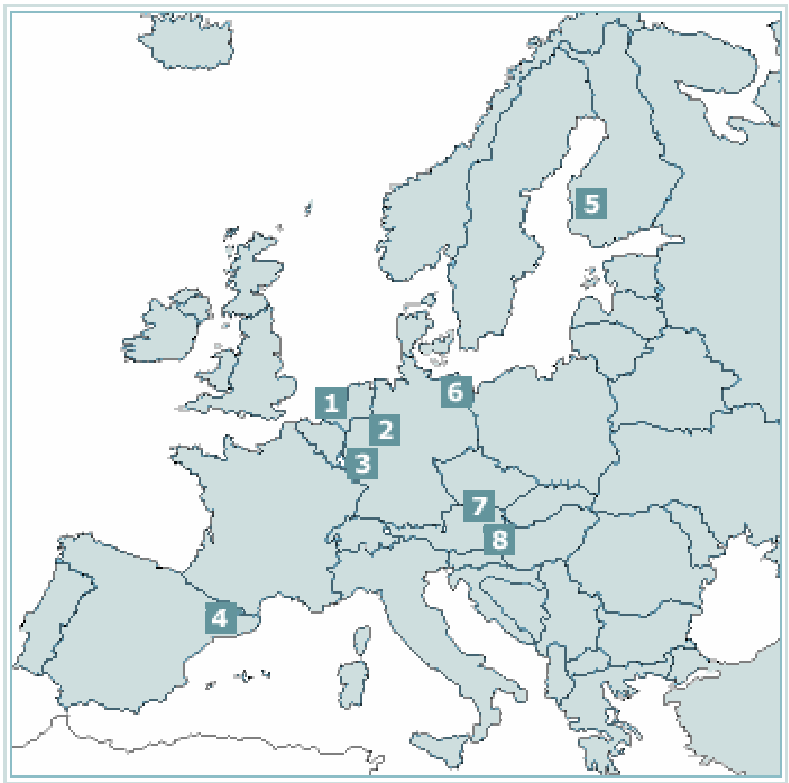
The polysomnographic SIESTA database

195 healthy subjects/97 patients were investigated for 2 consecutive nights, resulting in a total of 584 polysomnographies



8 clinical partners:

1 Holland Sleep Research

2 Philipps University Marburg

3 University of Mainz

4 Hospital de la Santa Creu i Sant Pau, Barcelona

5 Tampere University Hospital

6 Free University of Berlin

7 Department of Psychiatry, Medical University of Vienna

8 Department of Neurology, Medical University of Vienna

Entrance Examination for the SIESTA and SENSATION WP 1.6 Database

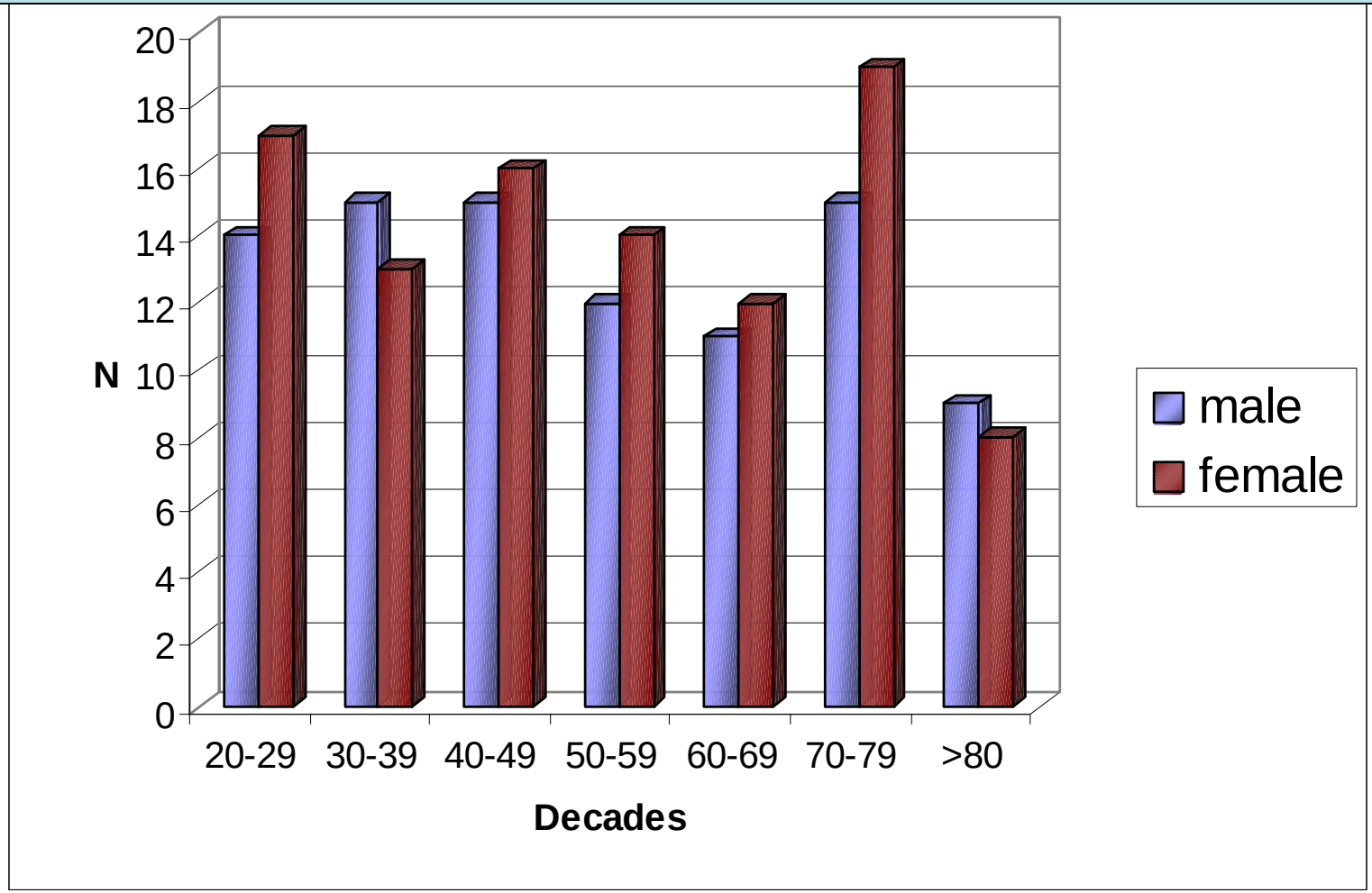
Table 1. Entrance examination.

Examination	Exclusion criteria (if applicable)
Physical examination	Any significant medical condition interfering with the aim of the study
Mini Mental State Examination	MMSE score (30 items) <25
Self-rated scales	Pittsburgh Sleep Quality Index: global score >5; PSQI item 1: usual bedtime before 22.00 or after 24.00 hours
	Quality of Life Questionnaire
	Generalised Self-Efficacy Scale
	Self-rated Anxiety Scale: raw score ≥33
	Self-rated Depression Scale: raw score ≥35
	Personal Inventory
Blood tests	Clearly pathological values for haemoglobin, haematocrit, erythrocyte count, leukocyte count, platelet count, ALT, AST, gamma-GT, bilirubin, alkaline phosphatase, creatinine, free T3; single laboratory values outside the normal range were generally not regarded as an exclusion criterion provided • they were not accompanied by clinical symptoms; • the context of related laboratory values did not indicate a pathological process; and • the investigator regarded these laboratory values as clinically irrelevant and documented that in writing on the Case Report Form.

Normal Healthy Subjects (PSQI ≤ 5)

- 177 healthy subjects (83 males and 94 females) aged between 20 and 95 years.

Normal Healthy Subjects (PSQI ≤ 5)



“Subjective Sleep Quality” versus **“Objective Sleep Quality”**

Evaluation of “Subjective Sleep Quality”

Self-Rating Scale for Sleep and Awakening Quality (SSA)

by Saletu et al. (1987)

20 items => 3 subscores and 1 total score

SSA-1 subjective sleep quality

SSA-2 subjective awakening quality

SSA-3 somatic complaints

Patient ID: _____ Date: _____ Night: ____

SELF-RATING SCALE FOR SLEEP AND AWAKENING QUALITY (SSA)

SLEEP QUALITY	no	slightly	moderately	very much
1. Did you sleep well ?				
2. Did you have deep sleep?				
3. Did you have difficulties in falling asleep?				
4. Did you have difficulties in staying asleep?				
5. Did you have bad dreams?				
6. Did you have difficulties getting back to sleep?				
7. Did you wake up earlier than usual?				

Subscore 1: _____

AWAKENING QUALITY	no	slightly	moderately	very much
8. Did you feel giddy after awakening?				
9. Did you feel disorientated?				
10. Did you feel tired?				
11. Were you in a good mood?				
12. Did you feel interested in your surroundings?				
13. Did you feel slowed down?				
14. Was your attention / concentration reduced?				
15. Did you feel refreshed and rested?				

Subscore 2: _____

SOMATIC COMPLAINTS	no	slightly	moderately	very much
16. Any nausea after awakening?				
17. Any headache?				
18. Dryness of your mouth?				
19. Any dizziness?				
20. Incoordination of movements?				

Subscore 3: _____ , **Total score:** _____

22. When did you go to bed? _____ h. _____ min.

23. When did you turn out the lights? _____ h. _____ min.

24. When did you fall asleep? _____ h. _____ min.

25. How often did you awake during the night? _____ times

26. When was your final awakening? _____ h. _____ min.

27. How much sleep did you get at all? _____ hrs. _____ min.

28. When did you get out of bed? _____ h. _____ min.

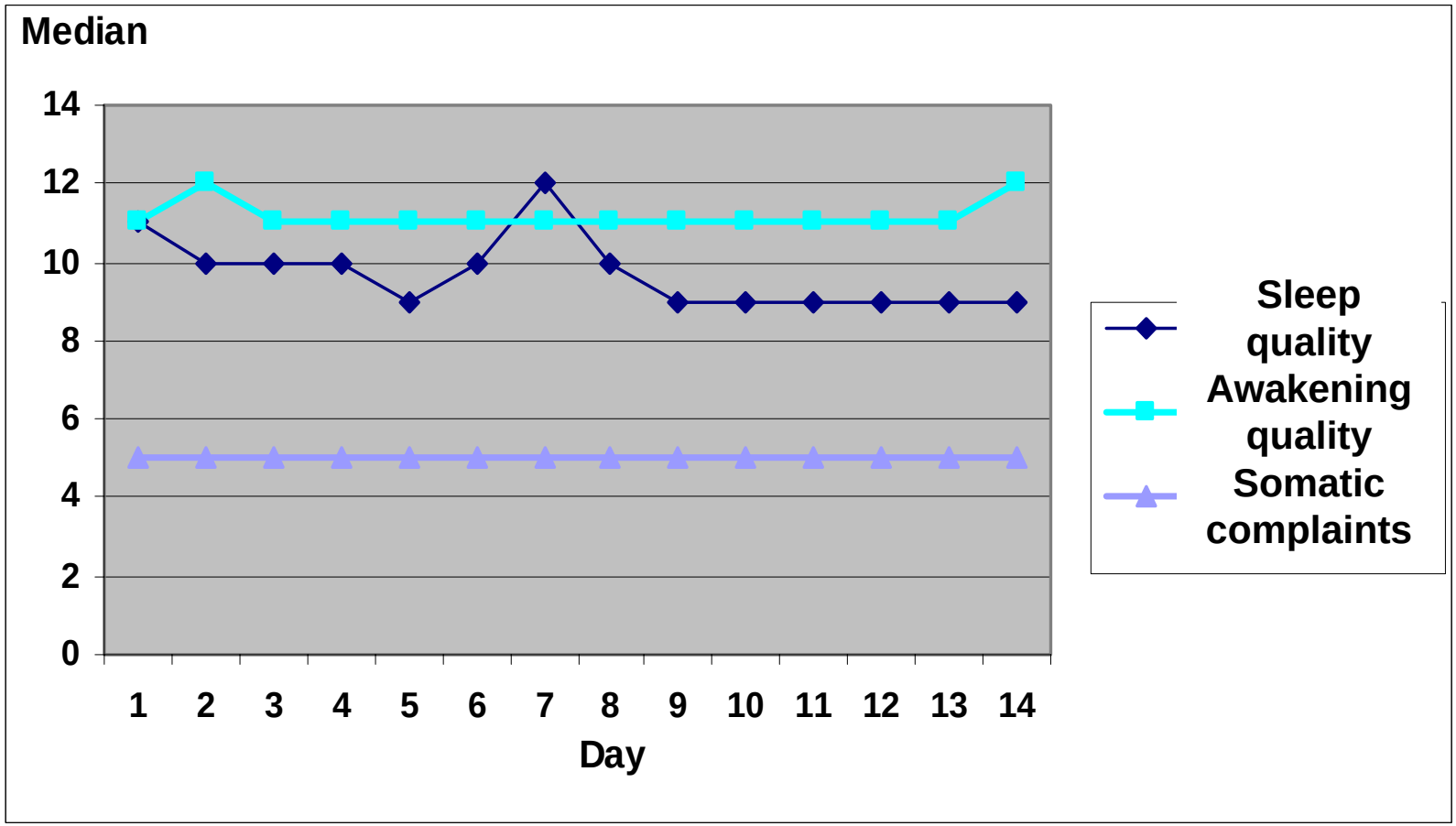
Evaluation of “Subjective Sleep Quality”

SLEEP QUALITY	no	slightly	moderately	very much
1. Did you sleep well ?				
2. Did you have deep sleep?				
3. Did you have difficulties in falling asleep?				
4. Did you have difficulties in staying asleep?				
5. Did you have bad dreams?				
6. Did you have difficulties getting back to sleep?				
7. Did you wake up earlier than usual?				

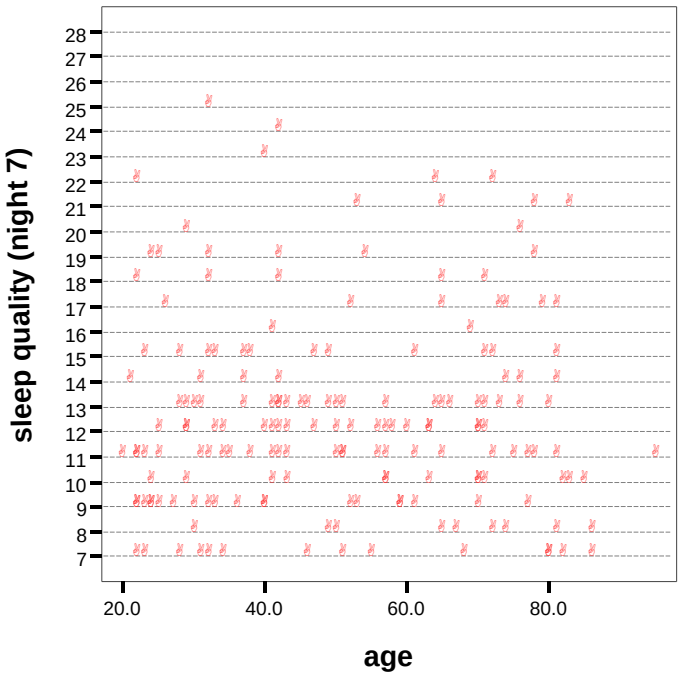
Subscore 1: _____

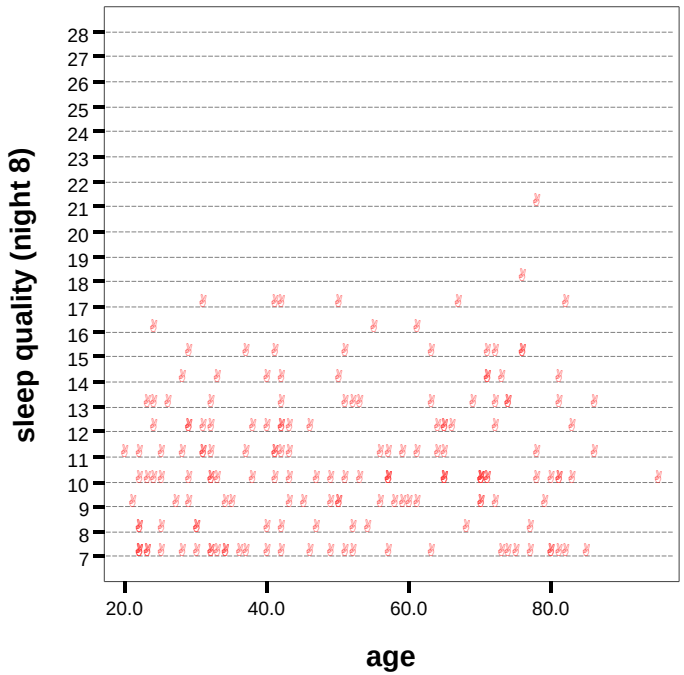
Range for sub-score 1 (Sleep Quality): 7 (good) – 28 (poor)

Subjective Sleep Quality (SSA-1)
Normal Healthy Subjects (n:177)



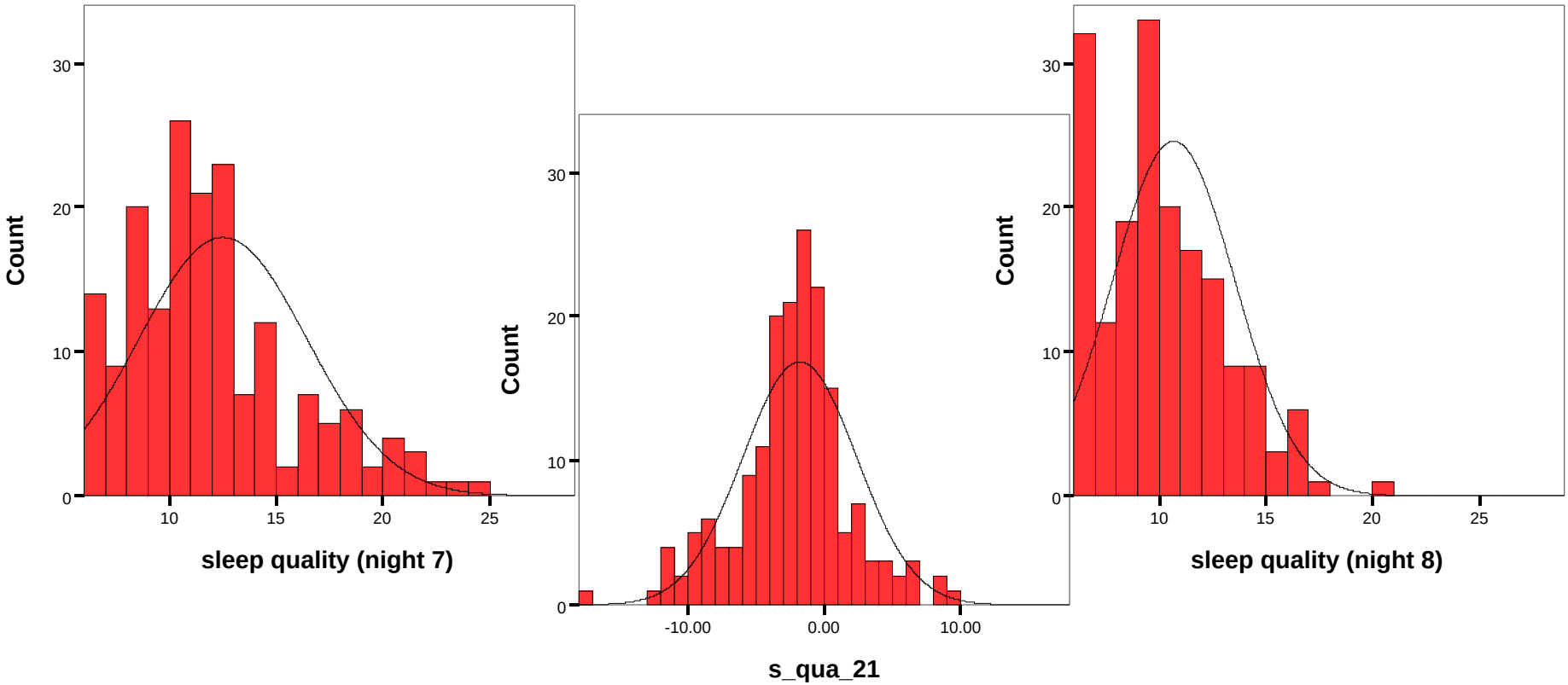
Subjective Sleep Quality (SSA-1)
Normal Healthy Subjects (n:177)





Adaptation night (“model of transient insomnia”):
Increases variance even in healthy subjects

Subjective Sleep Quality (SSA-1)
Normal Healthy Subjects (n:177)



Baseline - adaptation night (“normalization”):

Avoids the problem of interindividual differences in handling rating scales and sleep habits

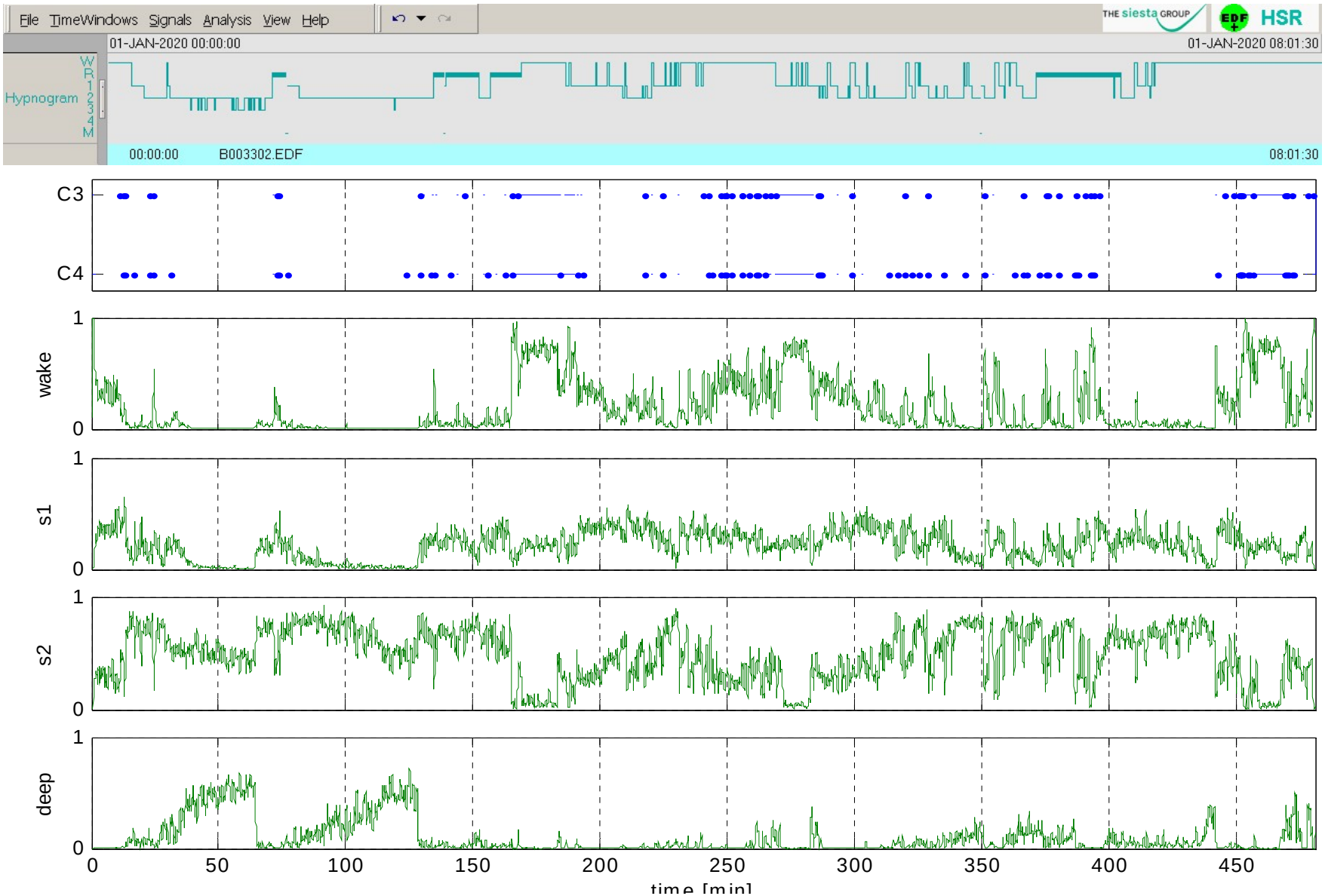
Evaluation of “Objective Sleep Quality”

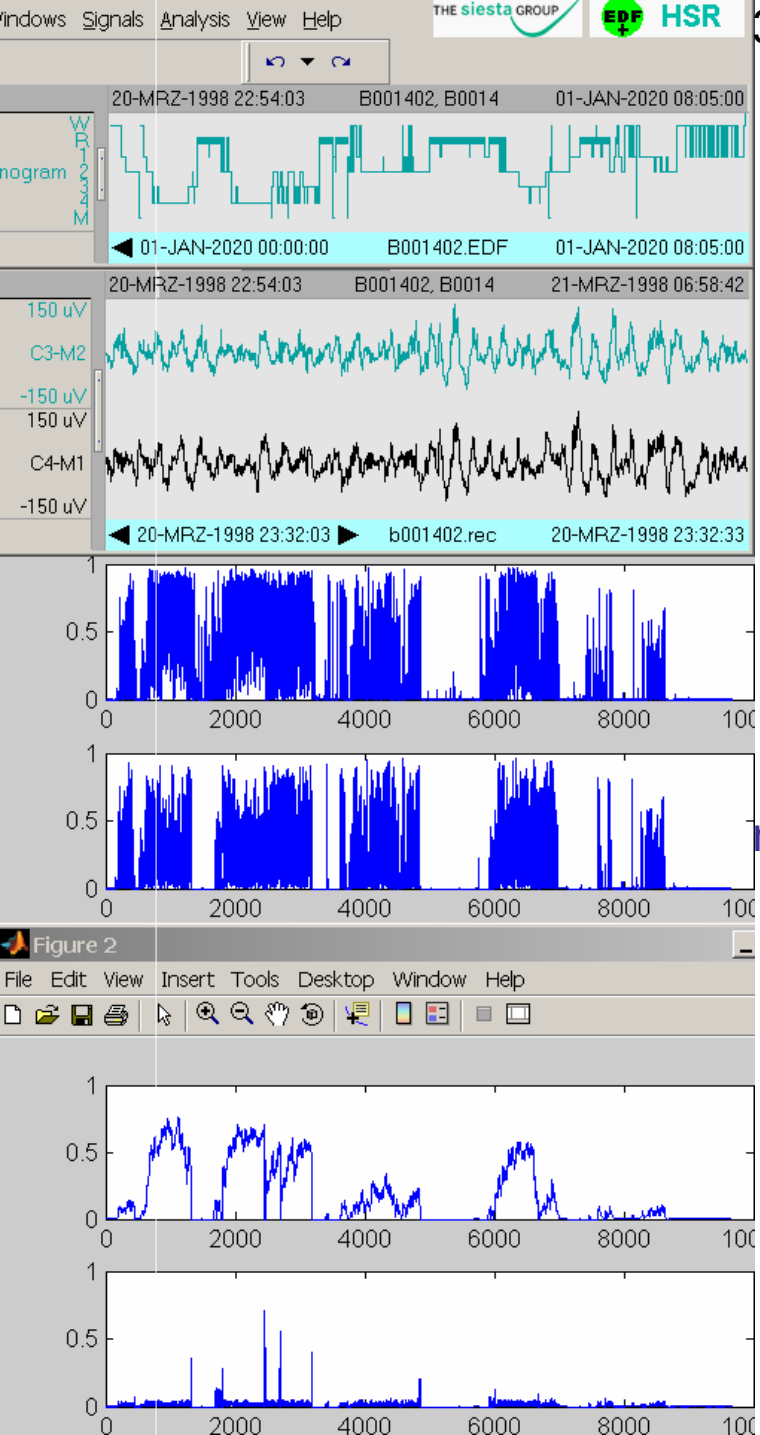
Polysomnographic investigations were analyzed by ***Somnolyzer 24x7*** according to the standard criteria (***Rechtschaffen & Kales*** 1968; ASDA criteria 1992) and by means of a newly developed continuous ***hierarchical Gaussian Mixture Model (hGMM)*** of the sleep process (SENSATION WP 1.4).

- **Sleep initiation and maintenance** (sleep latency, sleep efficiency, WASO, etc.)
- **Sleep continuity** (number of awakenings, stage shifts and cortical arousals per hour TST, hGMM stage shifts)
- **Sleep architecture** (sleep stages in % of TST; hGMM area under the curve (AUC) or entropy)

B001402: Male, 34 years

B003302: Female, 76 years





34 years male

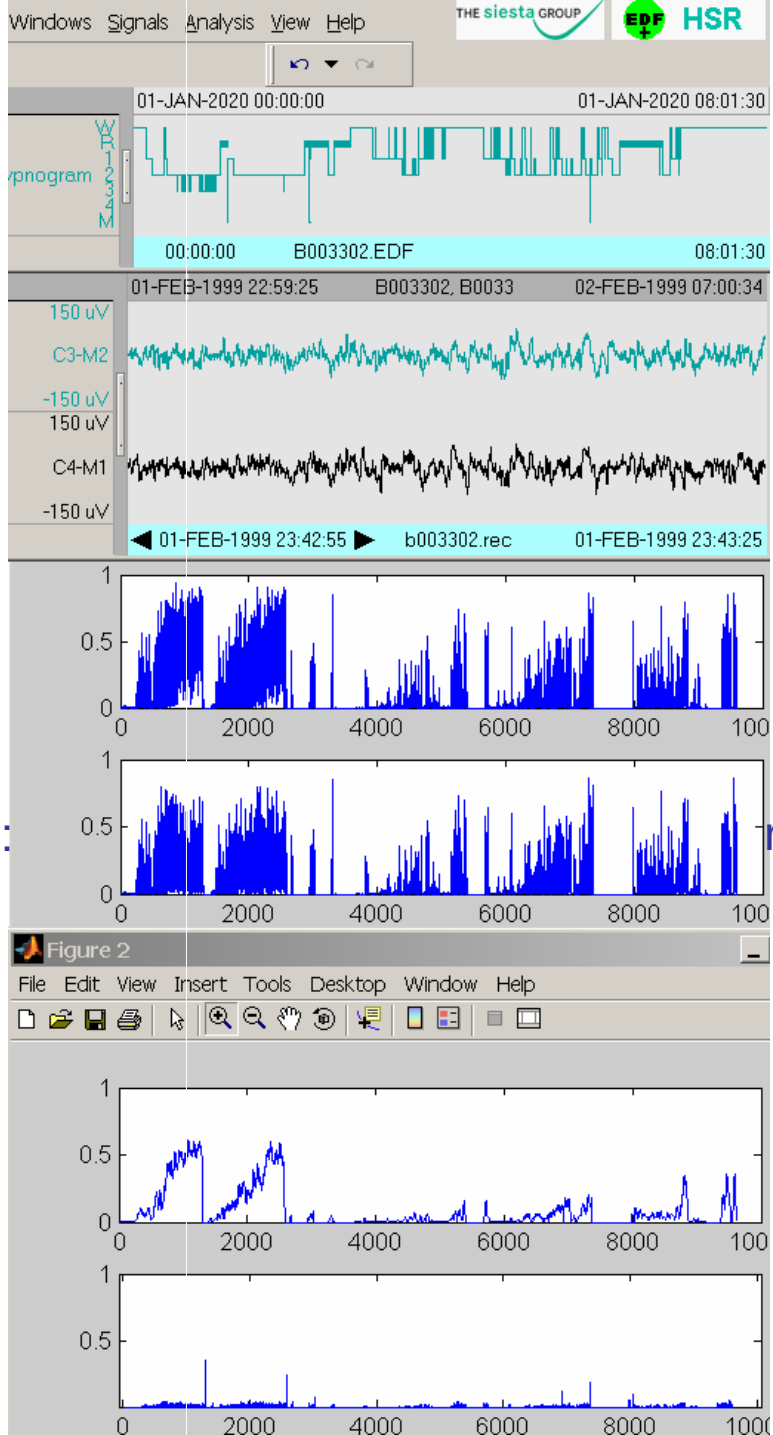
R&K

SWS= 25.7%

hGMM

rAUC_d: 16.6%

rAUC1_d: 12.4%



76 years female

R&K

SWS= 3.1%

hGMM

rAUC_d: 10.4%

rAUC1_d 8.3%

“Subjective sleep quality” versus “Objective sleep quality”

SSA-1

Sleep efficiency

SLEEP QUALITY	no	slightly	moderately	very much
1. Did you sleep well ?				
2. Did you have deep sleep?				
3. Did you have difficulties in falling asleep?				
4. Did you have difficulties in staying asleep?				
5. Did you have bad dreams?				
6. Did you have difficulties getting back to sleep?				
7. Did you wake up earlier than usual?				

Subscore 1: _____

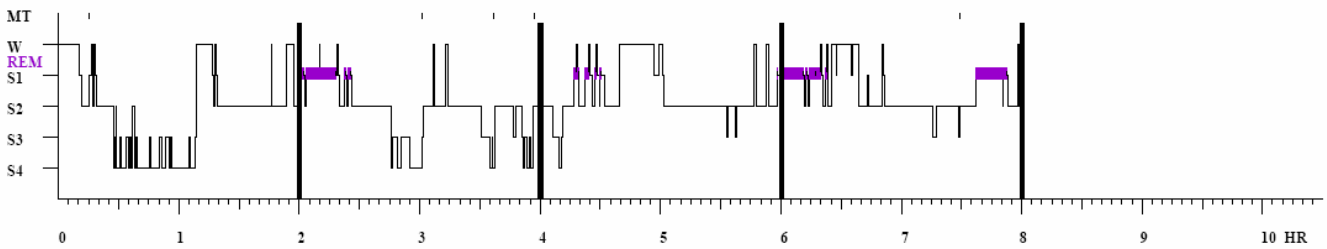
Siesta Spot Report™ **Date: Oct 31 , 2005** **Page 8 of 8**

Patient’s ID:	**637aaabe.edf**
Patient’s gender:	female
Patient’s age:	66 years
First Night:	No

Controls: SIESTA normative database

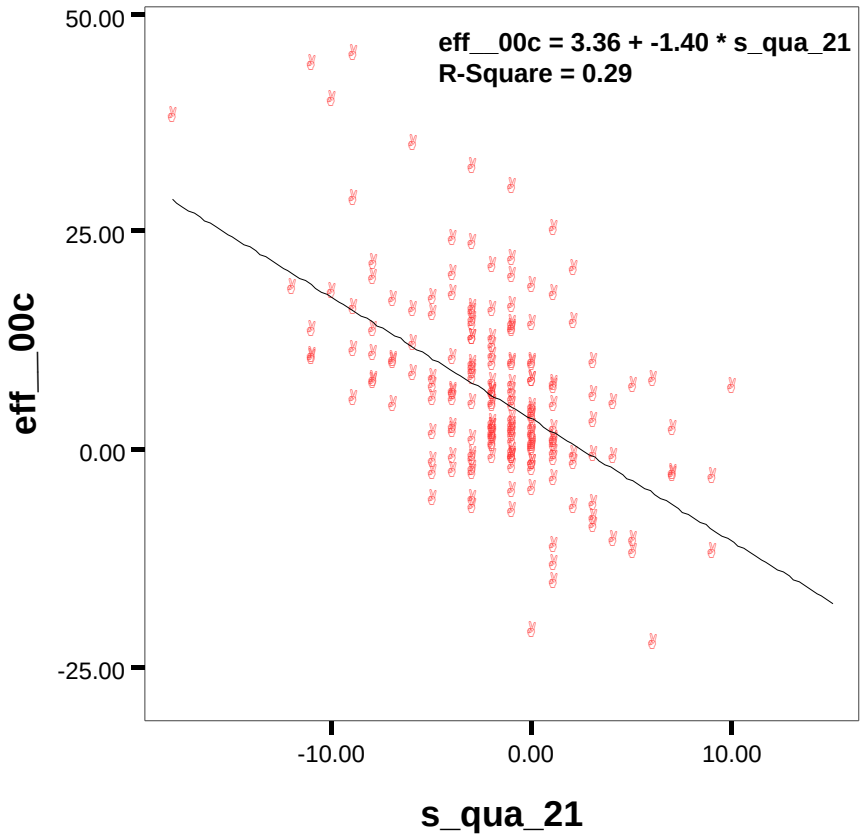
Number of controls:	31 females
Controls’ age:	66.9 ± 5.8 years

Analysis by fraction (1/4):



“Subjective sleep quality” versus **“Objective sleep quality”**

SSA-1 **R&K Sleep efficiency (% TIB)**

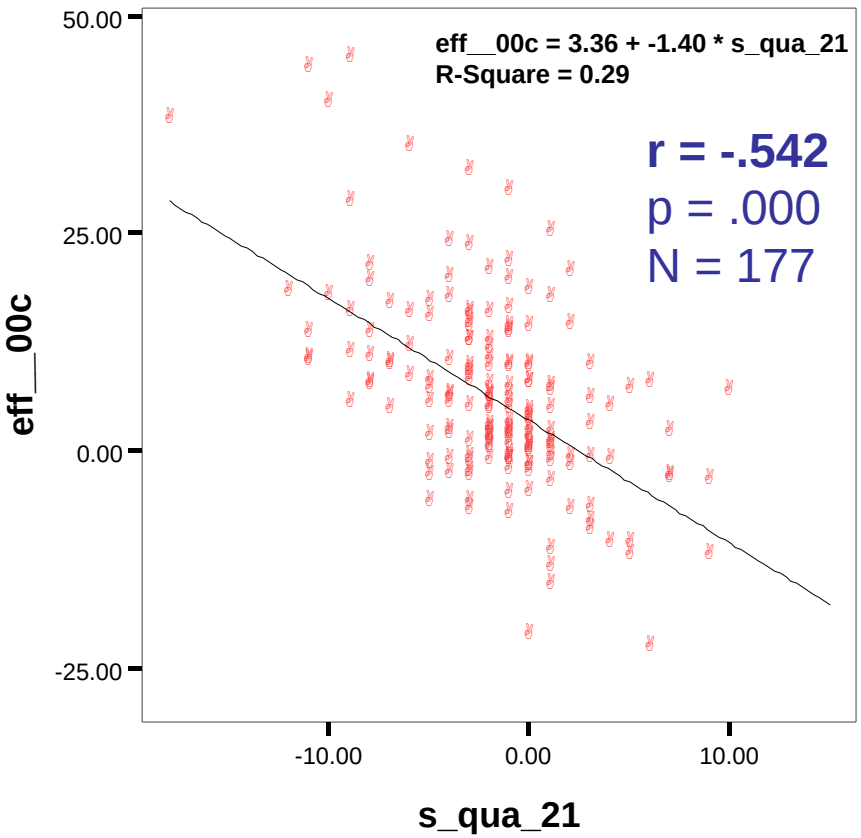


r = -.542
p = .000
N = 177

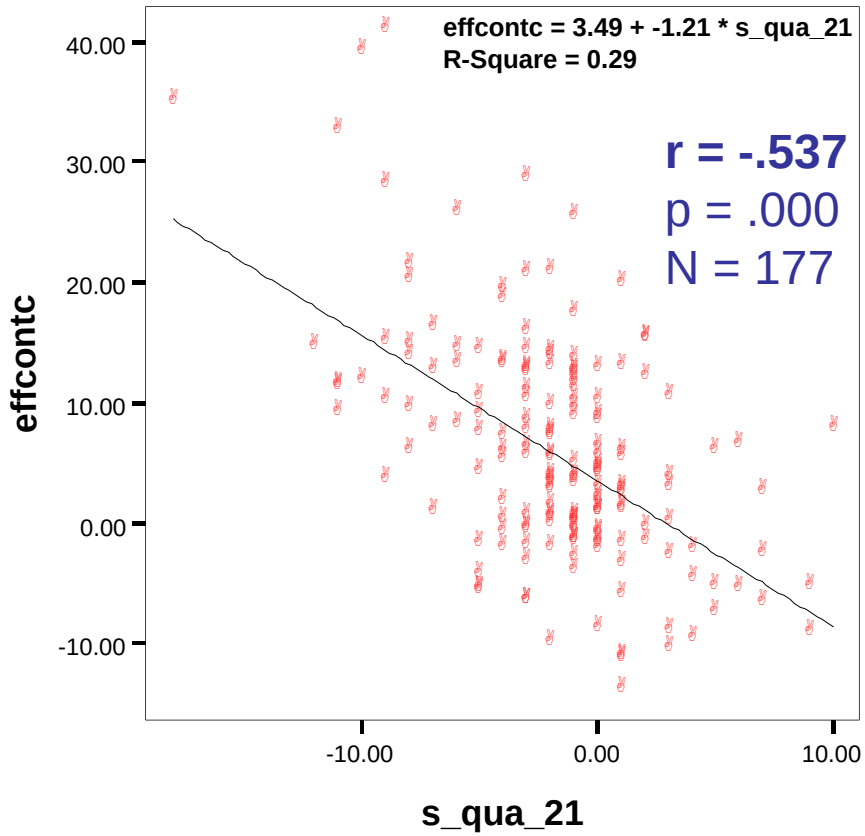
“Subjective sleep quality” versus “Objective sleep quality”

SSA-1 — **R&K Sleep efficiency (% TIB)**

R&K



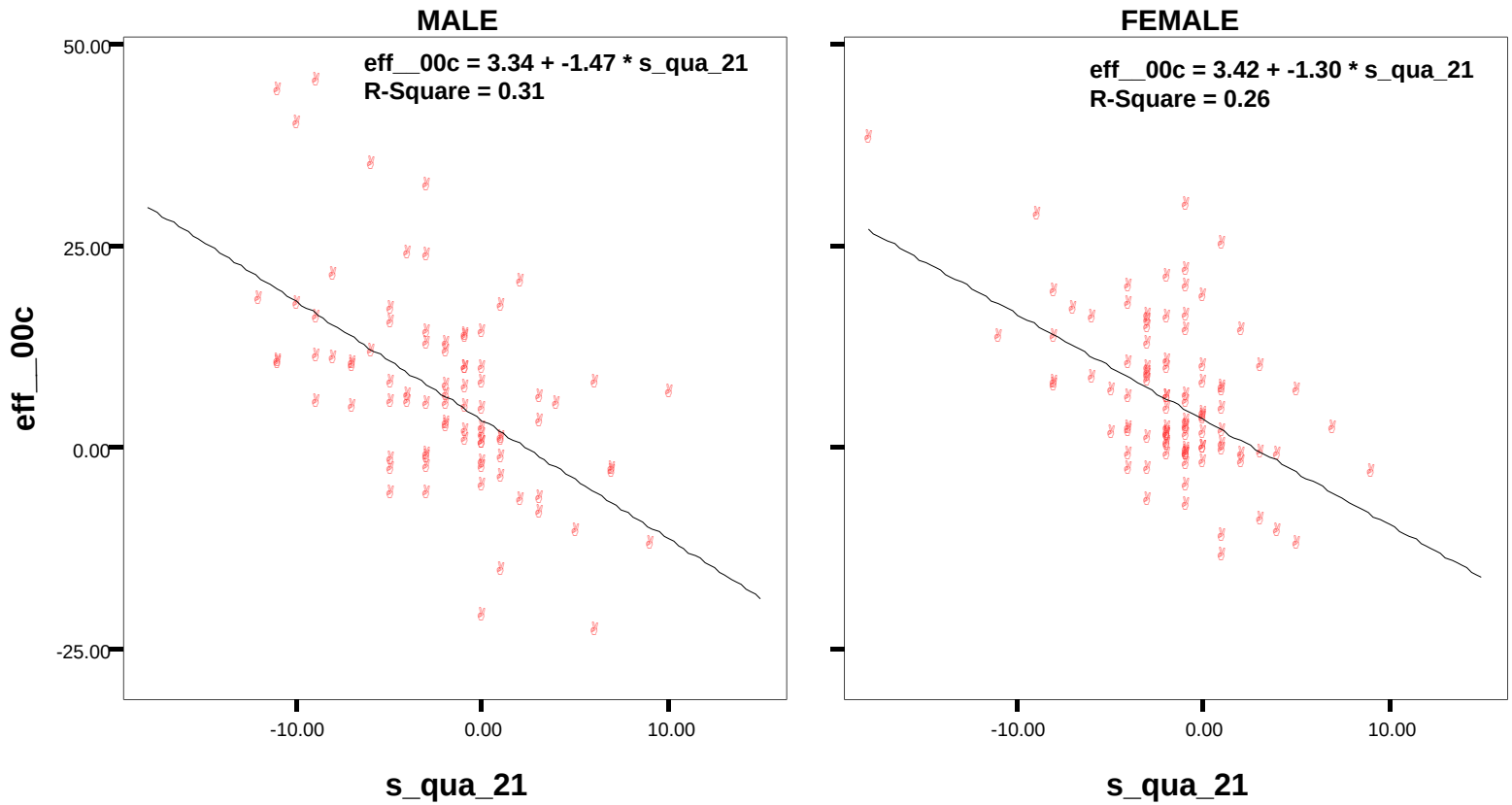
hGMM



“Subjective sleep quality” versus “Objective sleep quality”

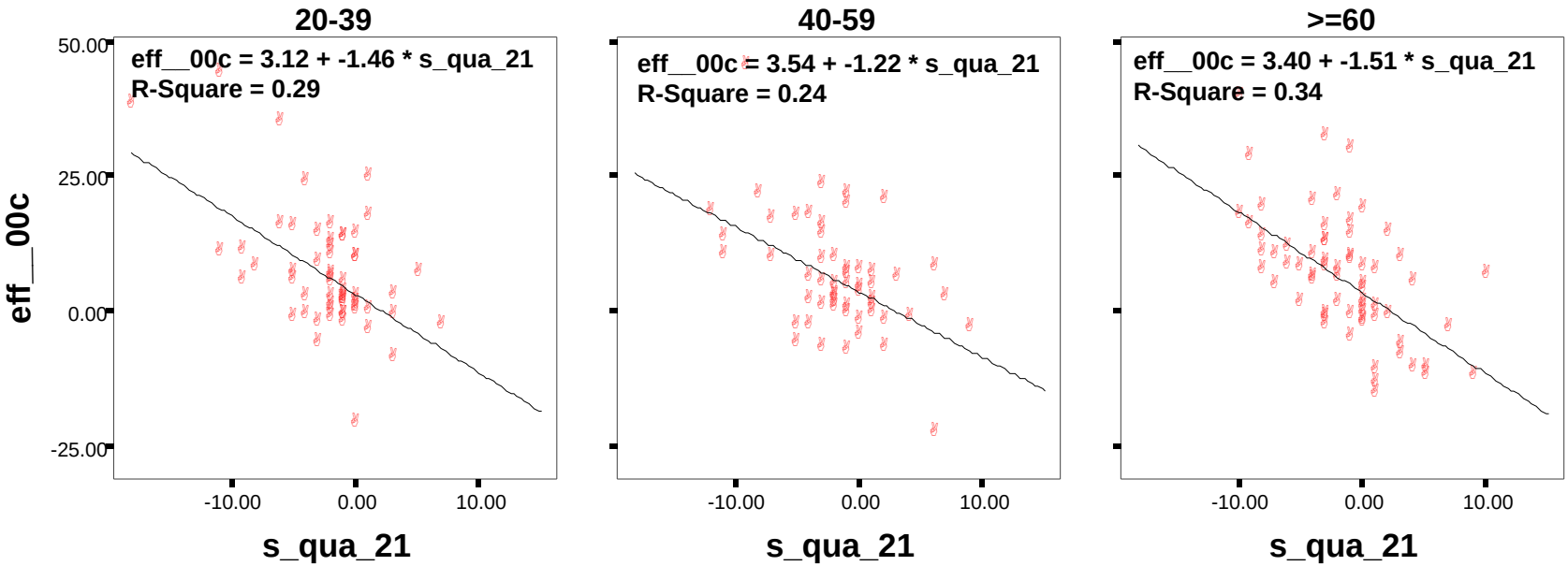
SSA-1

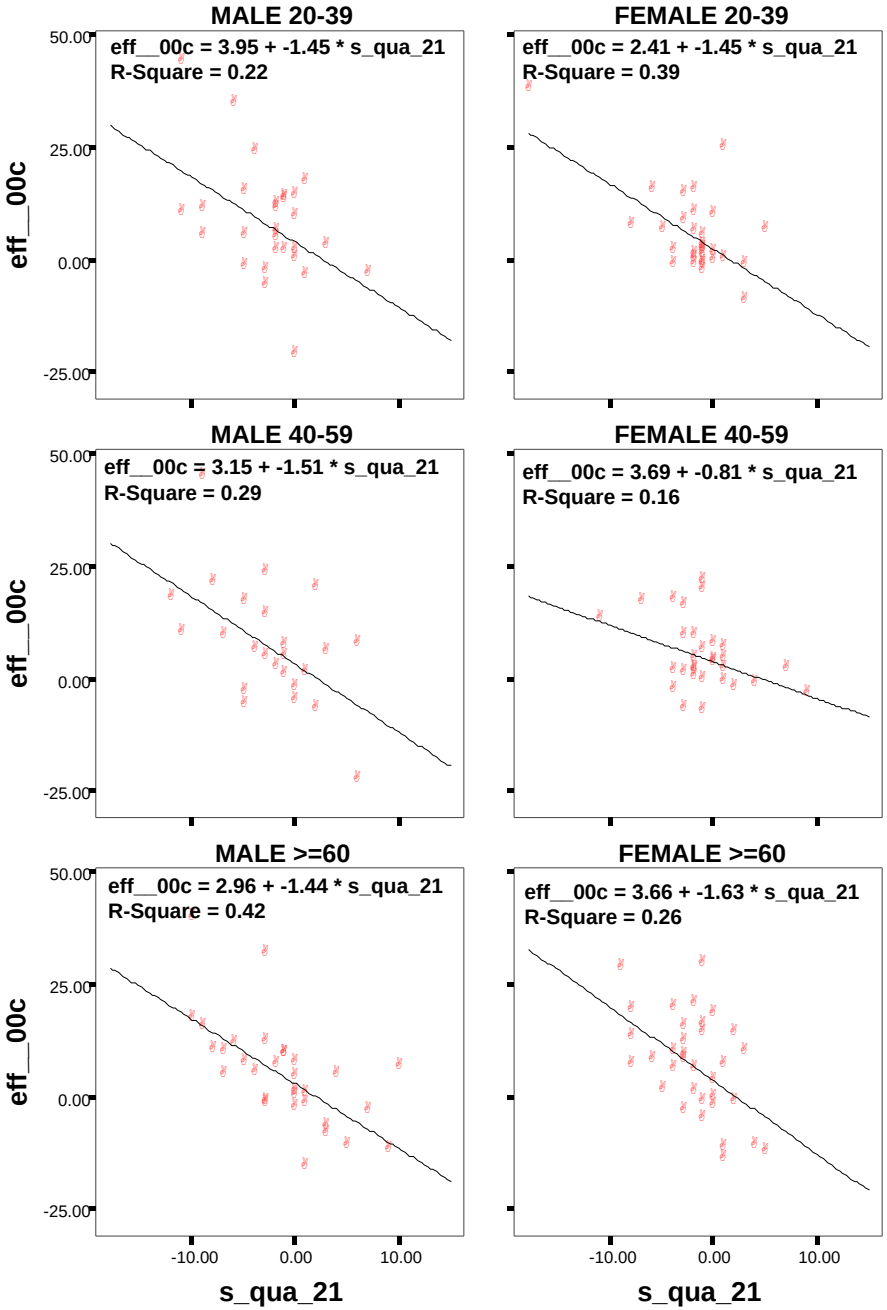
R&K
Sleep efficiency (% TIB)



“Subjective sleep quality” versus **“Objective sleep quality”**

SSA-1 **R&K**
Sleep efficiency (% TIB)





SSA-1

versus

R&K Sleep efficiency (% TIB)

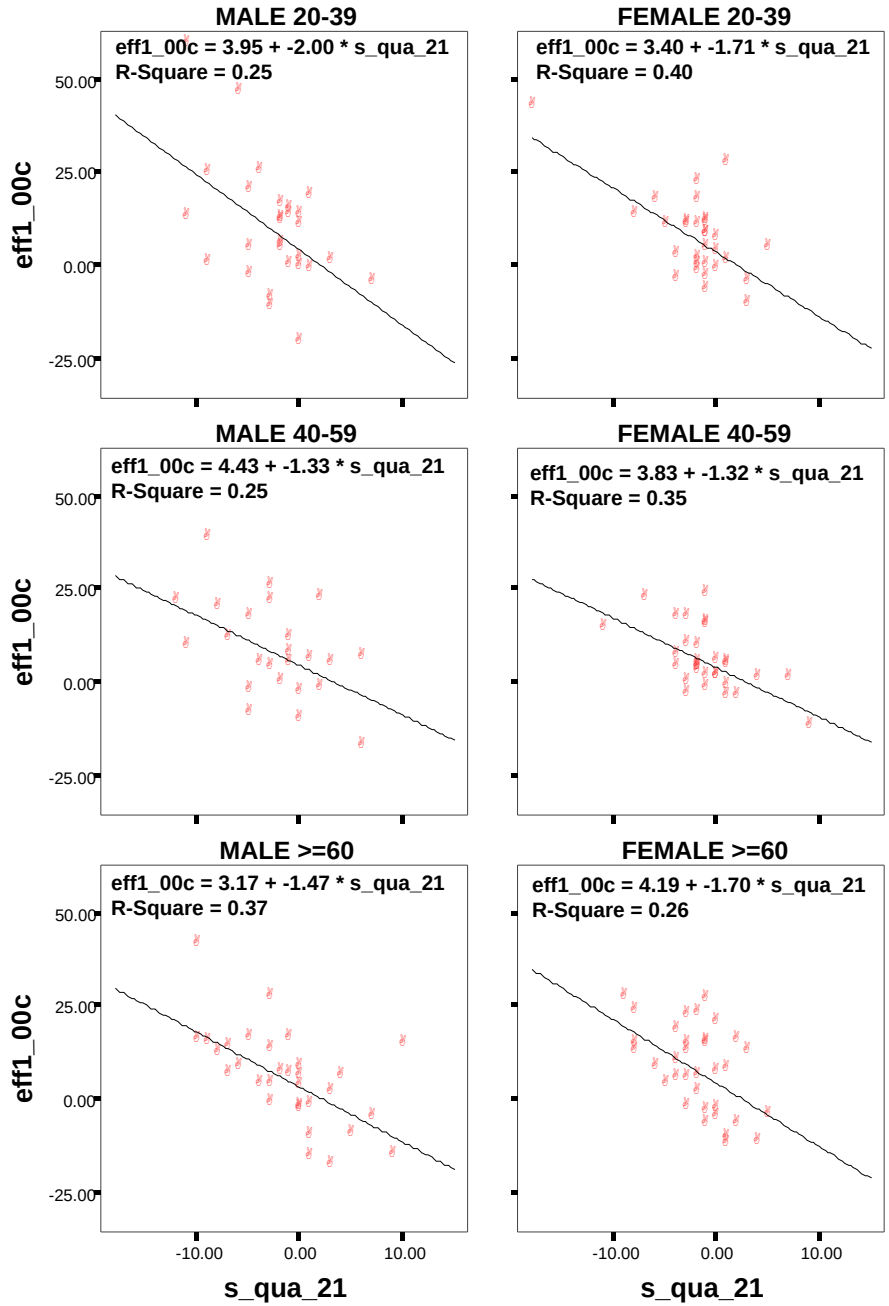
Sleep efficiency =

(100*TST/TIB)

with

TST =

S1+S2+S3+S4+REM



SSA-1

versus

R&K Sleep efficiency-1 (% TIB)

Sleep efficiency-1 =

(100*TST1/TIB)

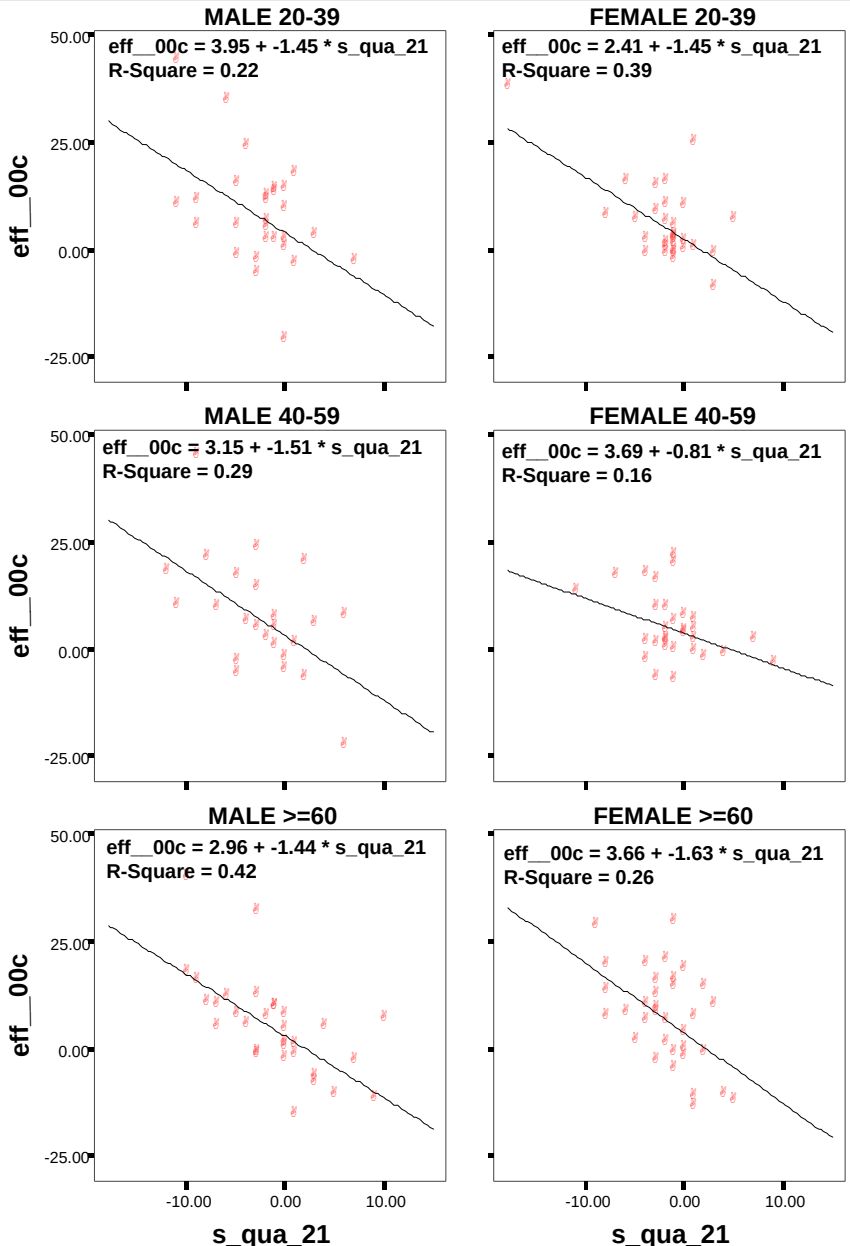
with

TST1 =

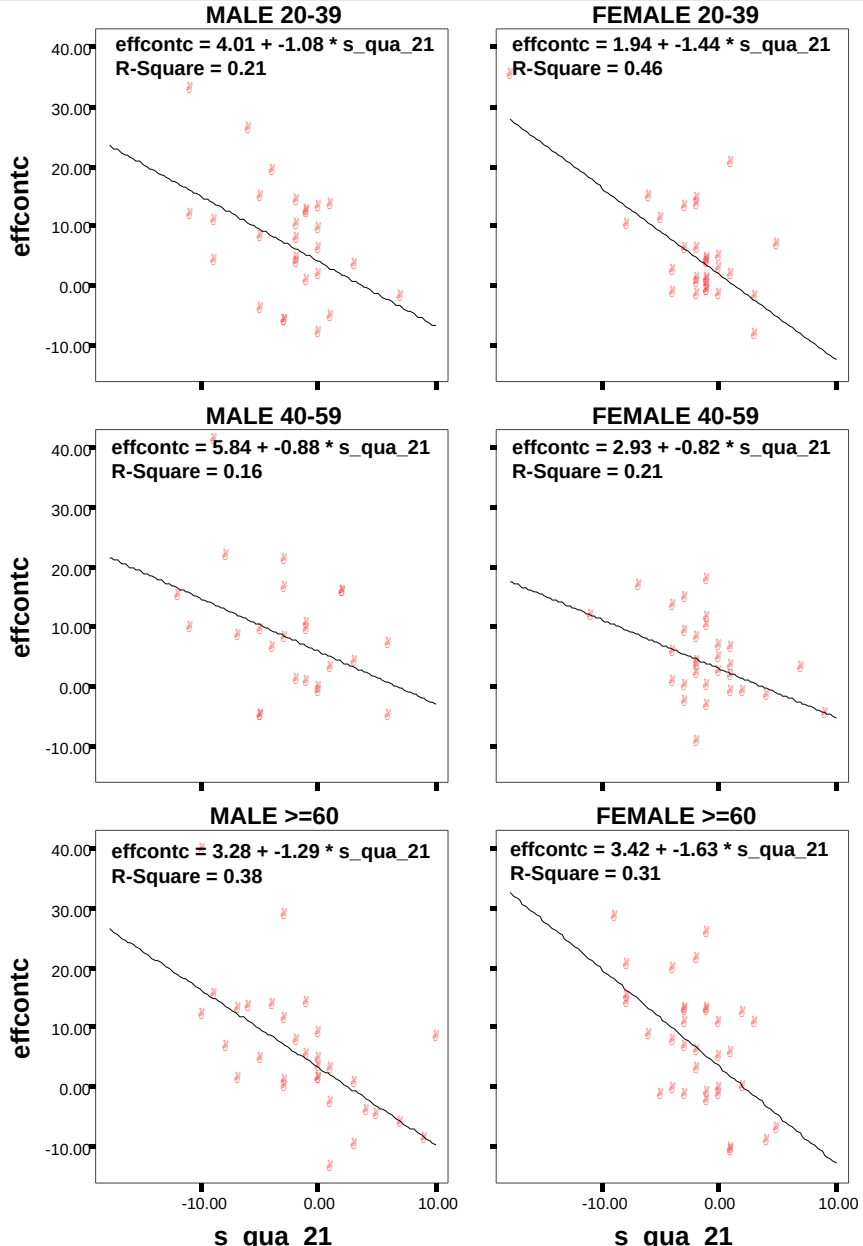
S2+S3+S4+REM

SSA-1 versus sleep efficiency (% TIB)

R&K



hGMM

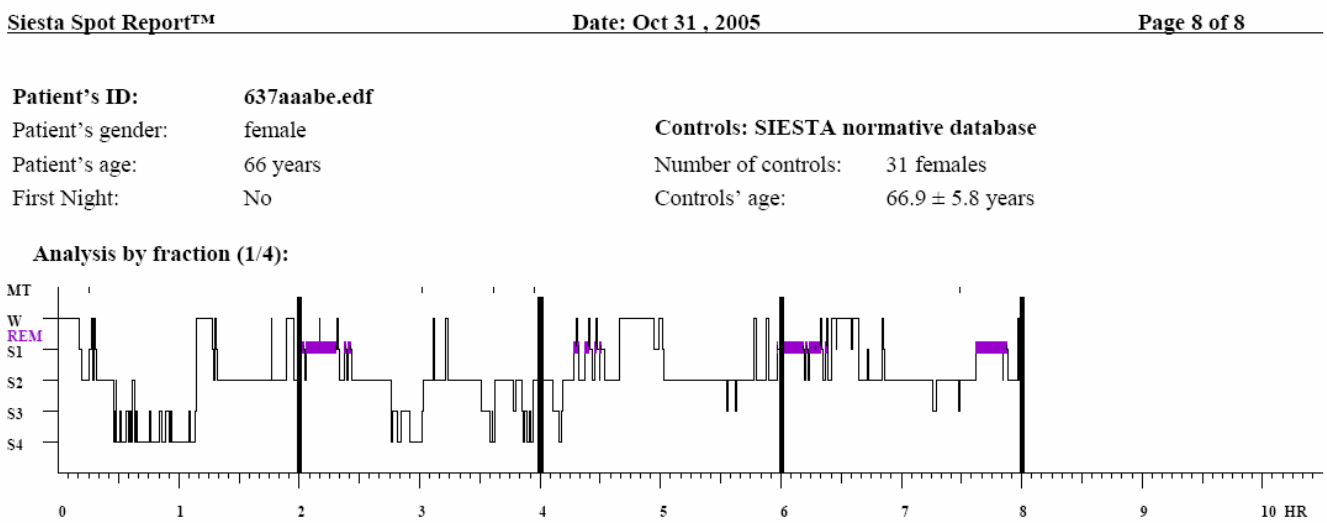


“Subjective sleep quality” versus “Objective sleep quality”

SSA-1 Sleep initiation

SLEEP QUALITY	no	slightly	moderately	very much
1. Did you sleep well ?				
2. Did you have deep sleep?				
3. Did you have difficulties in falling asleep?				
4. Did you have difficulties in staying asleep?				
5. Did you have bad dreams?				
6. Did you have difficulties getting back to sleep?				
7. Did you wake up earlier than usual?				

Subscore 1: _____



Siesta Spot Report™ Date: Oct 31 , 2005 Page 8 of 8

Patient’s ID: **637aaabe.edf**
Patient’s gender: female
Patient’s age: 66 years
First Night: No

Controls: SIESTA normative database
Number of controls: 31 females
Controls’ age: 66.9 ± 5.8 years

Analysis by fraction (1/4):

“Subjective sleep quality” versus **“Objective sleep quality”**

SSA-1 **R&K Sleep initiation**

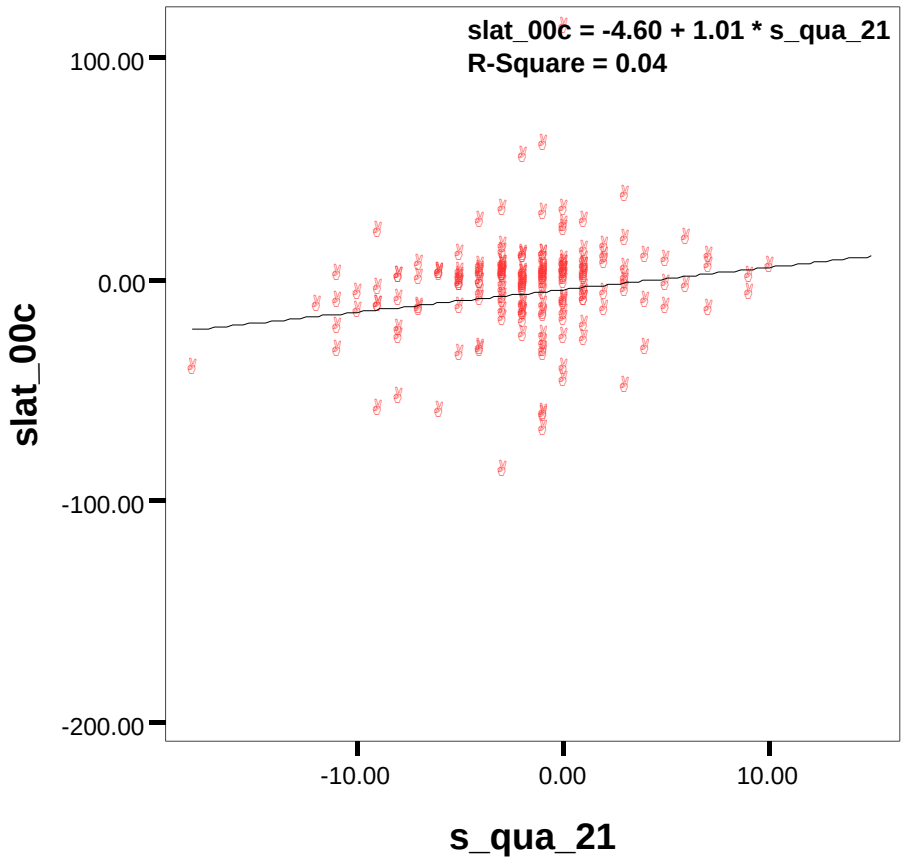
	Latency from „lights out“ to					
SSA-1	Sleep onset	10 min cont. sleep	S1	**S2**	SWS	REM
r	.194	.200	.217	**.252**	.245	.171
p	.010	.008	.004	**.001**	.001	.023
N	177	177	177	**177**	.169	177

“Subjective sleep quality” versus **“Objective sleep quality”**

SSA-1

R&K

Sleep latency (min)

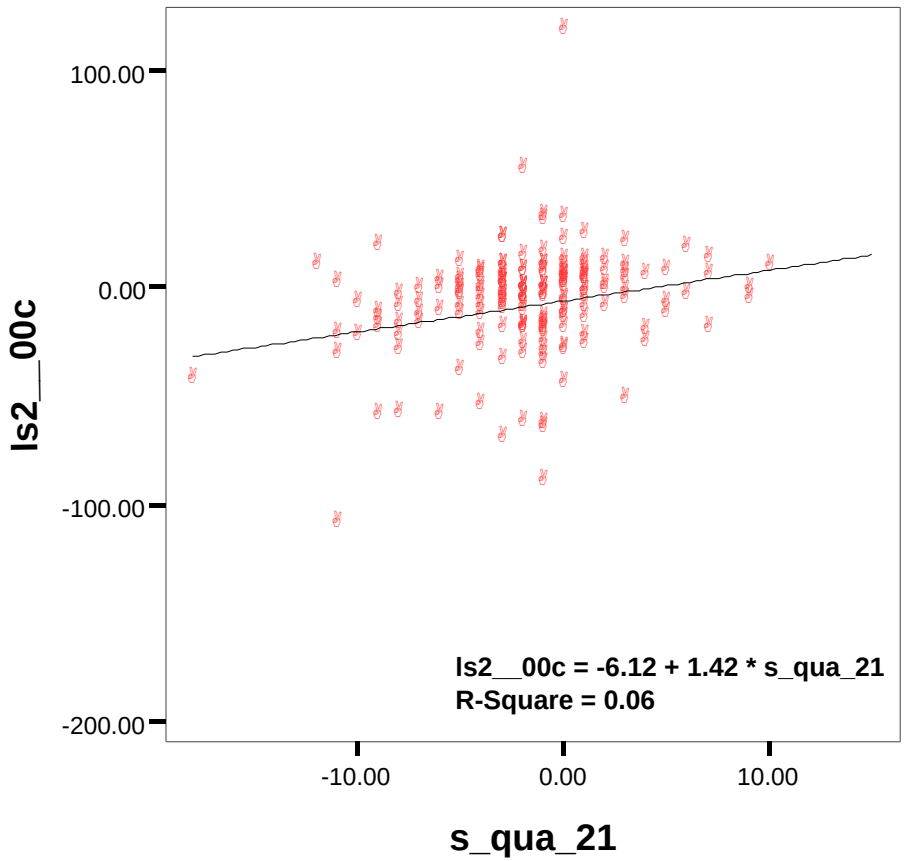


“Subjective sleep quality” versus **“Objective sleep quality”**

SSA-1

R&K

Latency to S2 (min)



“Subjective sleep quality” versus “Objective sleep quality”

SSA-1 Sleep maintenance

SLEEP QUALITY	no	slightly	moderately	very much
1. Did you sleep well ?				
2. Did you have deep sleep?				
3. Did you have difficulties in falling asleep?				
4. Did you have difficulties in staying asleep?				
5. Did you have bad dreams?				
6. Did you have difficulties getting back to sleep?				
7. Did you wake up earlier than usual?				

Subscore 1: _____

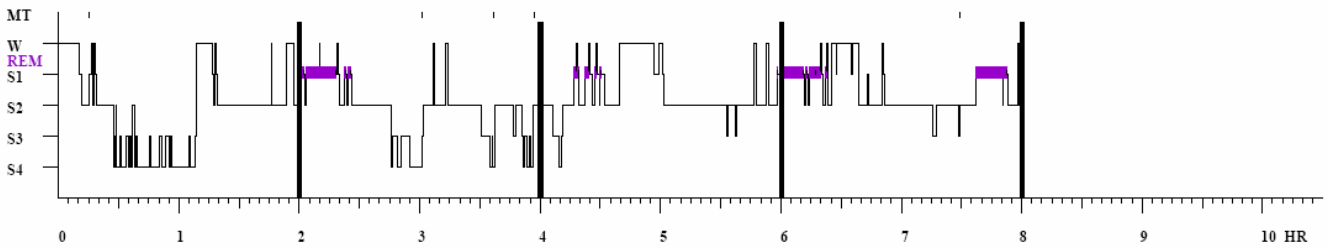
Siesta Spot Report™ **Date: Oct 31 , 2005** **Page 8 of 8**

Patient’s ID:	**637aaabe.edf**
Patient’s gender:	female
Patient’s age:	66 years
First Night:	No

Controls: SIESTA normative database

Number of controls:	31 females
Controls’ age:	66.9 ± 5.8 years

Analysis by fraction (1/4):



“Subjective sleep quality” versus **“Objective sleep quality”**

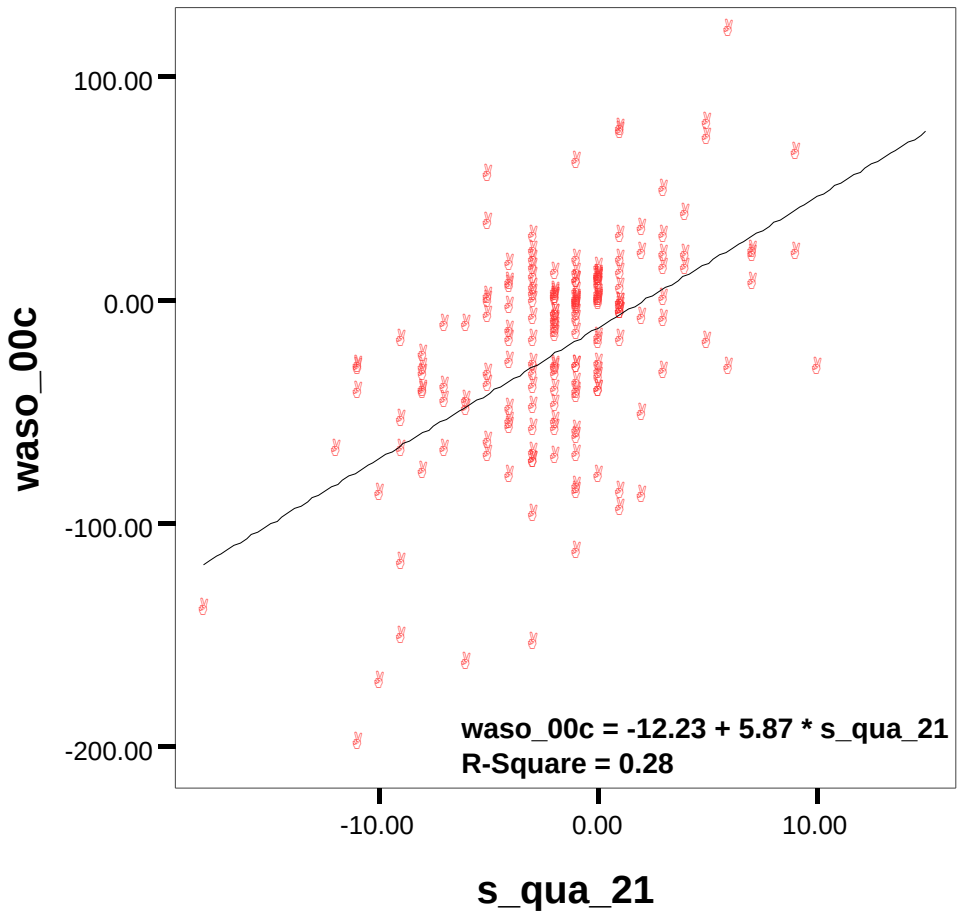
SSA-1 **R&K Sleep maintenance**

SSA-1	**Wake after sleep onset**	Wake within TSP	Wake after final awakening
r	**.528**	.505	.211
p	**.000**	.000	.005
N	**177**	177	177

“Subjective sleep quality” versus **“Objective sleep quality”**

R&K

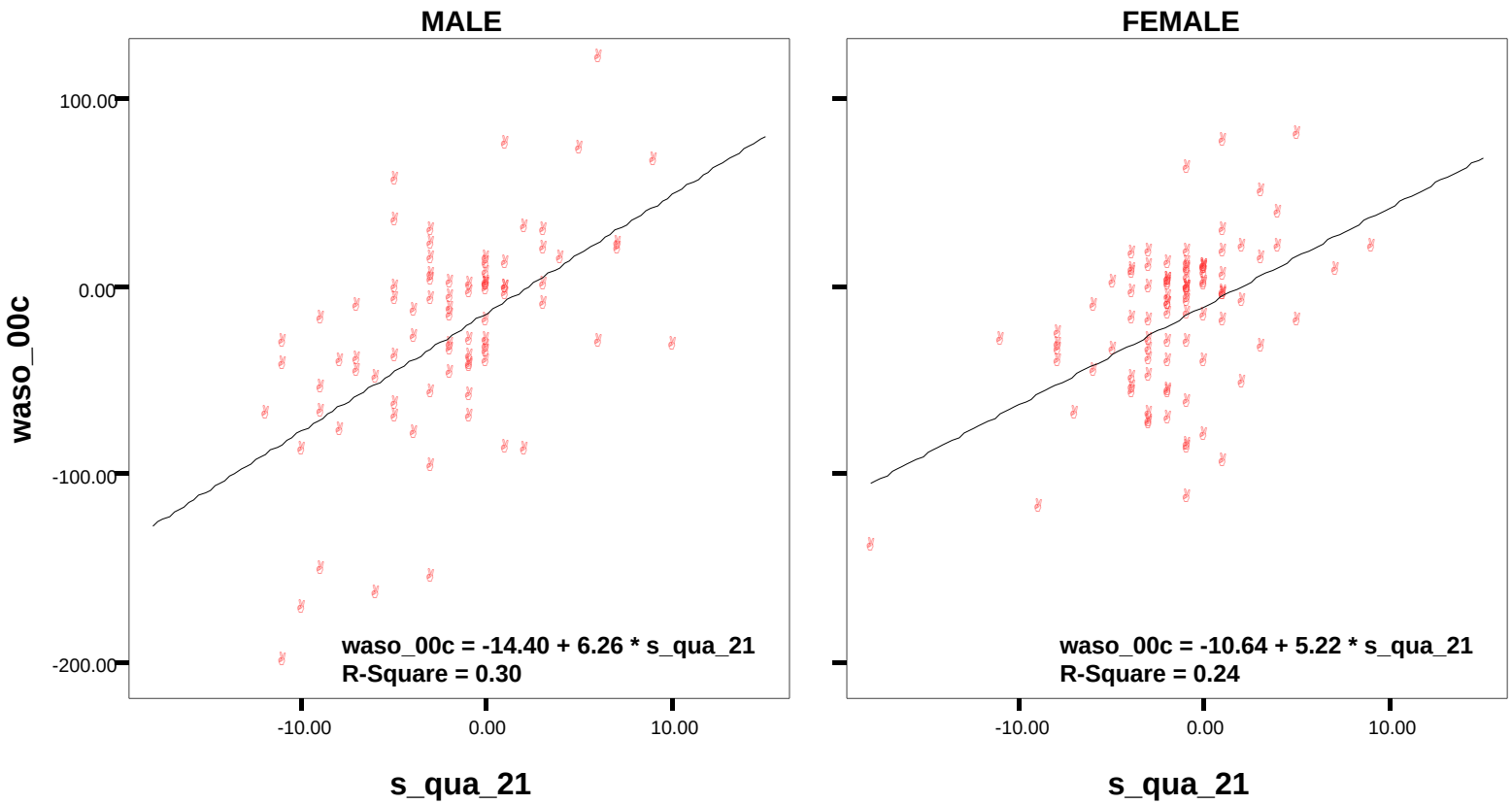
SSA-1 **Wake after sleep onset (min)**



“Subjective sleep quality” versus “Objective sleep quality”

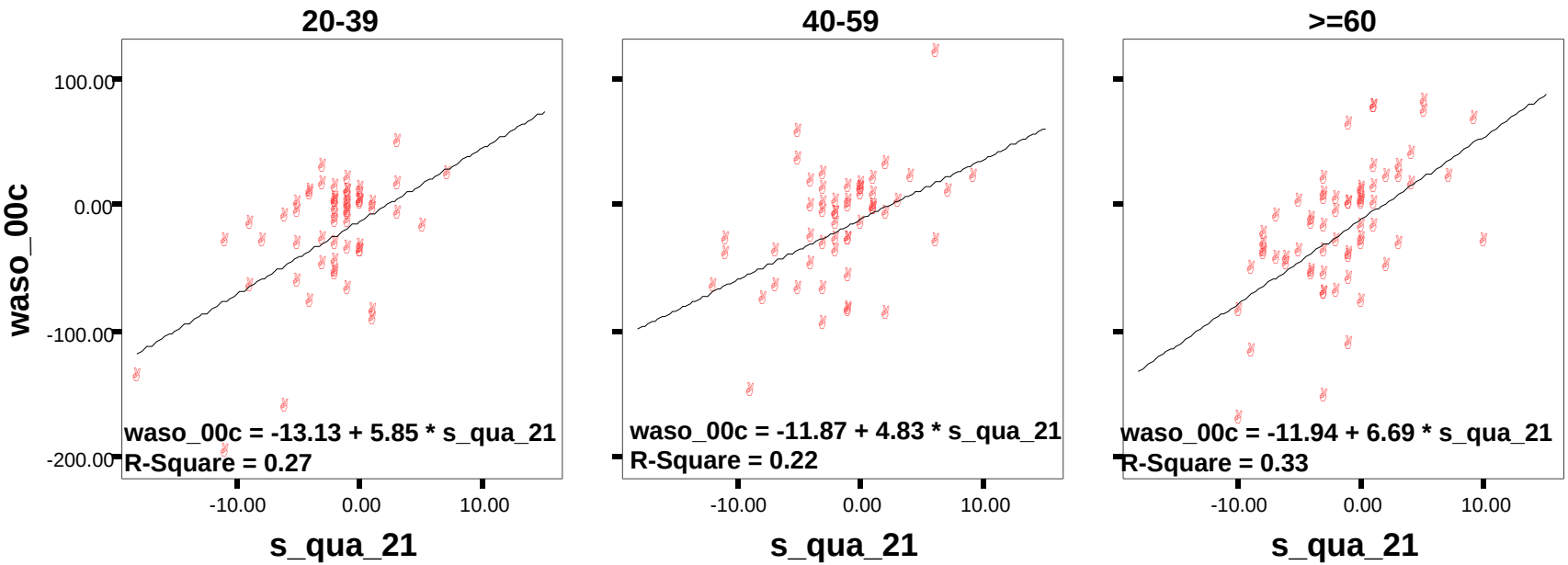
SSA-1 **R&K**

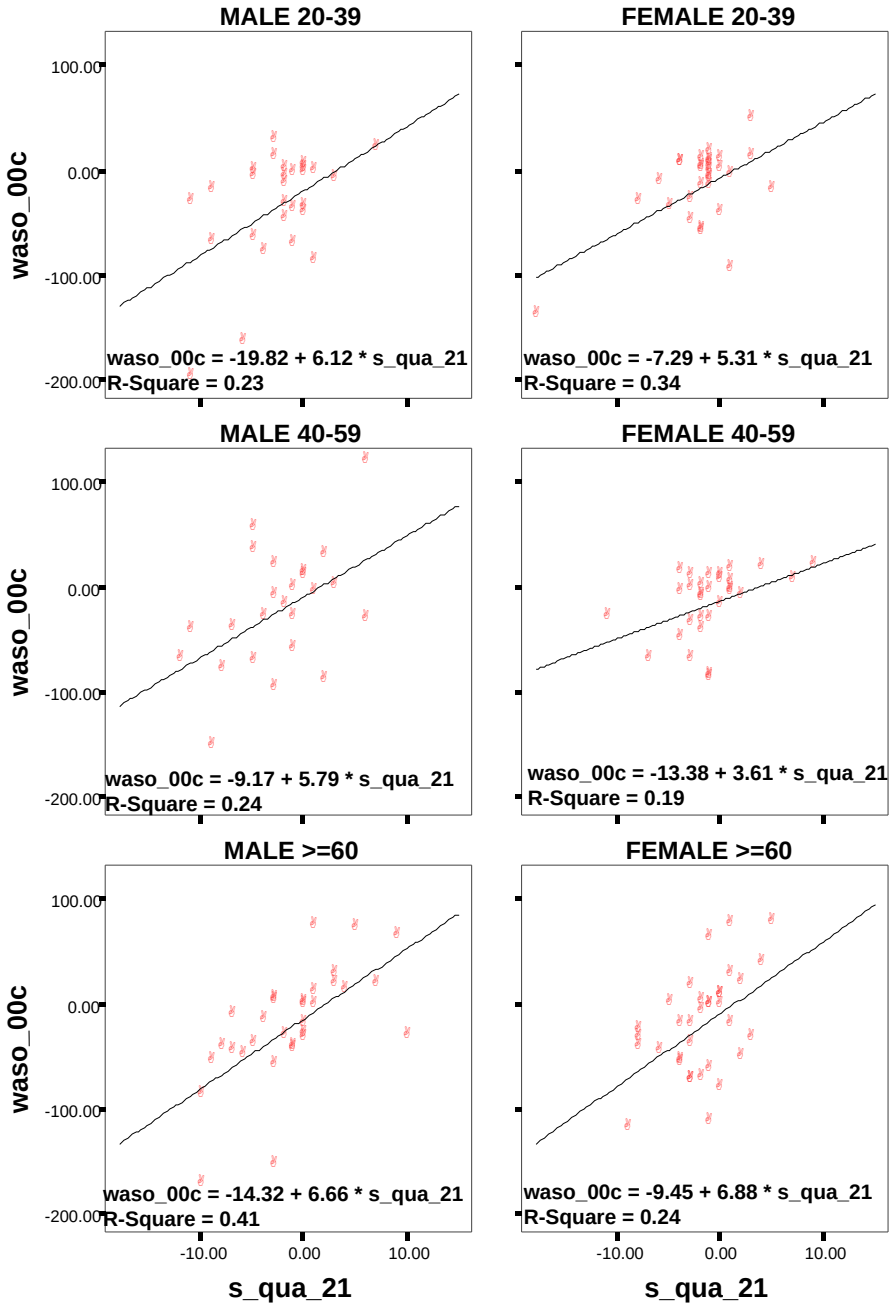
Wake after sleep onset (min)



“Subjective sleep quality” versus “Objective sleep quality”

SSA-1 **R&K Wake after sleep onset (min)**





SSA-1

versus

R&K

Wake after sleep onset (min)

“Subjective sleep quality” versus “Objective sleep quality”

SSA-1 Sleep continuity

SLEEP QUALITY	no	slightly	moderately	very much
1. Did you sleep well ?				
2. Did you have deep sleep?				
3. Did you have difficulties in falling asleep?				
4. Did you have difficulties in staying asleep?				
5. Did you have bad dreams?				
6. Did you have difficulties getting back to sleep?				
7. Did you wake up earlier than usual?				

Subscore 1: _____

Siesta Spot Report™ **Date: Oct 31 , 2005** **Page 8 of 8**

Patient’s ID:	**637aaabe.edf**
Patient’s gender:	female
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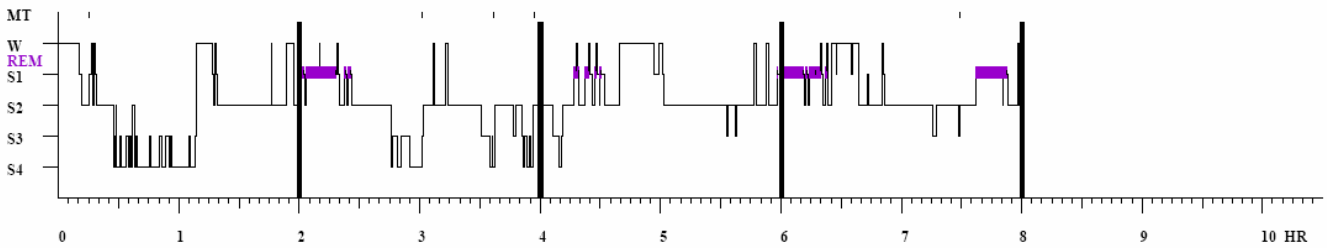


“Subjective sleep quality” versus **“Objective sleep quality”**

R&K - ASDA

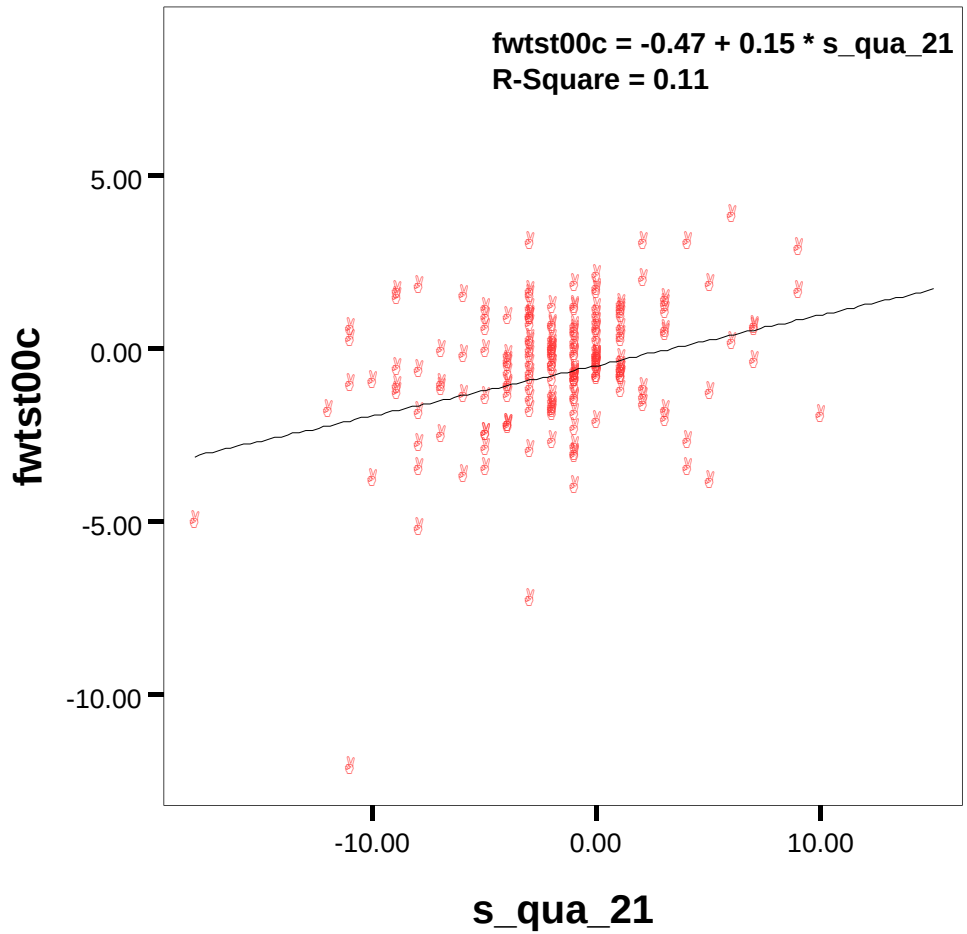
SSA-1 **Sleep continuity**

SSA-1	Number of awakenings	**Number of awakenings per hr**	Number of stage shifts	Number of stage shifts per hr	Number of arousals per hr
r	.200	**.328**	-.118	.186	.007
p	.006	**.000**	.118	.013	.931
N	177	**177**	177	177	.169

“Subjective sleep quality” versus **“Objective sleep quality”**

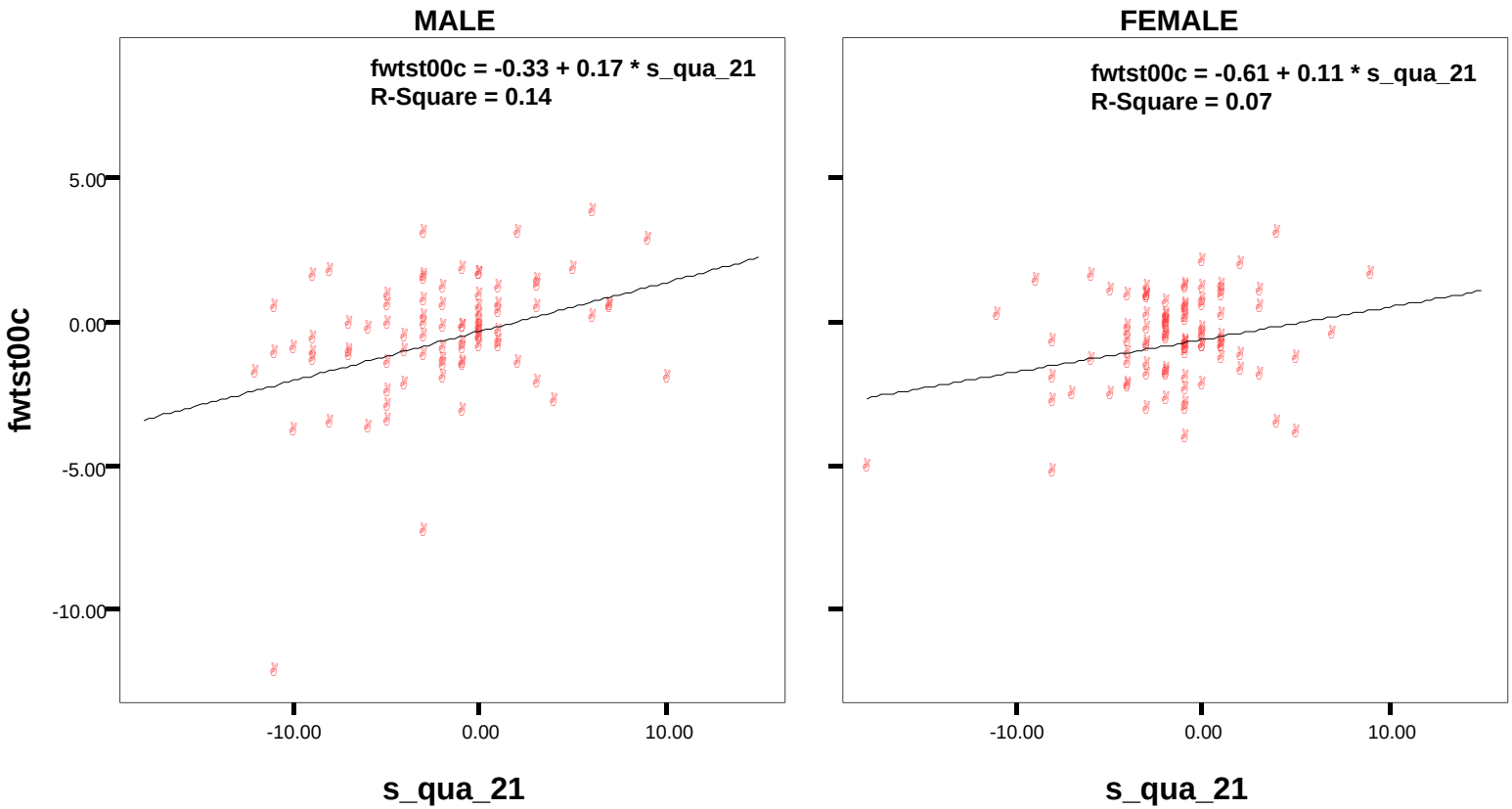
R&K

SSA-1 **Number of awakenings (/hr TST)**



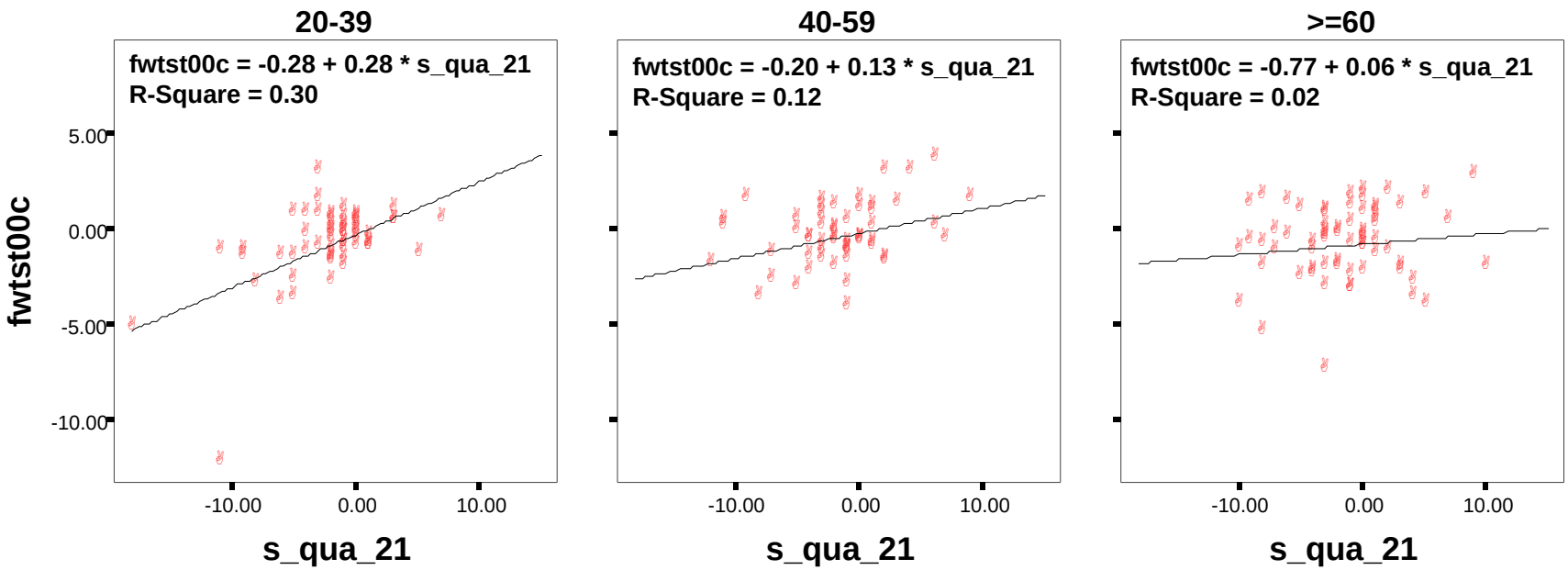
“Subjective sleep quality” versus “Objective sleep quality”

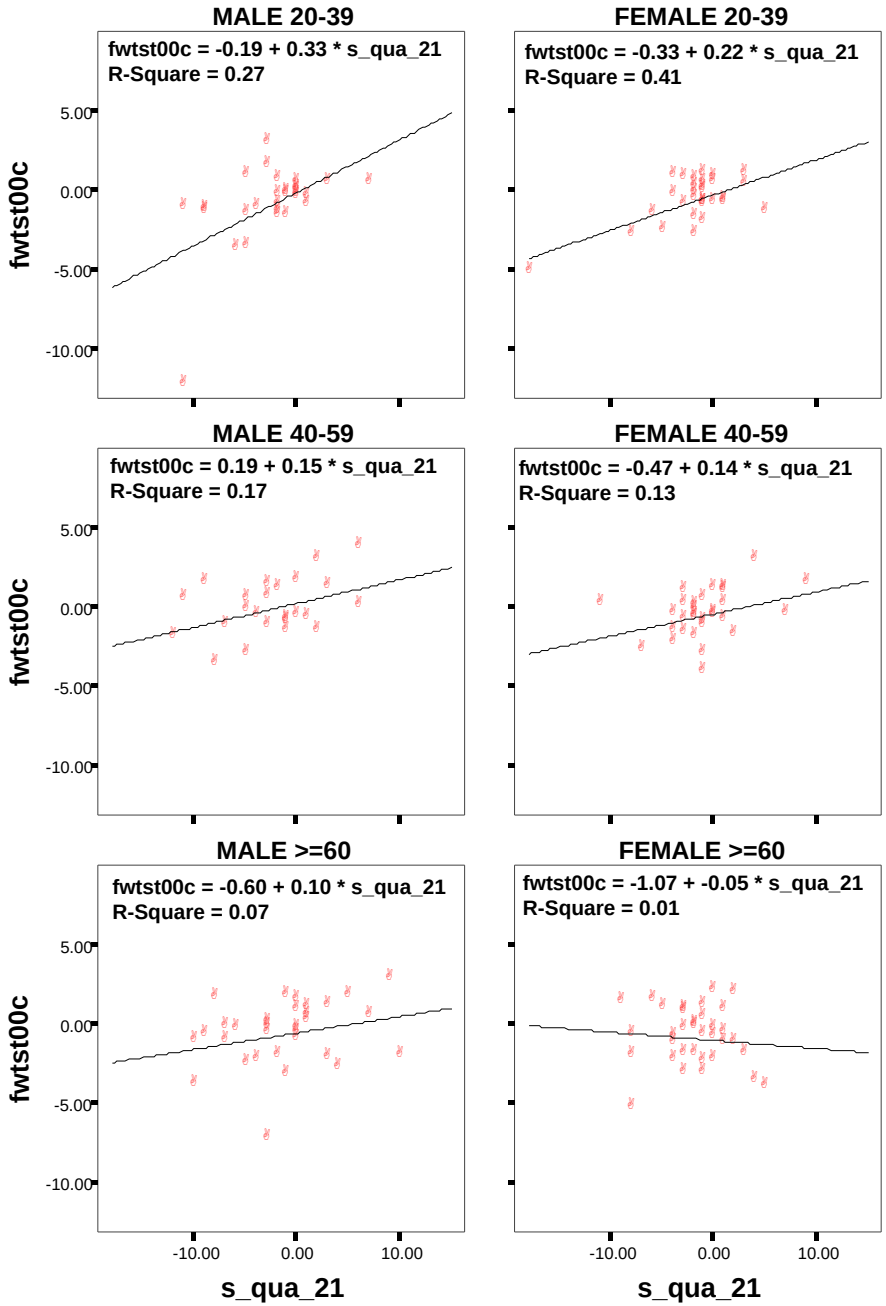
SSA-1 **R&K Number of awakenings (/hr TST)**



“Subjective sleep quality” versus “Objective sleep quality”

SSA-1 **R&K Number of awakenings (/hr TST)**





SSA-1

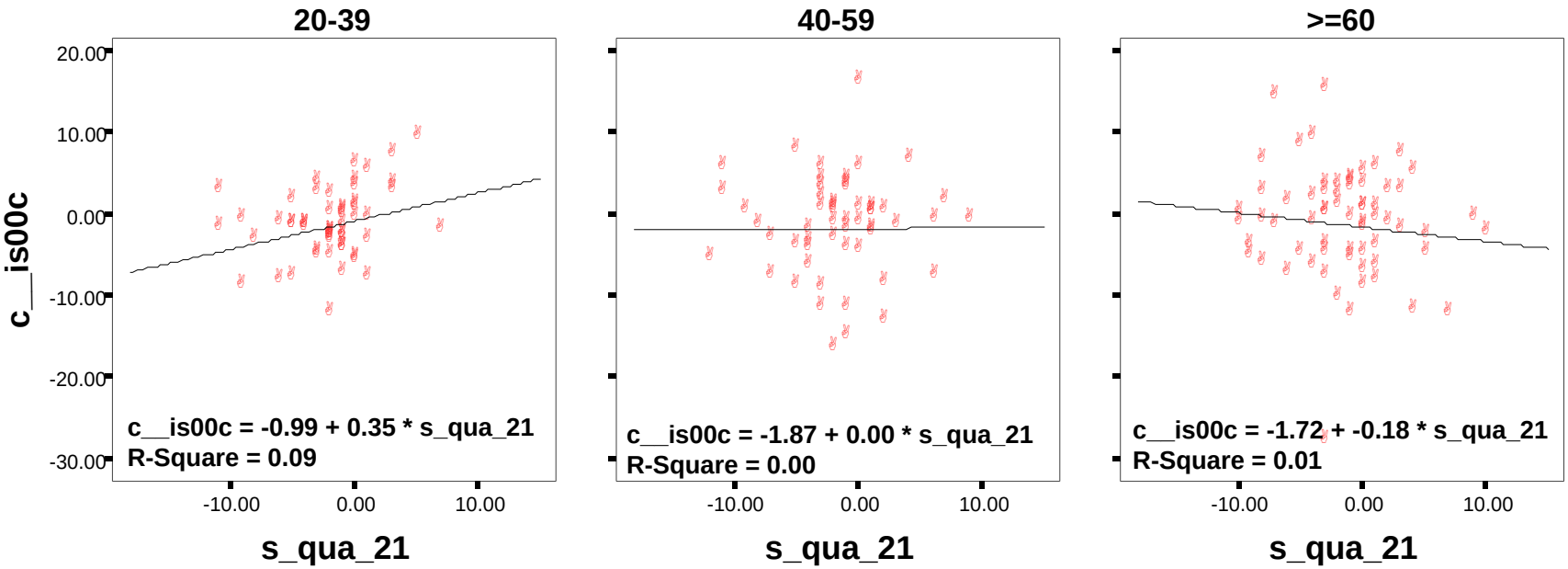
versus

R&K Number of awakenings (/hr TST)

“Subjective sleep quality” versus “Objective sleep quality”

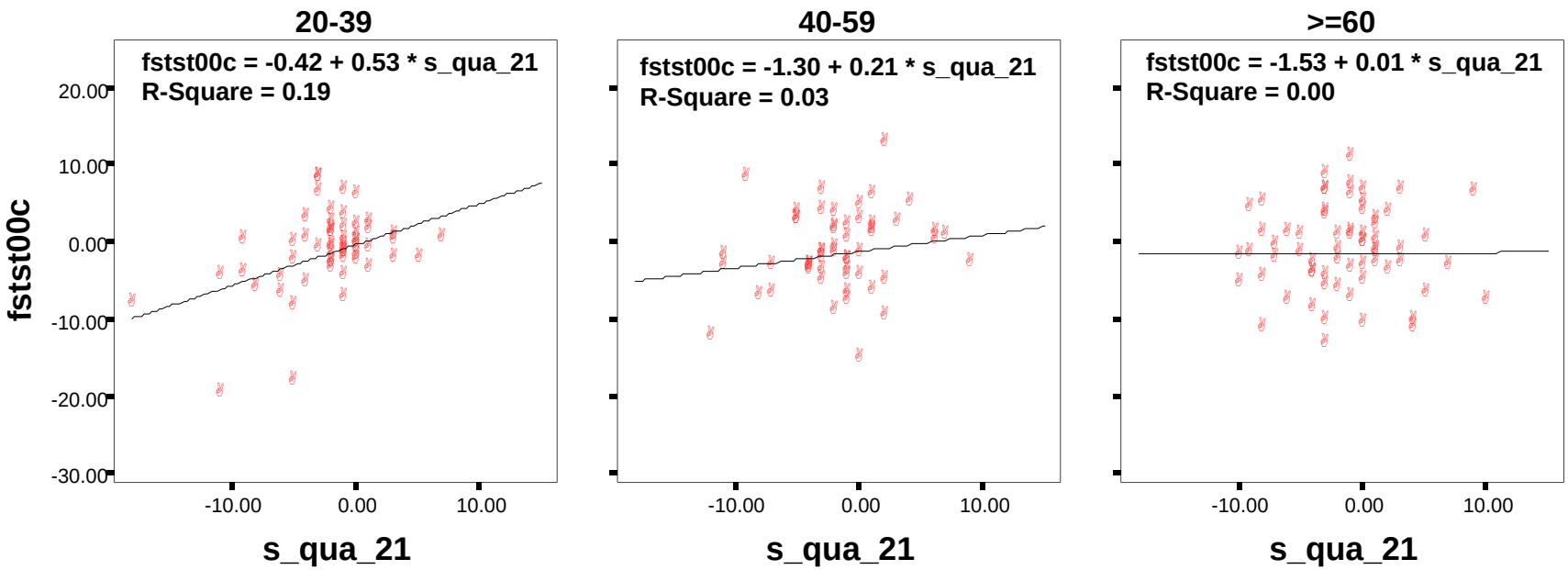
SSA-1 **ASDA**

Number of arousals (/hr TST)



“Subjective sleep quality” versus “Objective sleep quality”

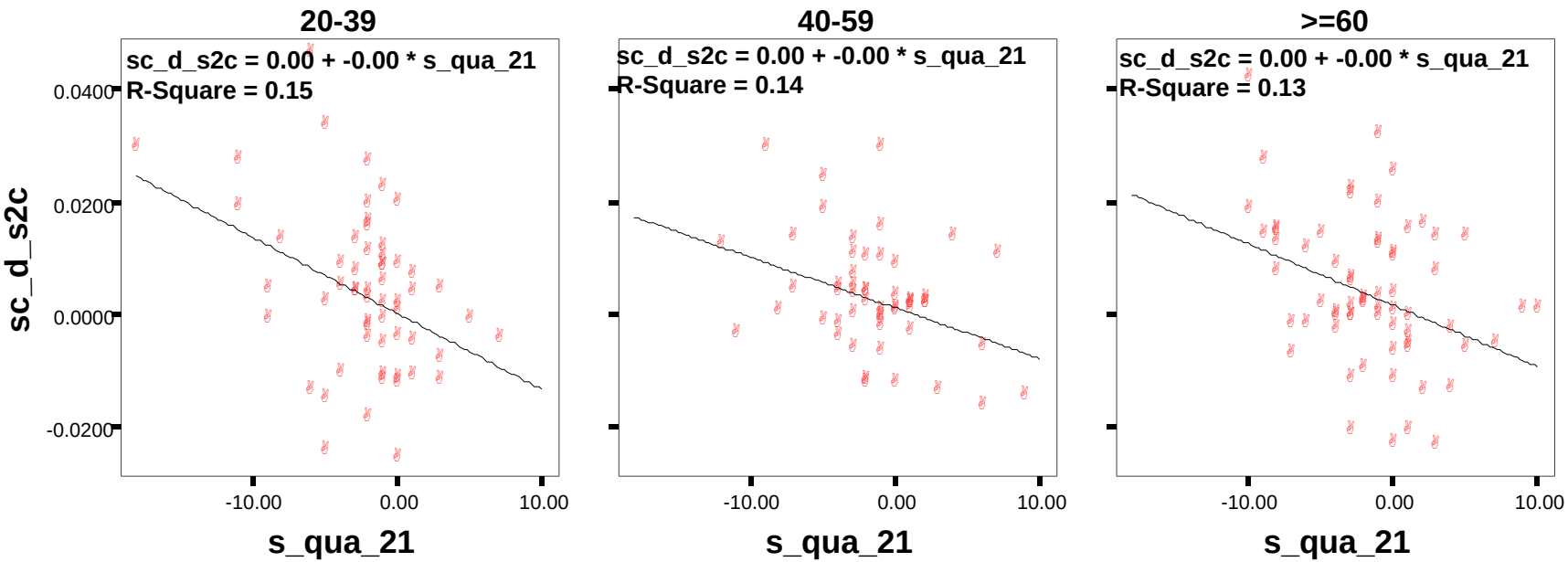
SSA-1 **R&K Number of stage shifts (/hr TST)**



“Subjective sleep quality” versus “Objective sleep quality”

hGMM

SSA-1 Number of stage shifts “deep – S2”

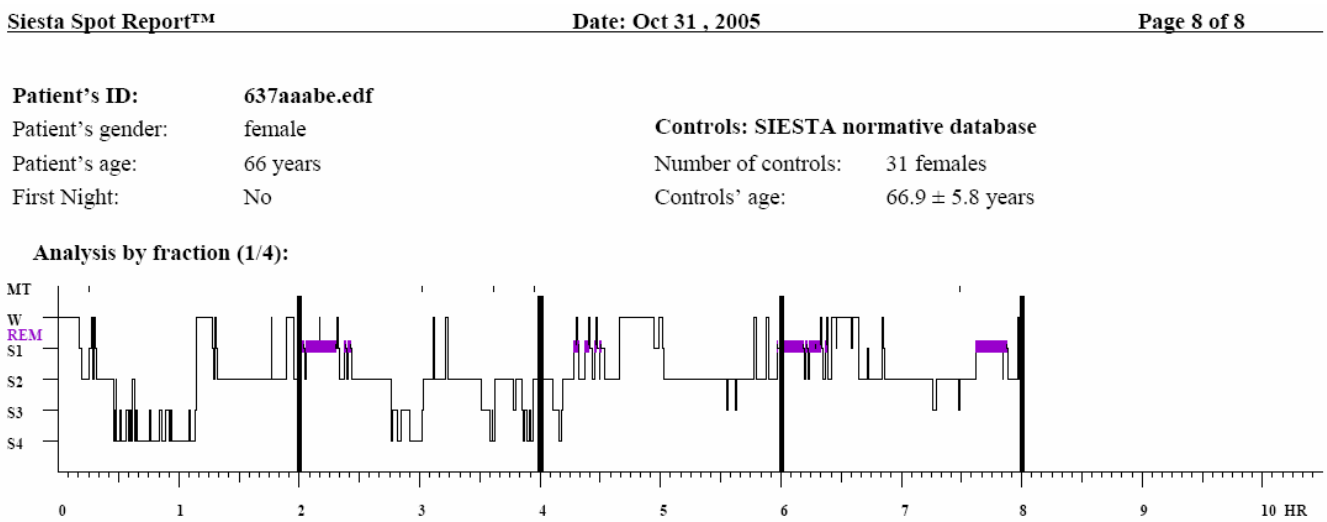


“Subjective sleep quality” versus “Objective sleep quality”

SSA-1 Sleep architecture

SLEEP QUALITY	no	slightly	moderately	very much
1. Did you sleep well ?				
2. Did you have deep sleep?				
3. Did you have difficulties in falling asleep?				
4. Did you have difficulties in staying asleep?				
5. Did you have bad dreams?				
6. Did you have difficulties getting back to sleep?				
7. Did you wake up earlier than usual?				

Subscore 1: _____



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Patient’s ID: **637aaabe.edf**
Patient’s gender: female
Patient’s age: 66 years
First Night: No

Controls: SIESTA normative database
Number of controls: 31 females
Controls’ age: 66.9 ± 5.8 years

Analysis by fraction (1/4):

“Subjective sleep quality” versus **“Objective sleep quality”**

SSA-1 **R&K Sleep architecture**

	Total Night – Stage in % of TST			
SSA-1	**S1**	S2	SWS	REM
r	**.327**	-.126	-.036	-.097
p	**.000**	.096	.631	.200
N	**177**	177	177	177

“Subjective sleep quality” versus **“Objective sleep quality”**

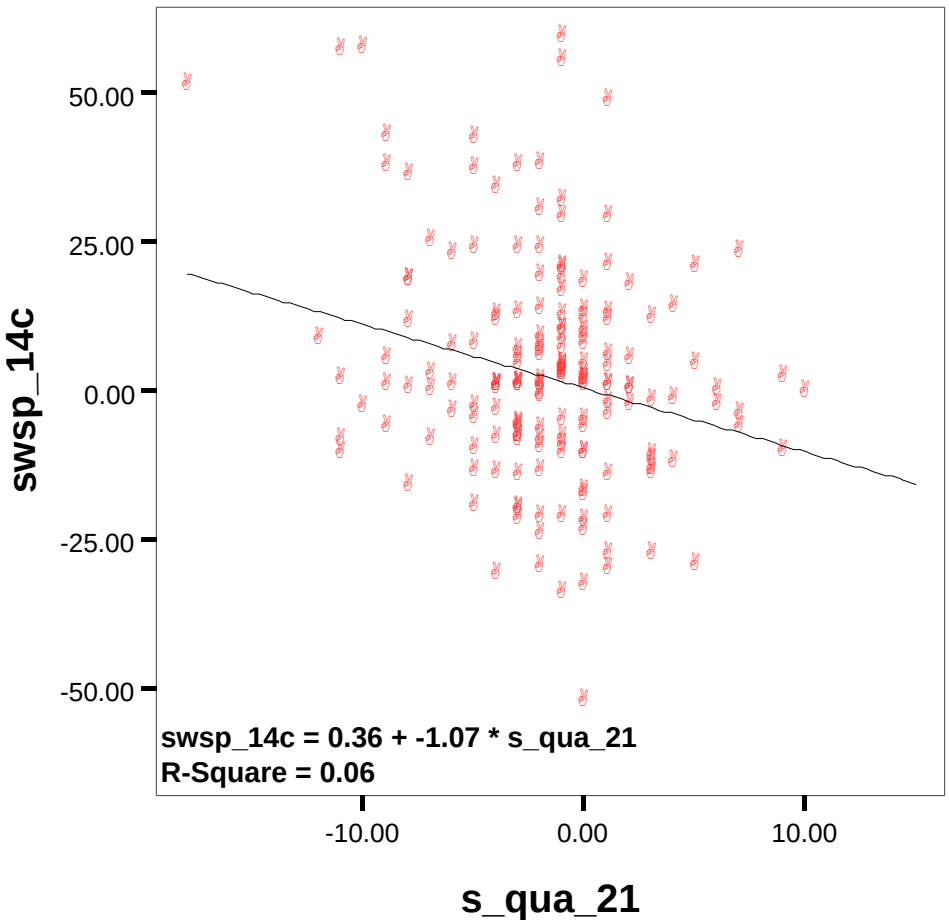
SSA-1 **R&K Sleep architecture**

	1st Quarter of the Night – Stage in % of TST			
SSA-1	S1	S2	**SWS**	REM
r	.284	-.030	**-.240**	-.071
p	.000	.688	**.001**	.350
N	177	177	**177**	177

“Subjective sleep quality” versus **“Objective sleep quality”**

R&K: 1st quarter of the night

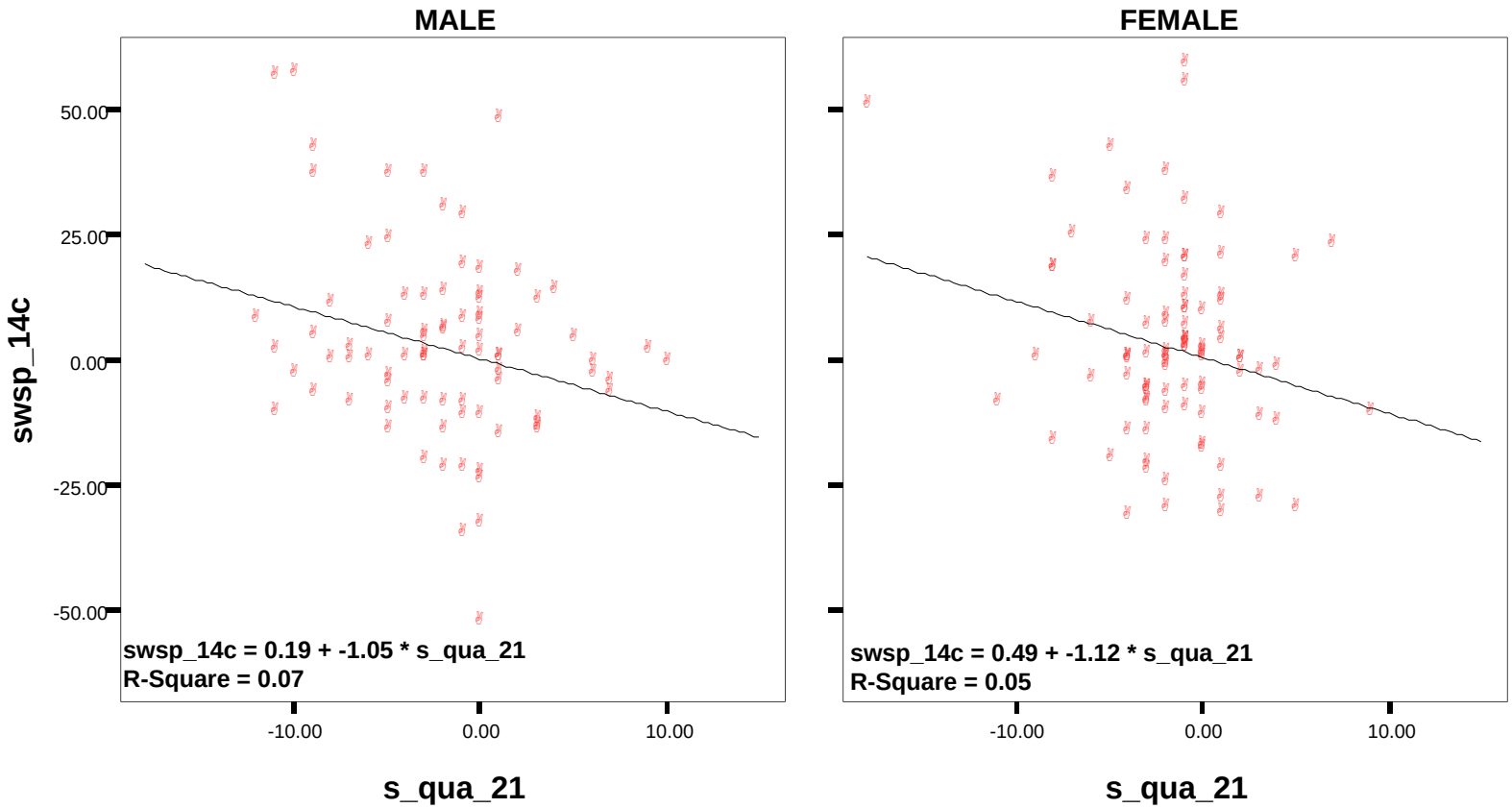
SSA-1 **Slow-wave sleep (% TST)**



“Subjective sleep quality” versus **“Objective sleep quality”**

R&K: 1st quarter of the night

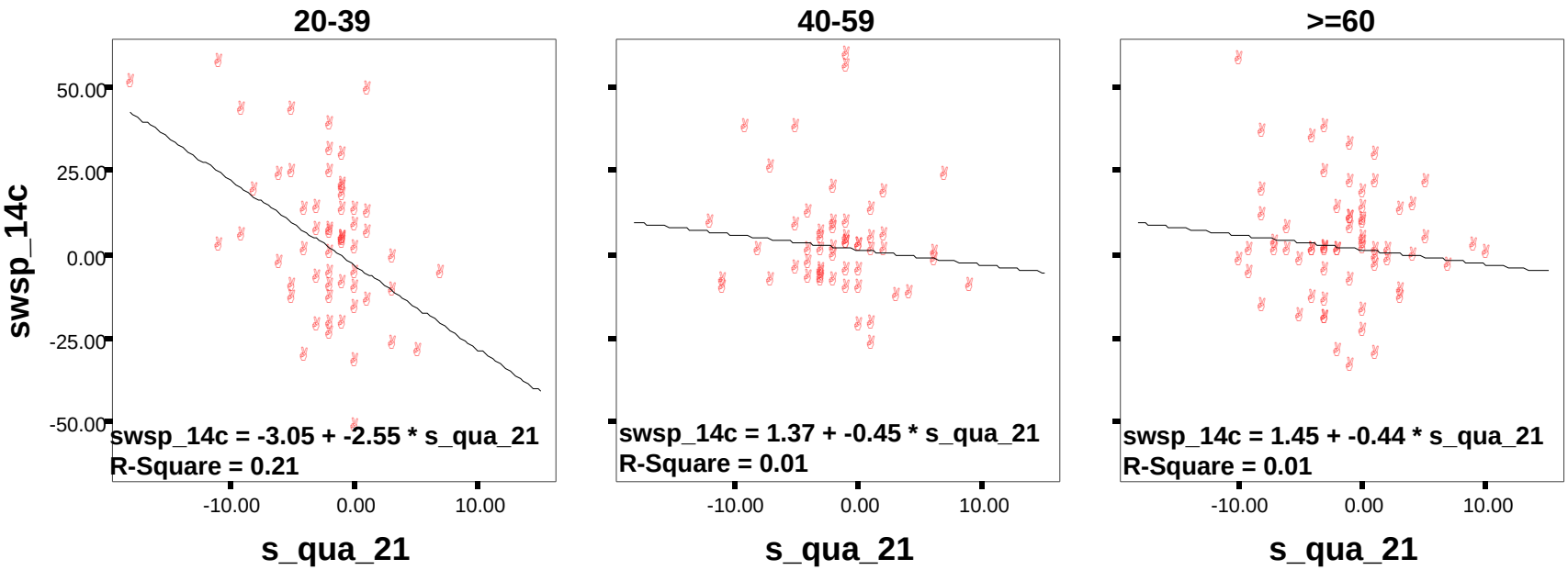
SSA-1 **Slow-wave sleep (% TST)**

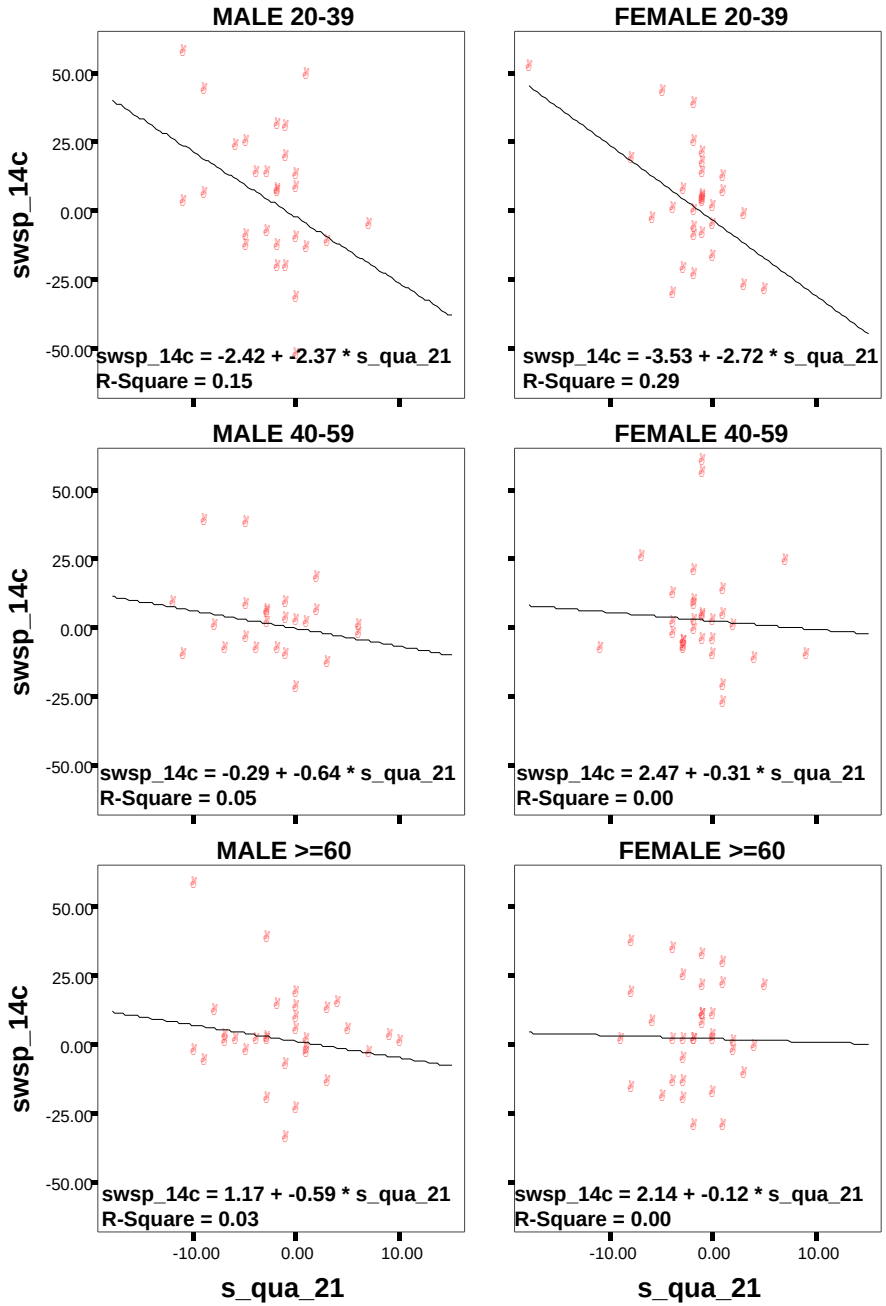


“Subjective sleep quality” versus **“Objective sleep quality”**

R&K: 1st quarter of the night

SSA-1 **Slow-wave sleep (% TST)**





SSA-1

versus

R&K SWS 1st quarter (% TST_1)

“Subjective sleep quality” versus **“Objective sleep quality”**

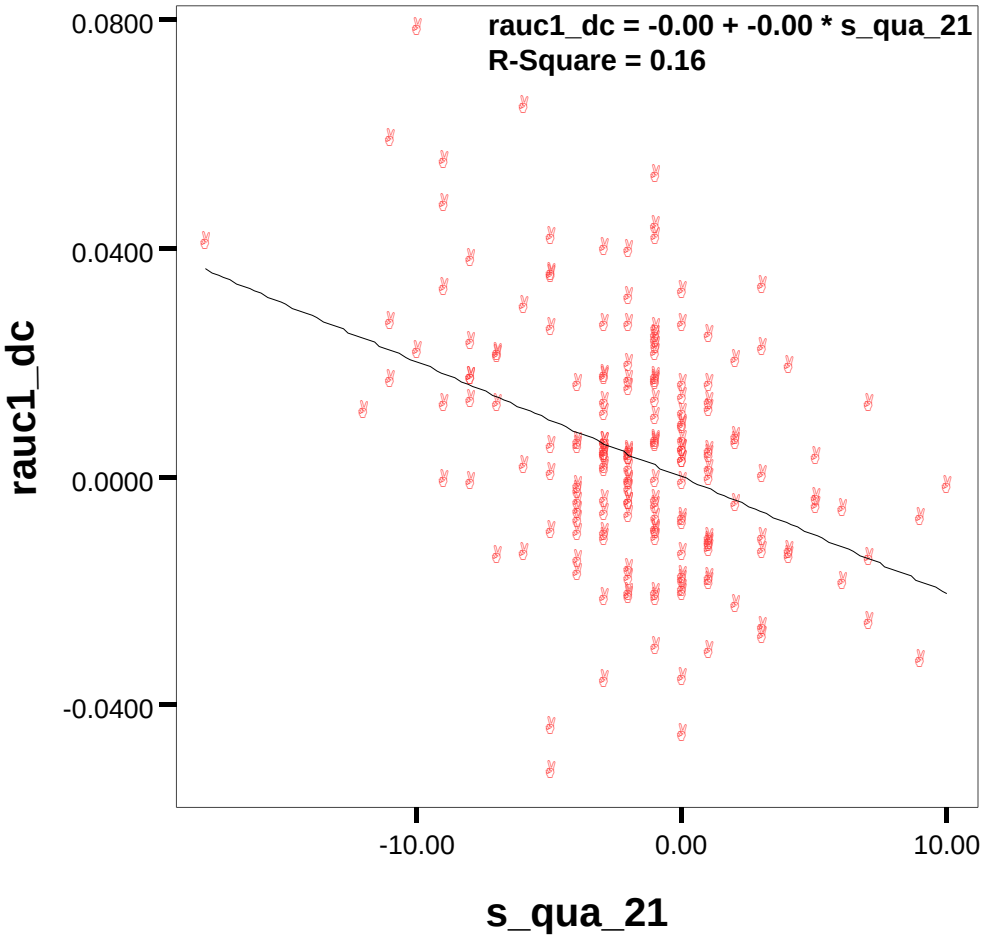
hGMM

SSA-1 **Sleep architecture**

	Total Night – AUC in % of TSP			
SSA-1	rAUC-S1	rAUC-S2	rAUC-Deep	**rAUC1-Deep**
r	0.321	-0.312	-.289	**-.396**
p	000	000	.000	**.000**
N	176	176	176	**176**

“Subjective sleep quality” versus **“Objective sleep quality”**

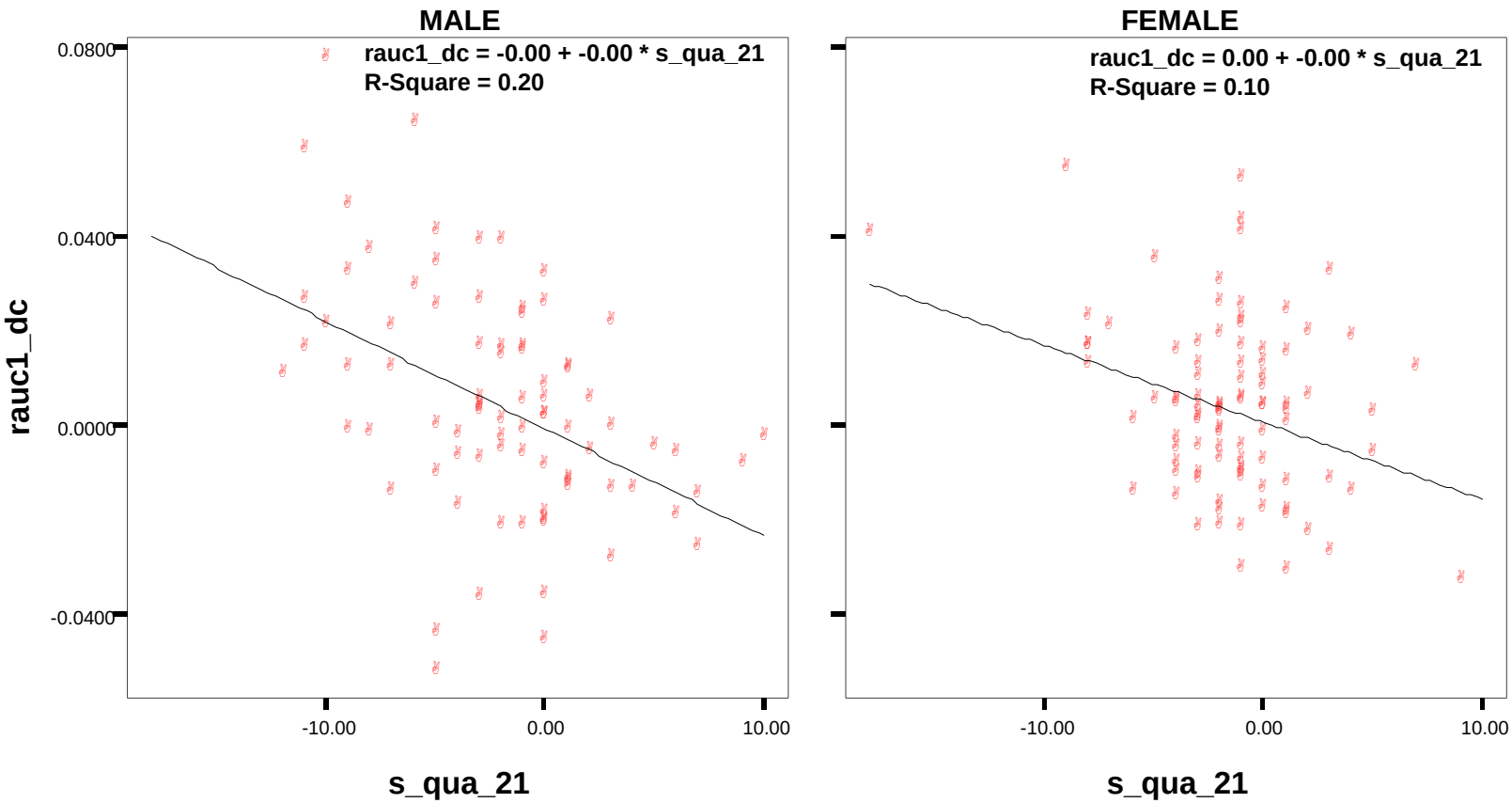
SSA-1 **hGMM rAUC 1st derivative deep (% TSP)**



“Subjective sleep quality” versus “Objective sleep quality”

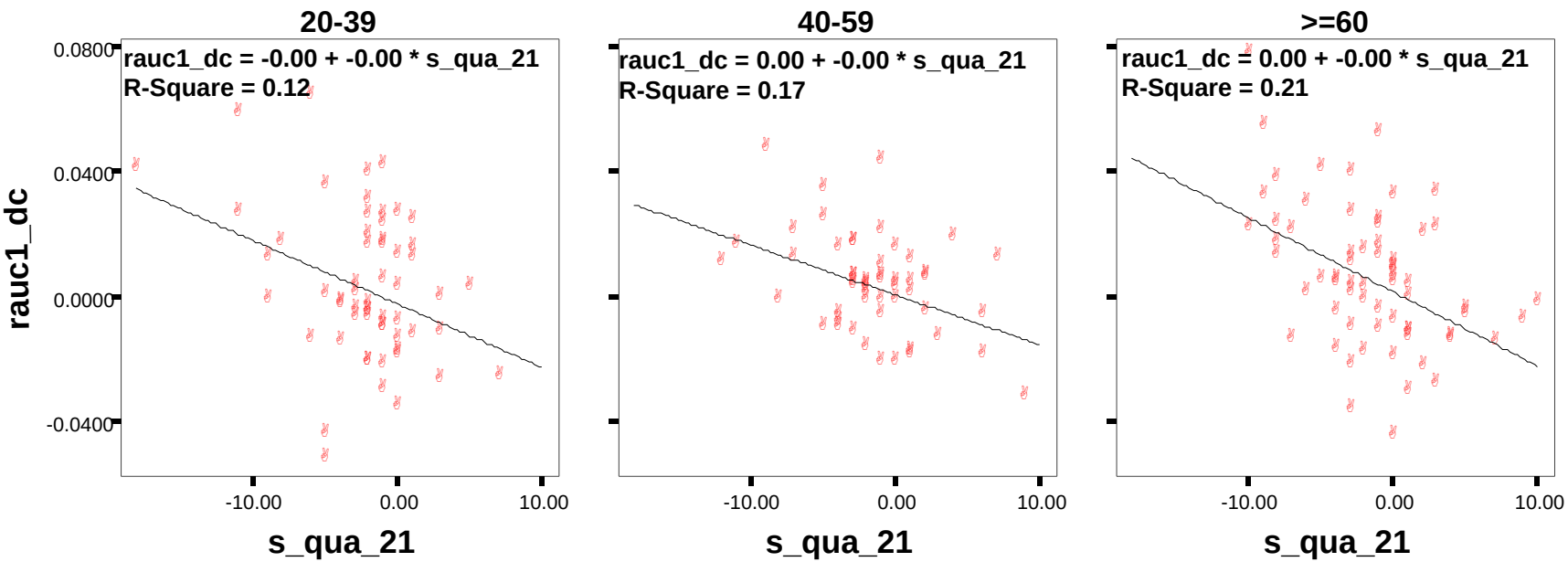
hGMM

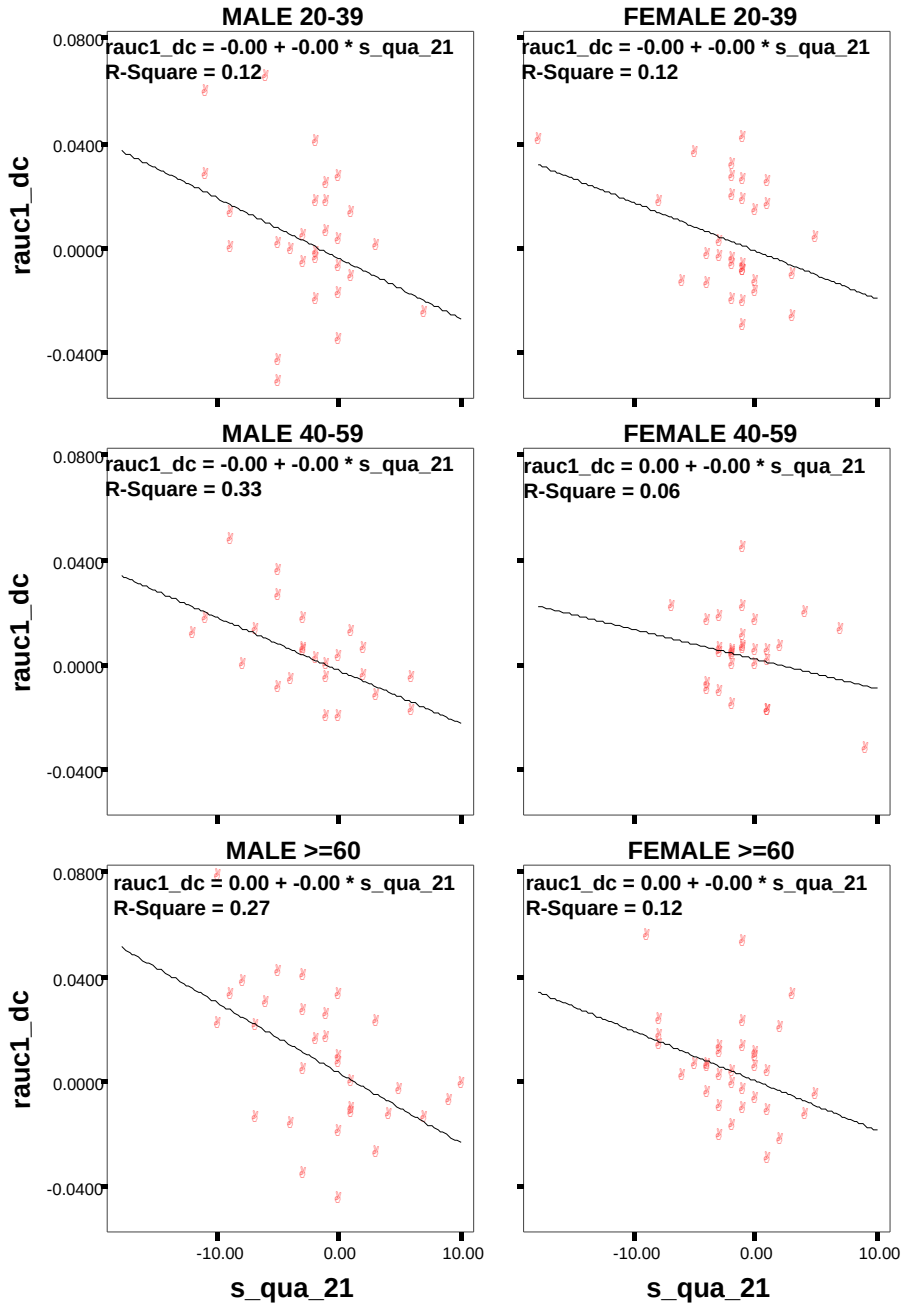
SSA-1 **rAUC 1st derivative deep (% TSP)**



“Subjective sleep quality” versus **“Objective sleep quality”**

SSA-1 **hGMM rAUC 1st derivative deep (% TSP)**





SSA-1

versus

hGMM
rAUC 1st deriv.
deep (% TSP)

“Subjective sleep quality” versus **“Objective sleep quality”**

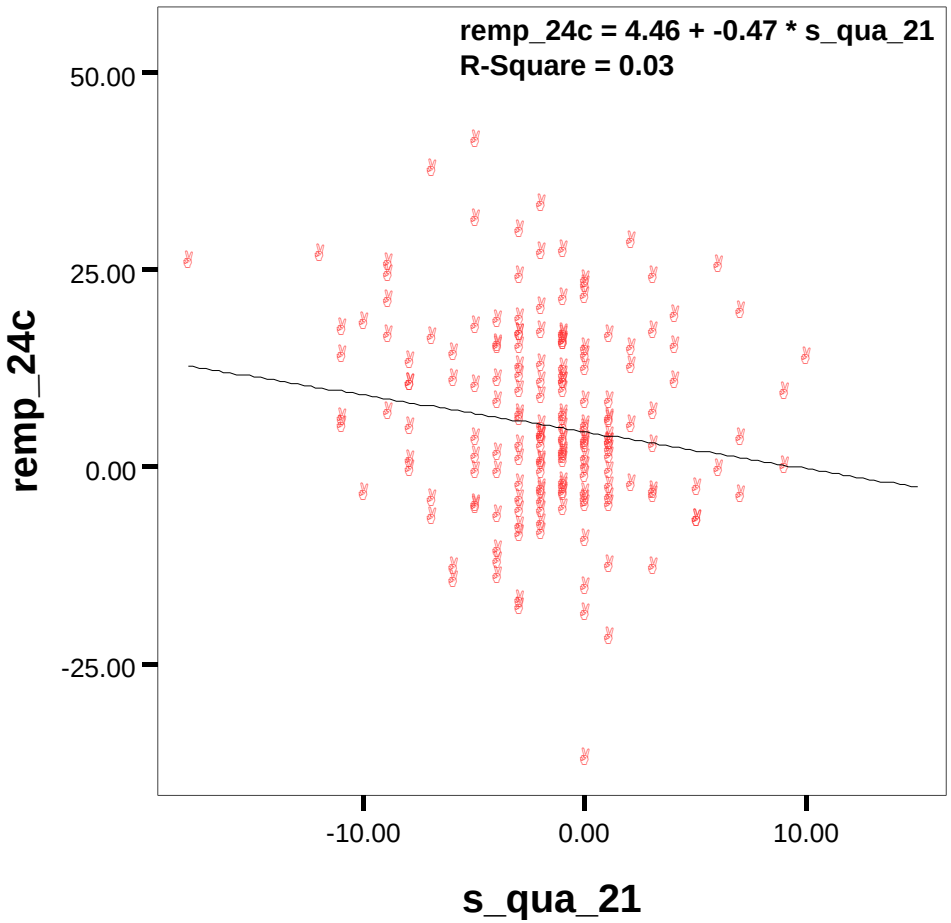
SSA-1 **R&K Sleep architecture**

	2nd Quarter of the Night – Stage in % of TST			
SSA-1	S1	S2	SWS	**REM**
r	.303	-.087	-.004	**-.162**
p	.000	.252	.955	**.031**
N	177	177	177	**177**

“Subjective sleep quality” versus **“Objective sleep quality”**

R&K: 2nd quarter of the night

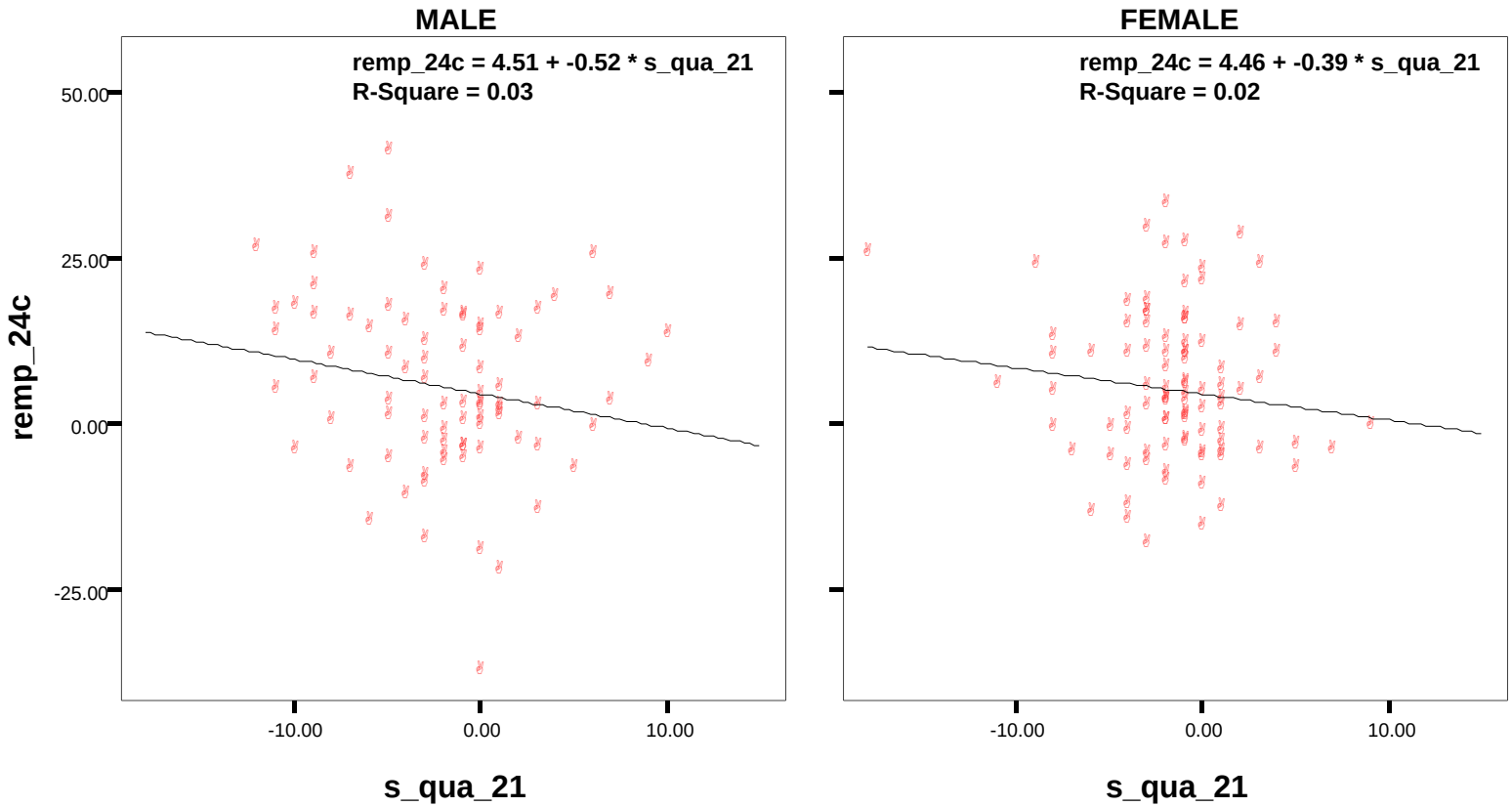
SSA-1 **REM sleep (% TST)**



“Subjective sleep quality” versus **“Objective sleep quality”**

R&K: 2nd quarter of the night

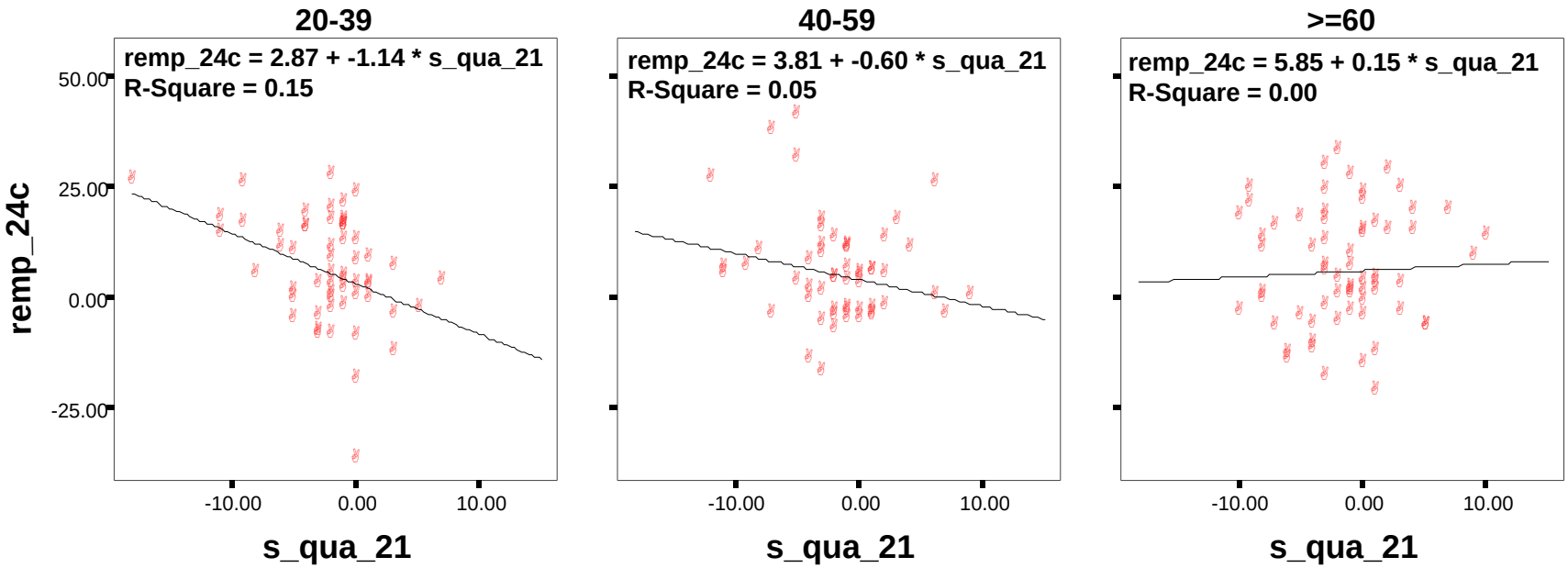
SSA-1 **REM sleep (% TST)**

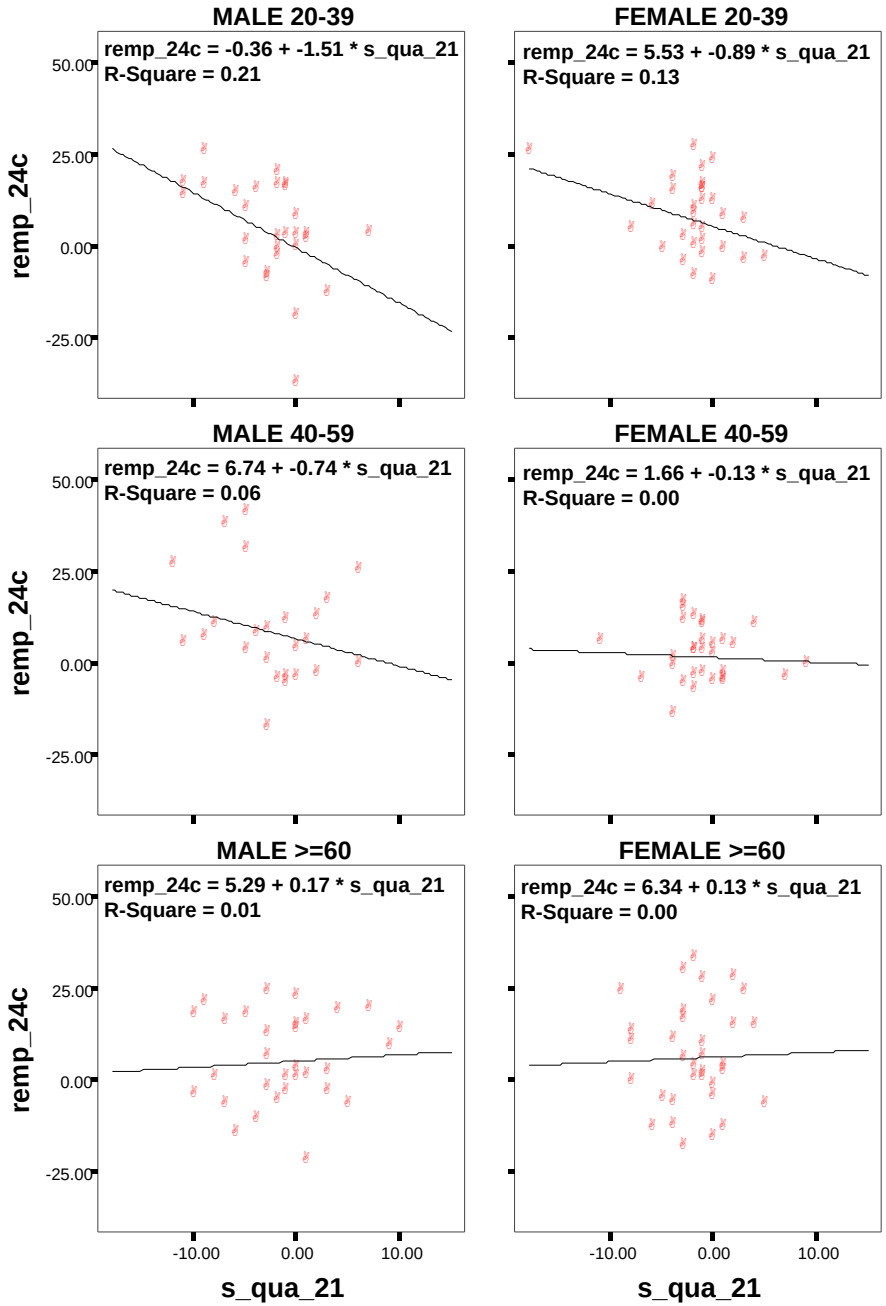


“Subjective sleep quality” versus **“Objective sleep quality”**

R&K: 2nd quarter of the night

SSA-1 **REM sleep (% TST)**





SSA-1

versus

R&K REM 2nd quarter (% TST_2)

“Subjective sleep quality” versus **“Objective sleep quality”**

CONCULSION – I

Even in “good” sleepers, the ***adaptation night*** introduced sufficient variance in sleep quality for a meaningful analysis.

Correlation analysis based on ***change values*** (2^{nd} – 1^{st} PSG night) reduced the problem of interindividual differences in handling rating scales and sleep habits.

Sleep efficiency based on R&K and hGMM explains approximately 25% of the observed variance in subjective sleep quality, independent of subjects’ sex and age.

“Subjective sleep quality” versus **“Objective sleep quality”**

CONCULSION – II

Measures for ***sleep continuity and architecture*** based on R&K showed significant correlations with subjective sleep quality only in young subjects.

In contrast, measures for ***sleep continuity and architecture*** based on hGMM showed significant correlations in all age-groups by exploiting the ***high temporal resolution*** (number of stage shifts) and by utilizing ***amplitude-independent*** measures (deep sleep).

Thus, the new continuous probabilistic ***hierarchical Gaussian Mixture Model*** (hGMM) provides additional complementary sleep characteristics.