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The validity of the fatigue and risk index for predicting impairments of health and safety under different shift schedules in the context of risk assessments

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Introduction

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legally required risk assessment of working conditions, including the design of the working time arrangements in Germany

research project on predicting impairments of health and safety due to work schedule characteristics

fatigue and risk index calculator (FRI) by Spencer et al. (2006) considered as an additional candidate to be used

Risk & Fatigue Index Calculator

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Fatigue Index Calculator

Read the manual before using! Go to http://www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf

Company
Location
Shift ID
Date
Mode: Fatigue | Defaults | Reset Index | Calculate Index

Assessor

☐ Display schedule

☐ Display charts

Version 2.2

About

Day	On Duty	Off Duty	Job type / breaks	Commuting Time	Duty Length	Rest Length	Average duty per day	Cumulative component	Duty timing component	Job type / Breaks component	Fatigue Index
03.01.2008	14:00	22:00	Default	Default	8h	Fully Rested	8h	0,1	0,9	2,5	**3,4**
04.01.2008	14:00	22:00	Default	Default	8h	16h	8h	0,3	0,9	2,5	**3,6**
05.01.2008	14:00	22:00	Default	Default	8h	16h	8h	0,6	0,9	2,5	**4,0**
06.01.2008	14:00	22:00	Default	Default	8h	16h	8h	1,1	0,9	2,5	**4,4**
07.01.2008	14:00	22:00	Default	Default	8h	16h	8h	1,6	0,9	2,5	**5,0**
08.01.2008	14:00	22:00	Default	Default	8h	16h	8h	2,2	0,9	2,5	**5,5**
09.01.2008	14:00	22:00	Default	Default	8h	16h	8h	2,8	0,9	2,5	**6,1**
12.01.2008	06:00	14:00	Default	Default	8h	2d 8h	6h 24m	1,1	1,0	1,6	**3,6**
13.01.2008	06:00	14:00	Default	Default	8h	16h	6h 33m	4,4	1,0	1,6	**6,9**
14.01.2008	06:00	14:00	Default	Default	8h	16h	6h 40m	8,3	1,0	1,6	**10,7**
15.01.2008	06:00	14:00	Default	Default	8h	16h	6h 46m	11,8	1,0	1,6	**14,0**
16.01.2008	06:00	14:00	Default	Default	8h	16h	6h 51m	14,4	1,0	1,6	**16,6**
17.01.2008	06:00	14:00	Default	Default	8h	16h	6h 56m	16,5	1,0	1,6	**18,6**
18.01.2008	06:00	14:00	Default	Default	8h	16h	7h	18,1	1,0	1,6	**20,2**
22.01.2008	22:00	06:00	Default	Default	8h	4d 8h	5h 43m	0,2	10,6	16,2	**27,0**
23.01.2008	22:00	06:00	Default	Default	8h	16h	5h 49m	3,5	10,6	16,2	**29,4**
24.01.2008	22:00	06:00	Default	Default	8h	16h	5h 55m	8,9	10,6	16,2	**33,3**
25.01.2008	22:00	06:00	Default	Default	8h	16h	6h	13,4	10,6	16,2	**36,6**
26.01.2008	22:00	06:00	Default	Default	8h	16h	6h 5m	16,7	10,6	16,2	**39,1**
27.01.2008	22:00	06:00	Default	Default	8h	16h	6h 9m	19,1	10,6	16,2	**40,8**

Background: FRI

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RI: relative accident risk associated with a working schedule

FI: percentage of persons who would get a KSS rating ≥ 7

Reference values for the reference schedule: **DDNNRRRR** (12h/duty)

- FI: 20.7
- RI: 1.0

Research Question

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Are the FI and the RI able to predict detrimental effects of different work schedules to health and safety, e.g.:

- incidence of occupational accidents (RI)

- health complaints

Methods – data base

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Secondary analysis

– survey on **working hours and health**
  - reported working hours over 4 weeks
  - question on the incidence of occupational accidents
  - questions on health impairments

    all respondents (n=337)

– survey on **flexible working times**
  - reported working hours over 4 weeks
  - questions on health impairments

    only those who worked shifts (n=121)

both datasets: **n=458**

Independent and dependent variables

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independent variables:

– parameters of the RI and the FI
  - maximum, mean, variance, factor scores

dependent variables:

– incidence of an occupational accident within the last year

– frequencies of 17 different health complaints

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Results

Distribution of the FRI

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	$\overline{x}$	σ	x_{min}	x_{max}	skewness	kurtosis
RI_{max}	1.18	.02	.74	3.78	3.36	15.28
RI_{mean}	.90	.01	.70	2.35	3.98	24.49
RI_{var}	.03	.00	.00	.70	5.95	40.88
FI_{max}	22.13	.71	2.09	62.30	.78	-.81
FI_{mean}	10.35	.34	1.51	58.15	1.90	5.76
FI_{var}	80.35	5.56	.13	530.46	1.62	1.63

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Correlations between the FRI

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non-parametric correlations (Kendall Tau-b)

	RI_{mean}	RI_{var}	FI_{max}	FI_{mean}	FI_{var}
RI_{max}	.73	.83	.52	.47	.46
RI_{mean}		.63	.47	.49	.42
RI_{var}			.52	.44	.48
FI_{max}				.80	.89
FI_{mean}					.78

Factor analysis of the FRI

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factor analysis (PA) of the parameters of the indices

two factors with eigenvalues > 1

$R^2 = 87.47$

rotated factor matrix (varimax-rotation):

	Factor	
	1	2
RI_{var}	.930	.175
RI_{max}	.903	.334
RI_{mean}	.877	.314
FI_{max}	.300	.950
FI_{var}	.146	.872
FI_{mean}	.434	.771

Correlations (φ) FRI / accidents

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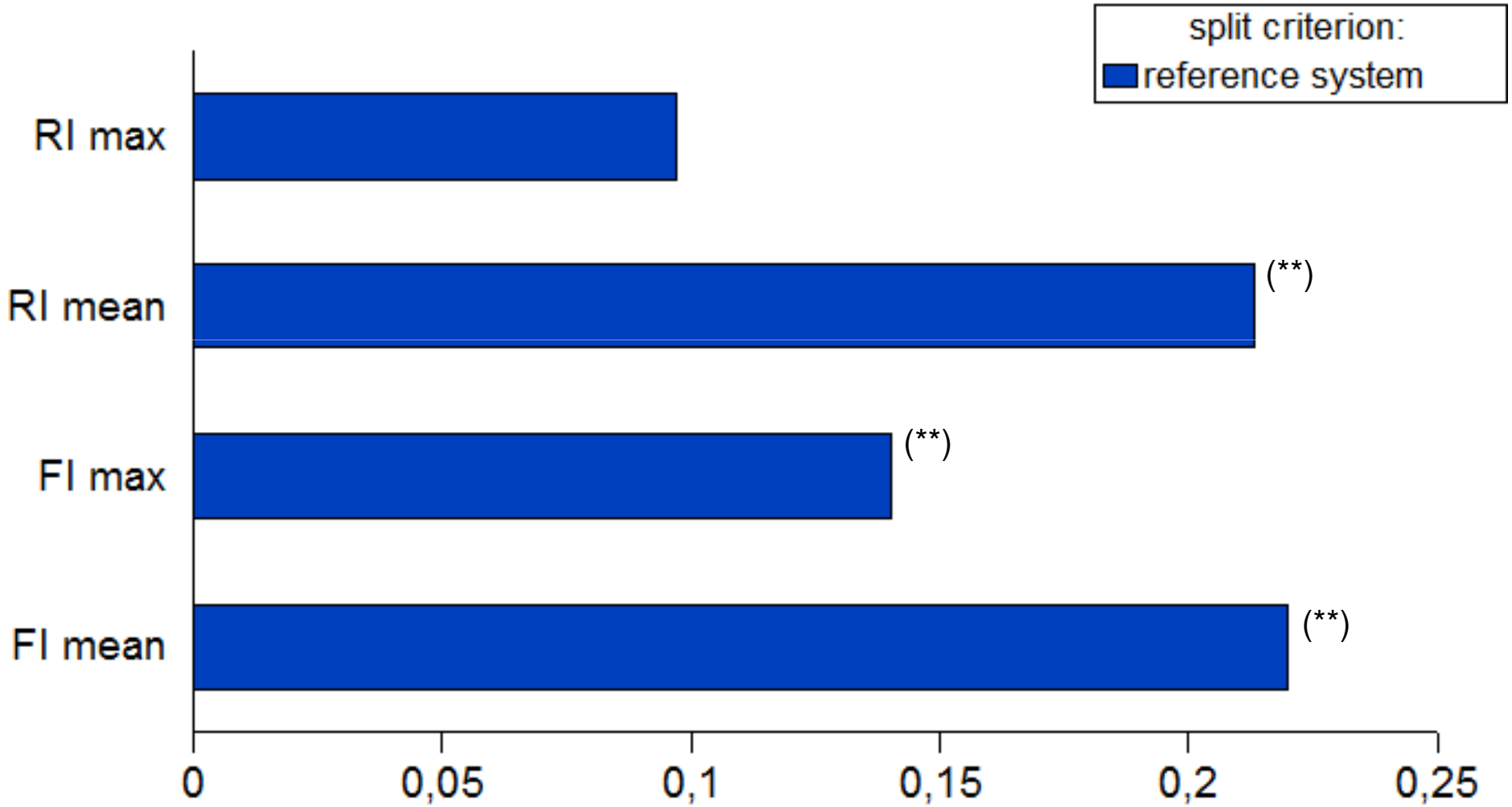

n=337 (18 with an accident)

(**) p<0.01

Correlations FRI / health complaints

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Correlations: Kendall Tau-b	RI_{max}	RI_{mean}	RI_{var}	FI_{max}	FI_{mean}	FI_{var}	RI_{factor}	FI_{factor}
Stomach pain (n=457)			***.09****	***.08****		***.07****		***.07****
Digestive problems (n=456)								
Nausea /diminished appetite (n=455)								
Eructations / heartburn (n=456)	***.09****	***.09****	***.09****	***.11****	***.11****	***.11****		***.11****
Backache /neck pain /muscle tensions (n=457)								
Sleep problems (n=456)	***.13****	***.10****	***.15****	***.18****	***.17****	***.18****		***.19****
Vertigo (n=455)								
Nervousness /throbbing / sweating (n=456)								
Tinnitus /sudden deafness (n=457)								
Breathing problems (n=457)								
Heart aches (n=457)								
Pulsation in the veins (n=457)								.09*
Lack of concentration /untimely fatigue (n=456)								
Dejection /sadness /depression (n=457)								
Headache (n=456)			.07*					
Skin problems /allergies (n=456)								
Aching limbs /cold /cough /bronchitis / asthma (n=457)								.07*

(*) p<.05 (**) p<.01

Correlations FRI / health complaints

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(*) p<.05 (**) p<.01

Regression analyses to predict accidents

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logistic regression analyses (stepwise) to predict occupational accidents (n=337)

– using the indices (max, mean)

	Nagelkerks R^2	χ^2	Exp(B)			
			RI_{max}	RI_{mean}	FI_{max}	FI_{mean}
accident	.073	8.457**	n.s.	n.s.	1.043**	n.s.

– using FI/RI factor scores

	Nagelkerks R^2	χ^2	Exp(B)	
			RI_{factor}	FI_{factor}
accident	.072	8.408**	n.s.	1.899**

(**) p<0.01

Regression analyses to predict health

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multiple regression analyses (stepwise) to predict health complaints using FI/RI factor scores

– sleep problems

	R^2	F-value	ß-coefficients	
			RI_{factor}	FI_{factor}
Sleep problems	.064	30.918**	n.s.	.253**

– backache /neck pain /muscle tensions

	R^2	F-value	ß-coefficients	
			RI_{factor}	FI_{factor}
Backache / neckpain / muscle tensions	.011	4.843*	n.s.	.103*

(*) $p<0.05$ / (**) $p<0.01$

Discussion

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only moderate correlations between FRI and our criteria, especially with the incidence of an accident

– however, in spite of not controlling for any other risk factors

in general, the correlations for the FI
(or its components) are higher than those for the RI

FI is able to predict sleep / or circadian related problems to some extent
in line with expectations

Discussion

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FI rather than RI able to predict the incidence of occupational accidents

– FI assesses expected sleepiness

shift systems leading to increased sleepiness may, as a consequence, lead to increased (sleepiness related) accident risk

– problems with the RI

distribution of its parameters and the lack of variance and thus a lack of covariance with the criteria

Conclusions

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Due to the socio-political situation within the FRG, the correlations reported are not sufficient to justify a mandatory use of the FRI.

- A voluntary use of the indices, however, might be beneficial in redesigning shift systems

Including control over other aspects influencing the risk of an accident or impairment (e.g. workload) might lead to better predictability

Modifications of the RI might be appropriate to increase its variance

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Thank you for your attention!

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