A Prospective Exploration of the Relationship Between Objectively Measured Sleep and Fatigue in People with Early Rheumatoid Arthritis

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BACKGROUND

In people with RA, self-reported sleep disturbance is mildly correlated with fatigue[1,2]. People, however, tend to overestimate their sleep quality in self reports as compared to Polysomnography (PSG)[3-5] measurement, which is the gold standard done in a laboratory setting[6].To our knowledge, no study has yet examined the relationship between objectively measured sleep quality and fatigue experienced by people with RA in their usual living environment.

PURPOSE

To explore the relationship between self-reported fatigue and sleep in individuals with early rheumatoid arthritis (RA), taking into account potential moderating effects of demographics, presence of joint inflammation, and self-reported functional limitation.

METHODS

Study Design and Participants

- Prospective longitudinal (1-year) cohort study
- 30 individuals diagnosed with RA in previous 12-months at baseline; 26 completed the study (4 withdrawals).

Evaluations @ Baseline & 12 Months

- Self-reported Measures: Multidimensional Assessment of Fatigue (MAF), Modified Health Assessment Questionnaire (mHAQ)
- Physical Evaluation: 28-Tender & Swollen (T&S) Joint Count
- Activity Motion Sensor: SenseWear™ (SW) monitors
- Valid and reliable tools for objective sleep measurement in real-world settings[7-9]
- Participants wore the SW for 7-Days on their non-dominant arm (off for water activities only)

  Sleep Outcomes:
  - Quantity: Total Sleep Time (TST)
  - Quality: Sleep Efficiency (SE; TST/ Lying Down Time)

Statistical Analysis

- Pearson's Correlation: Assessing individual association between MAF Global Fatigue Index (GFI) and Sleep (Quality / Quantity), Disease Activity (28-T&S Joints, mHAQ) and Personal Demographics (Age)
- Multiple Regression
  - Forced Hierarchical Entry: 1) Demographics (Age) 2) Disease Status (28-T&S) 3) Sleep Metrics (TST, SE)
  - Variables excluded for collinearity and weak correlations

DISCUSSION

- Higher levels of fatigue were predicted by presence of joint inflammation, younger age, and objective measures of disturbed sleep in individuals living with early RA
- After accounting for the stronger predictors, self-reported functional limitation was not found to be a predictor of fatigue
- Disease activity was not associated with age, so higher fatigue levels among younger participants may not be explained by more disease activity
- Strength of the prediction model weakened at 12 months, which may be explained in part by lower disease activity at 12 months

RESULTS

Figure 1: Predictors of Fatigue

Note: Figure 1 represents the proportions of the unique variance in fatigue accounted for by each variable (semipartial correlation squared), at baseline.

Participant Characteristics

Table 1: Rheumatoid Arthritis (RA) Participant Characteristics

Domain	Parameter	RA Baseline (n=30)	RA 12-Months (n=26)
Demographics	Age [mean (SD)]	53.3 (13.7)	n/a
	Sex	80% female	85% female
28-Tender & Swollen Joint Count	Number with at least one Tender & Swollen Joint (T&S Joints) [n (%)]	21 (70.0)	11 (42.3)
Stanford mHAQ	Disability Index - 0 to 3 [mean (SD)]	0.59 (0.60)	0.48 (0.66)
	Pain Visual Analog Scale (VAS): 0-100 [mean (SD)]	21.2 (16.4)	20.4 (23.3)
	Global Functioning VAS: 0-100 [mean (SD)]	23.7 (18.8)	18.2 (21.7)
Fatigue	Global Fatigue Index: 0-50 [mean (SD)]	21.56 (10.73)	19.61 (15.19)
Sleep	Sleep Efficiency (SE): 0-100% [mean (SD)]	84 (6)	85 (7)
	Total Sleep Time (TST [minutes]) [mean (SD)]	433 (58)	429 (65)

Correlation and Regression

Bivariate Correlation (Table 2)

- Fatigue associated with younger age, presence of tender & swollen joints, and worse sleep efficiency at baseline. Only age remained significantly correlated at 12-months (Table 2)
- mHAQ-Disability Index not correlated with fatigue (r = 0.233, p = 0.252)
- Age not correlated with 28-T&S (r = -0.077, p = 0.685) or mHAQ-Disability Index: (r = -0.009, p = 0.962)

Table 2: Correlations with Fatigue at Baseline and 12 Months

	Variable	Pearson's R	p-value
Baseline	Age	-0.477	0.007
	T&S Joints	0.684	<0.001
	TST	-0.108	0.308
	SE	-0.395	0.028
12 Months	Age	-0.496	0.005
	T&S Joints	0.244	0.115
	TST	0.000	0.500
	SE	-0.210	0.168

Multiple Regression (Table 3)

- At baseline, model #3 (Age, Presence of T&S Joints, TST, and SE) predicted a significant proportion of the variation in fatigue (adj. $R^2 = 0.677$, $p < 0.001$) (Figure 1)
- At 12 months, model #3 (Age, Presence of T&S Joints, TST, and SE) explained less of the variation in fatigue (adj. $R^2 = 0.369$), p = 0.014)

Table 3: Hierarchical Multiple Regression Modelling (3 Models) at Baseline and 12 months

	Model Number	Adj. R^2	Change in R^2	p-value of Change
Baseline	**1:** Age	0.192	0.227	0.019
	2: Age, T&S Joints	0.615	0.421	<0.001
	3: Age, T&S Joints, TST, SE	0.677	0.085	0.072
12 Months	**1:** Age	0.210	0.246	0.016
	2: Age, T&S Joints	0.336	0.151	0.037
	3: Age, T&S Joints, TST, SE	0.369	0.087	0.247

Baseline-Model 3: Fatigue = 67.25 – 0.38*Age + 12.88*Presence of TS Joints + 0.04*Sleep Time – 60.30*Sleep Efficiency

12 Months-Model 3: Fatigue = 90.79 – 0.70*Age + 12.30*Presence of TS Joints + 0.04*Sleep Time – 67.67*Sleep Efficiency

CONCLUSION

Poor quality and quantity of sleep predicted fatigue in adults recently diagnosed with RA, even after controlling for the stronger predictors (younger age and presence of tender & swollen joints). Interventions aimed at optimizing restful sleep may help individuals living with early RA manage fatigue, particularly in younger people with active joint disease.

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