



GAWO e.V.

The logo features the text 'GAWO' in a large, bold, blue-outlined font, followed by 'e.V.' in a smaller, blue-outlined font. To the right of the text are several blue silhouettes of people in various poses, standing on a reflective surface. The entire logo is set against a blue gradient background that transitions from a darker blue on the left to a lighter blue on the right.

The validity of the risk index for the evaluation of shift systems – a study based on aggregated data

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20th international Symposium on Shiftwork and Working Time

Stockholm, 2011-06-28 to 07-01

Background

- Fatigue and risk index calculator (FRI) by Spencer et al. (2006)
- Risk index (RI):
tool designed to assess the relative accident risk associated with different shift schedules

Risk & Fatigue Index Calculator

Risk Index Calculator

Read the manual before using! Go to <http://www.hse.gov.uk/RESEARCH/rrpdf/rr446q.pdf>

Company

Location

Shift ID

Date

Mode

Risk
Defaults
Reset Index
Calculate Index

Assessor

Display schedule

Display charts

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Version 2.2

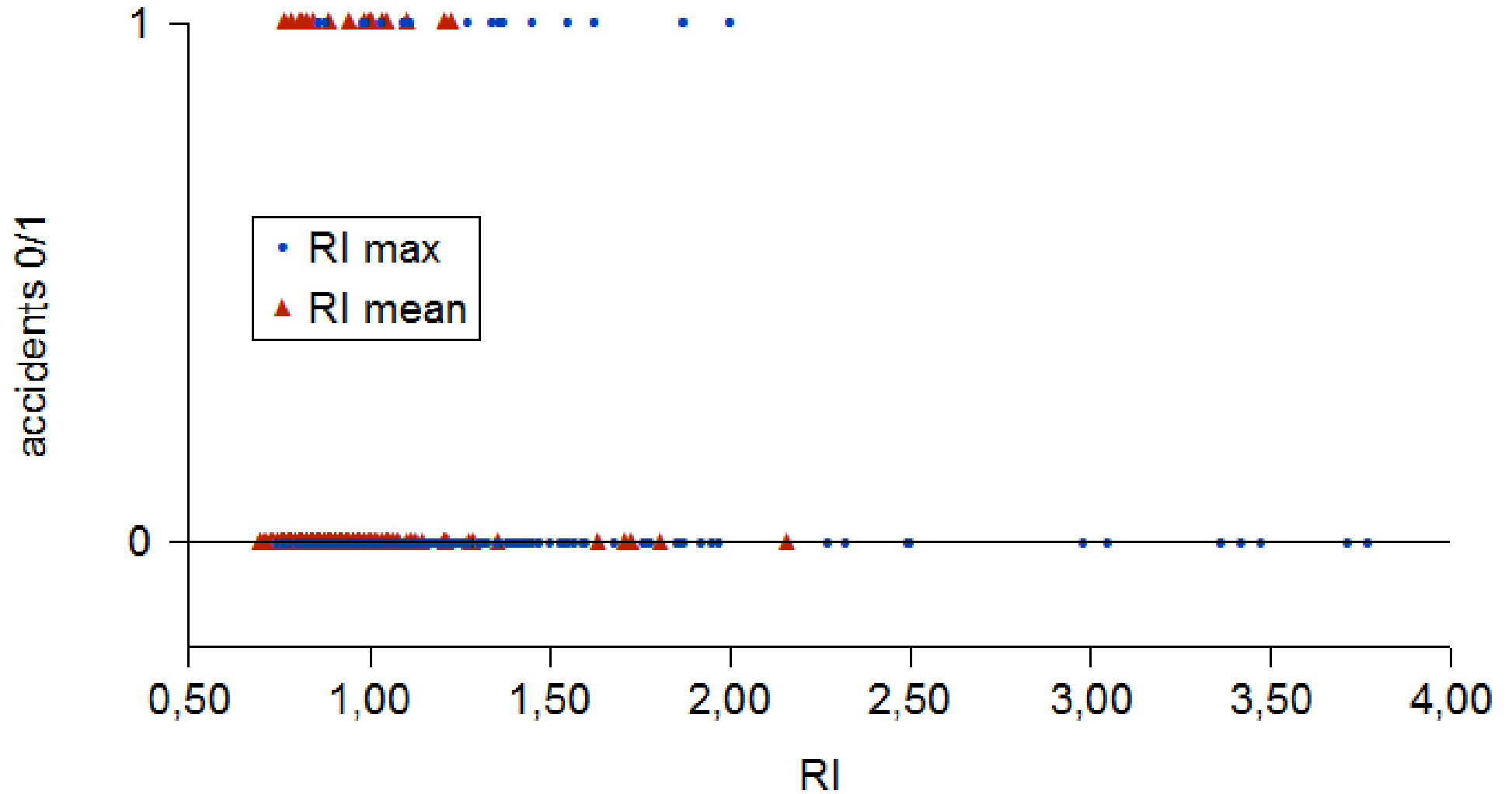
[About](#)

Day	On Duty	Off Duty	Job type / breaks	Communiting Time	Duty Length	Rest Length	Average duty per day	Cumulative component	Duty timing component	Job type / Breaks component	Risk Index
01.01.2008	08:00	17:00	Default	Default	9h	Fully Rested	9h	0,89	0,76	1,05	0,70
02.01.2008	08:00	17:00	Default	Default	9h	15h	9h	0,94	0,76	1,05	0,74
03.01.2008	08:00	17:00	Default	Default	9h	15h	9h	0,98	0,76	1,05	0,78
04.01.2008	08:00	17:00	Default	Default	9h	15h	9h	1,03	0,76	1,05	0,81
05.01.2008	08:00	17:00	Default	Default	9h	15h	9h	1,08	0,76	1,05	0,85
08.01.2008	08:00	17:00	Default	Default	9h	2d 15h	6h 45m	0,95	0,76	1,05	0,75
09.01.2008	08:00	17:00	Default	Default	9h	15h	7h	1,00	0,76	1,05	0,79
10.01.2008	08:00	17:00	Default	Default	9h	15h	7h 12m	1,04	0,76	1,05	0,83
11.01.2008	08:00	17:00	Default	Default	9h	15h	7h 22m	1,09	0,76	1,05	0,86
12.01.2008	08:00	17:00	Default	Default	9h	15h	7h 30m	1,14	0,76	1,05	0,90
15.01.2008	08:00	17:00	Default	Default	9h	2d 15h	6h 36m	0,97	0,76	1,05	0,77
16.01.2008	08:00	17:00	Default	Default	9h	15h	6h 45m	1,02	0,76	1,05	0,80
17.01.2008	08:00	17:00	Default	Default	9h	15h	6h 53m	1,06	0,76	1,05	0,84
18.01.2008	08:00	17:00	Default	Default	9h	15h	7h	1,11	0,76	1,05	0,88
19.01.2008	08:00	17:00	Default	Default	9h	15h	7h 6m	1,16	0,76	1,05	0,92
22.01.2008	08:00	17:00	Default	Default	9h	2d 15h	6h 33m	0,98	0,76	1,05	0,77
23.01.2008	08:00	17:00	Default	Default	9h	15h	6h 39m	1,02	0,76	1,05	0,81
24.01.2008	08:00	17:00	Default	Default	9h	15h	6h 45m	1,07	0,76	1,05	0,85

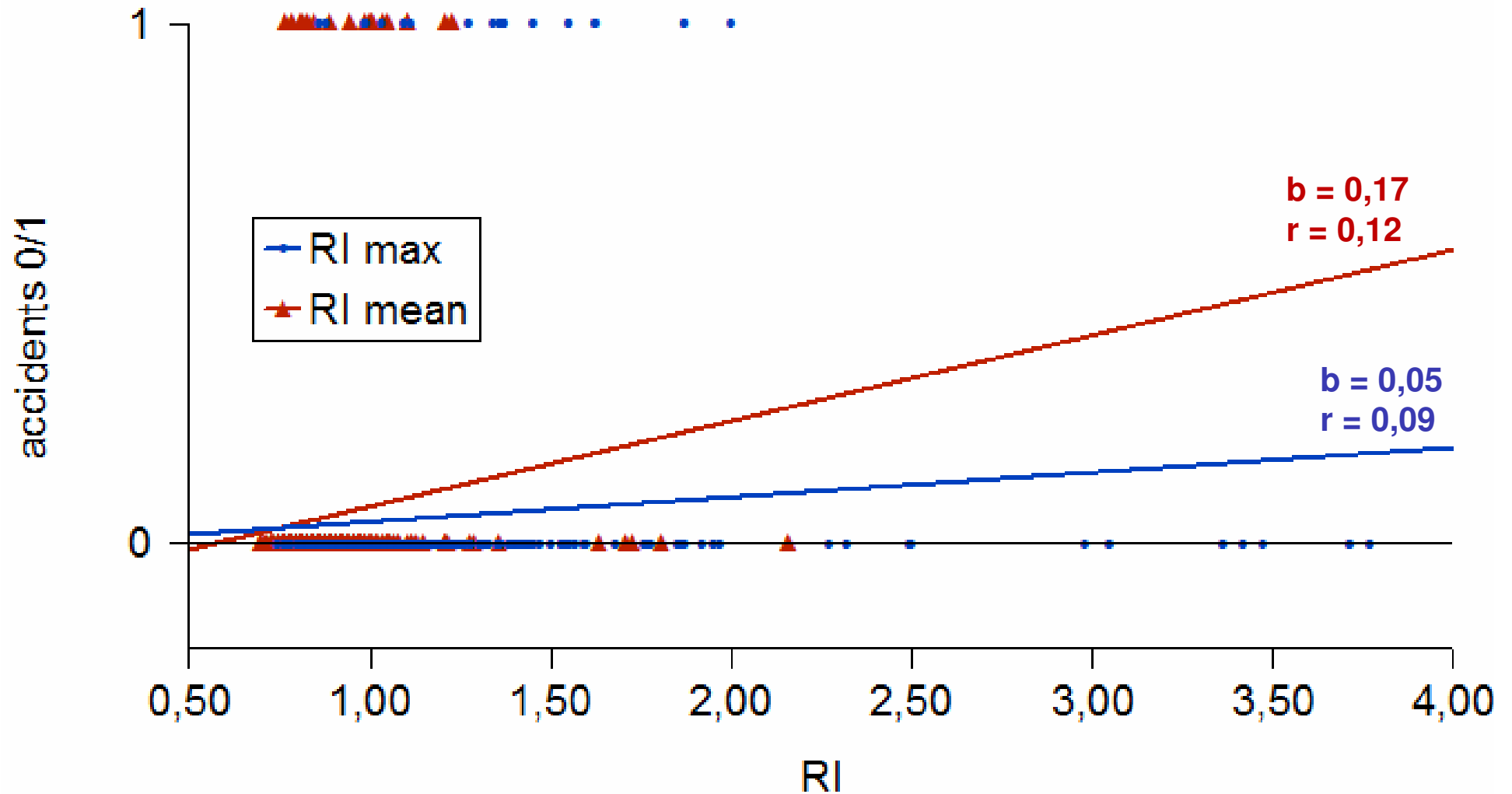
Background

- Fatigue and risk index calculator (FRI) by Spencer et al. (2006)
- Risk index (RI):
tool designed to assess the relative accident risk associated with different shift schedules
- Reference value $RI = 1.0$
reference schedule DDNNRRRRR (12h/duty)
- Studies on the basis of individual data found only moderate associations (Greubel et al., 2010)

Background



Background



Background

Problems:

- Accidents are statistically rare events
- High proportion of random / individual variance to be expected as confounder
- Focus of interest:
Risks associated with different **shift schedules**
(not with individuals under different shift schedules!)
 - Estimation of the individual risk not of primary interest
 - Associations based on individual data probably not adequate
- Studying the validity of the RI using aggregated data, e.g. controlling for individual variance, might yield a more appropriate risk assessment

Research Question

- Do analyses based on aggregated data allow for a better prediction of the accident risk associated with different shift schedules?

Methods – data base

➤ Secondary analysis

(same data base as in Greubel et al., 2010)

– Survey on **working hours and health**

- Reported working hours over 4 weeks
- Question on the incidence of occupational accidents
- Questions on health impairments

– n = 337

- Age: 22 - 63 (median: 44)
- Female: n = 89 (26,4%)
- Occupational accidents: n = 18 (5,3%)

Methods

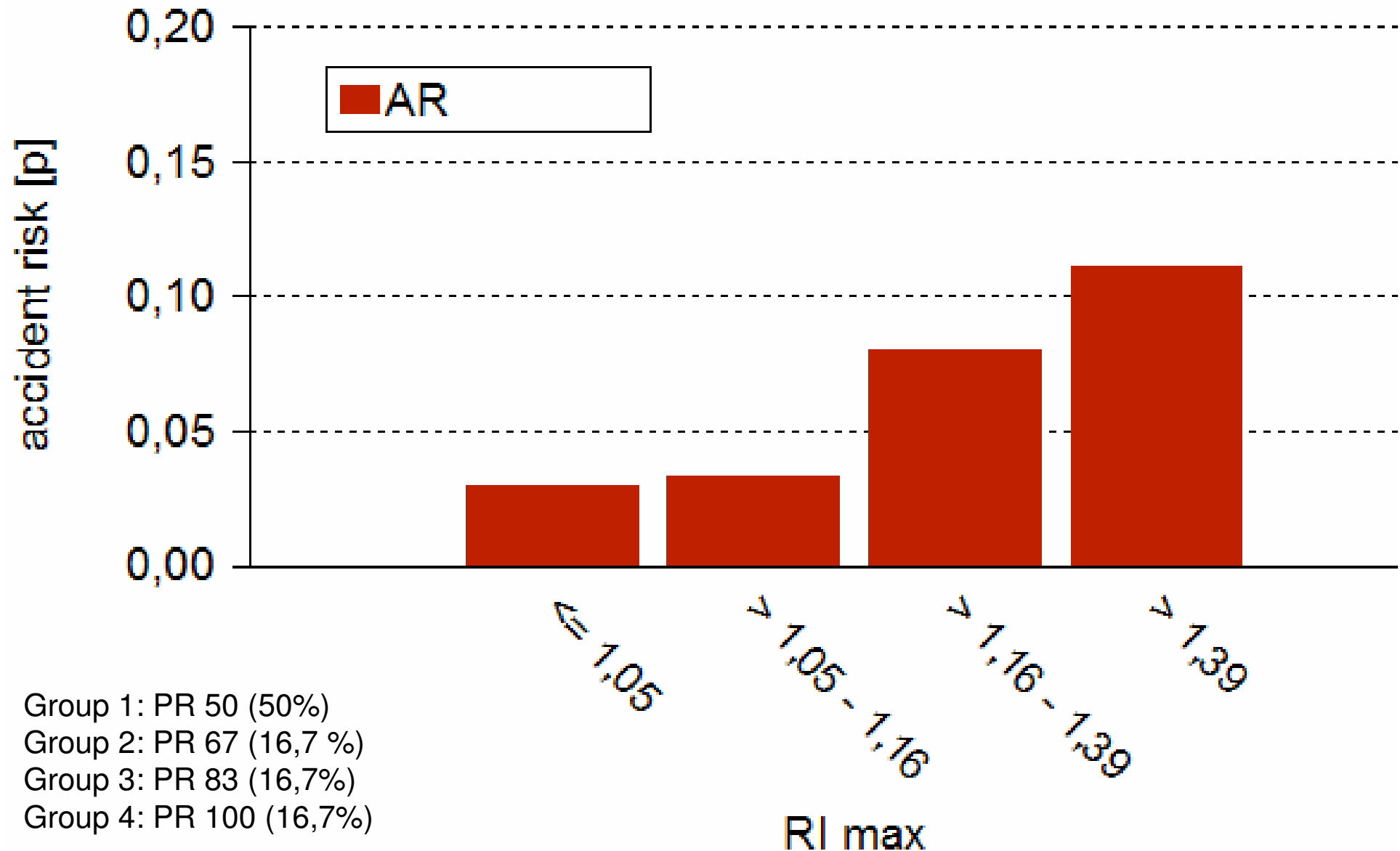
- Calculation of RI_{\max} and RI_{mean} for each person (Greubel et al., 2010)
- Aggregation according to different RI-values resulting from:
 - Distribution parameters: e.g. median, quartiles
 - Theoretical considerations: e.g. RI-values of proto-typical shift schedules
- Statistical analyses
 - χ^2 tests / Distribution fitting
 - Estimation of the explained variance
 - Controlling for workload and occupational sector where possible

Methods of grouping

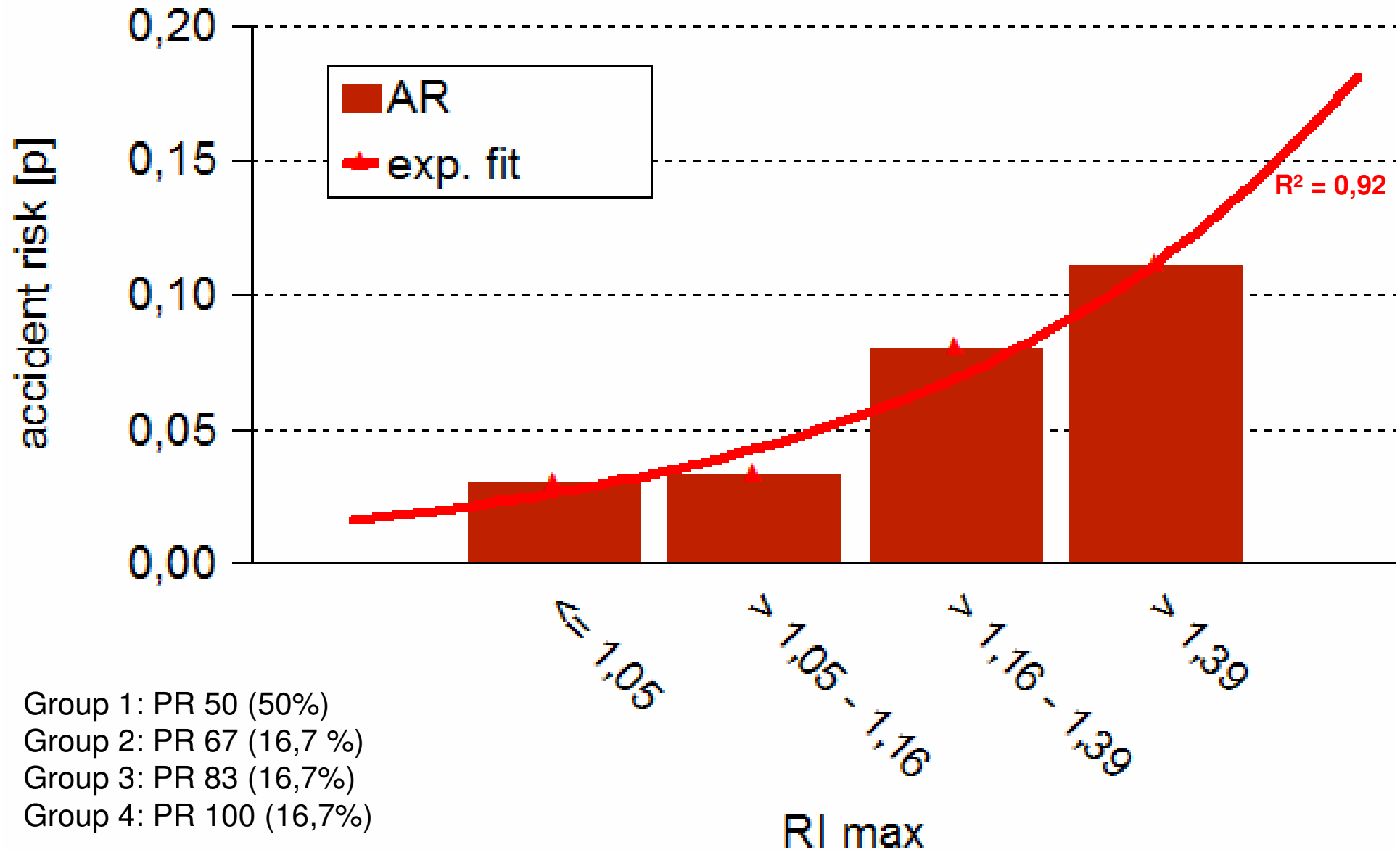
- Aggregation into 4 groups:
 - Limiting values according to percentile rank (% based aggregation), e.g.
 - Group 1: up to the median (PR 50)
 - Groups 2 – 4: 16,67 % each (PR 67, 83, 100)
 - Limiting values according to proto-typical shift schedules (shift based aggregation)
 - Day system
 - Discontinuous long and counter clockwise rotating 3-shift system with 8h-shifts
 - Continuous short and clockwise rotating shift system with 12h-shifts on weekends

Results

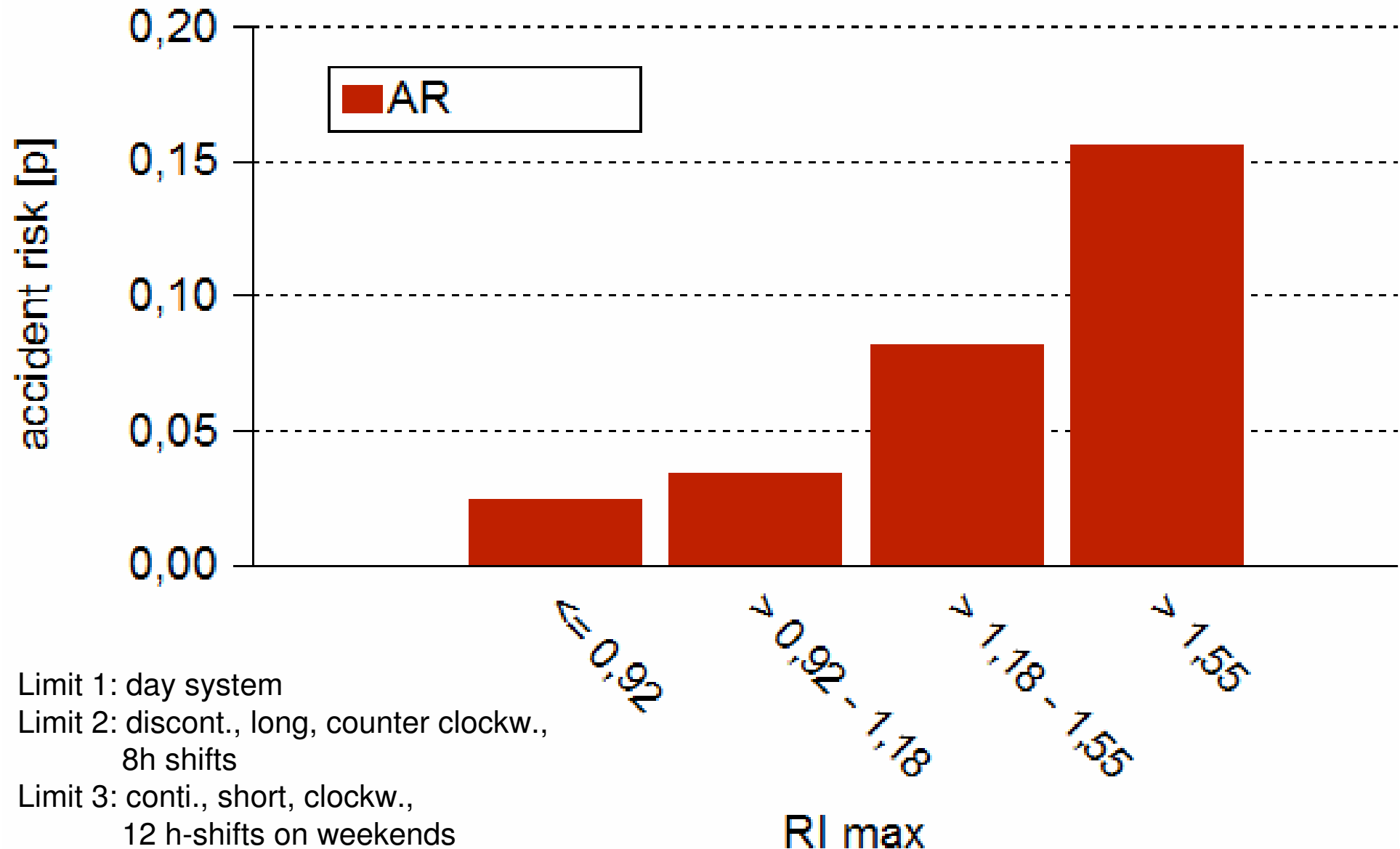
% based aggregation



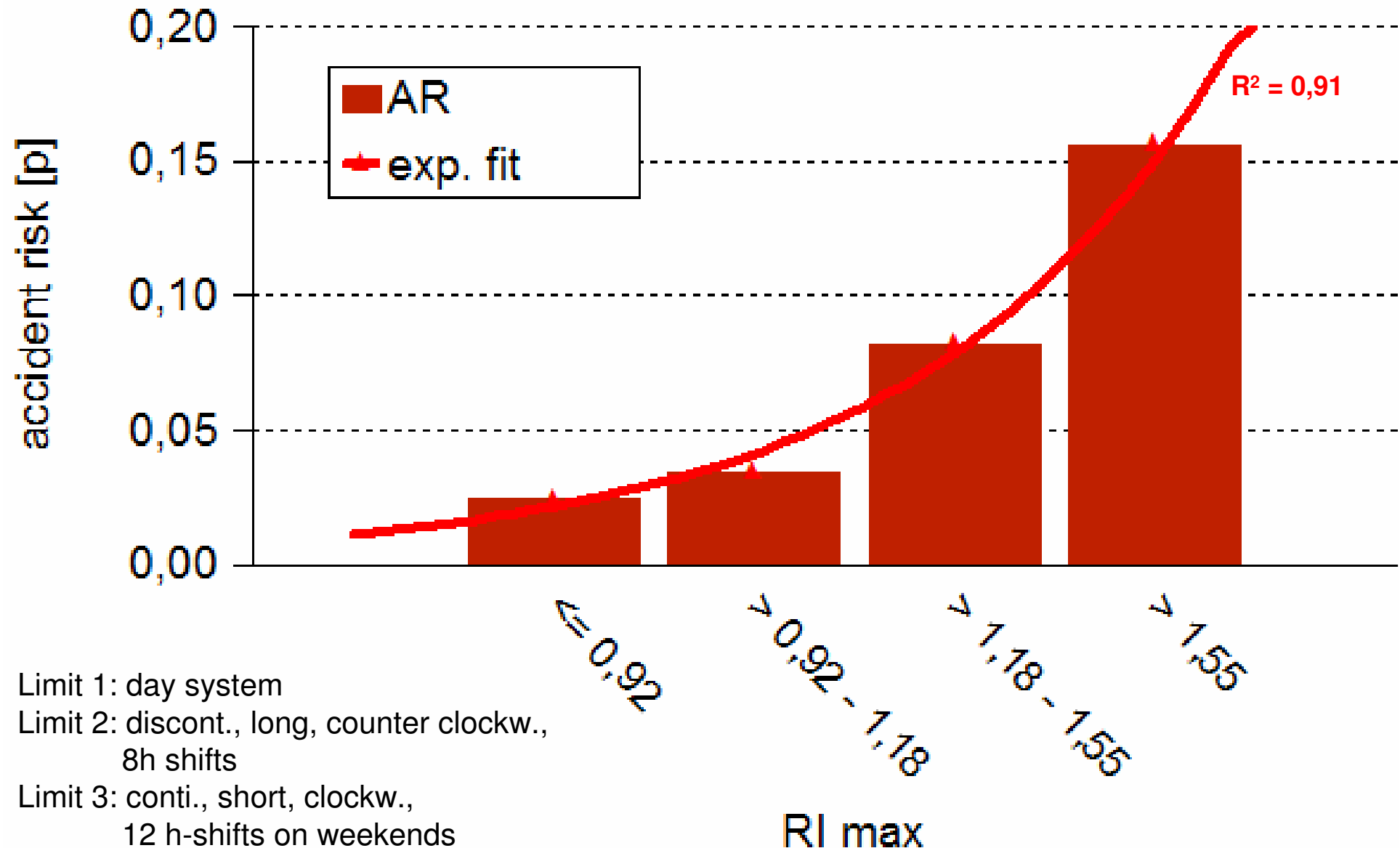
% based aggregation



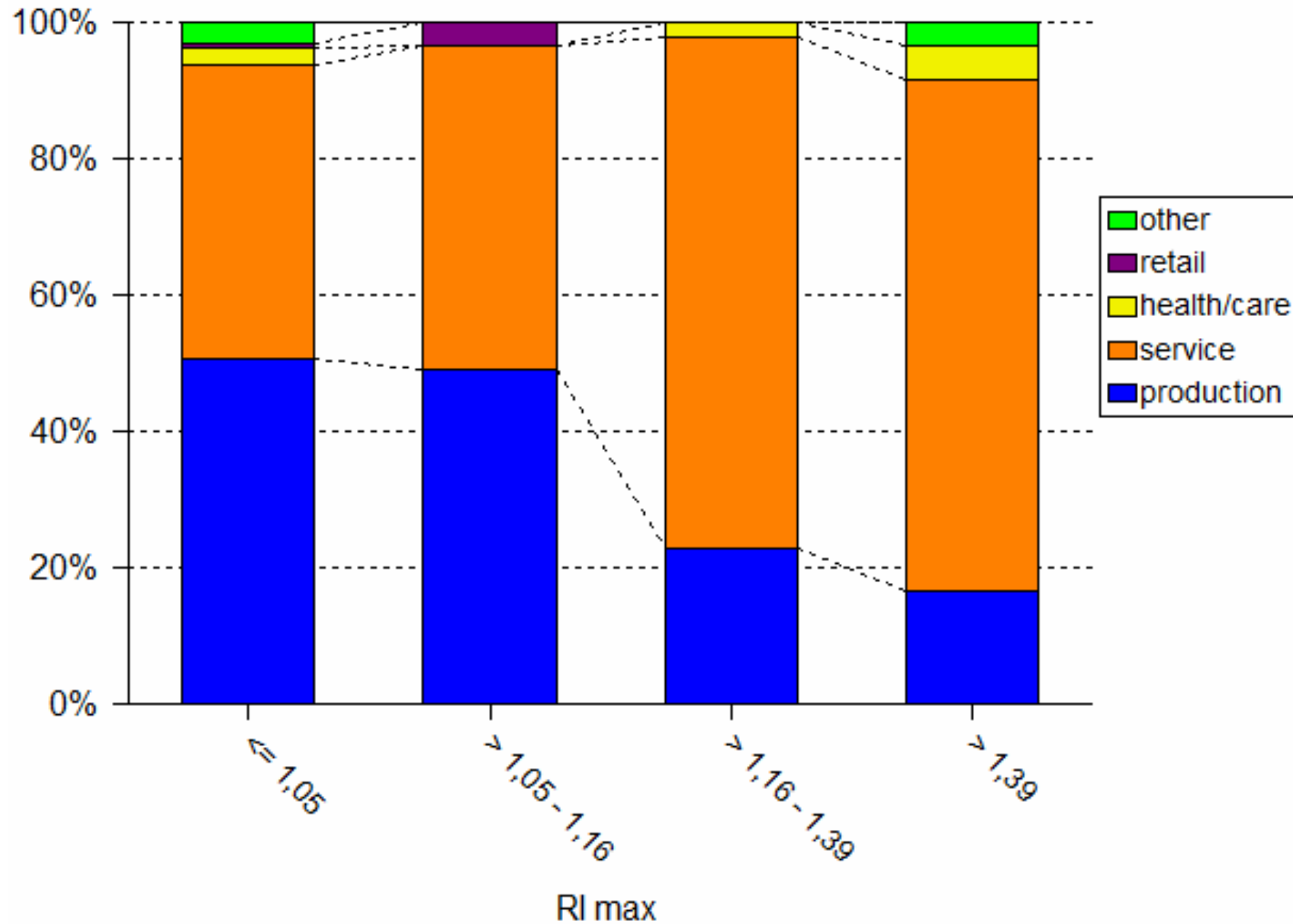
Shift schedule based aggregation



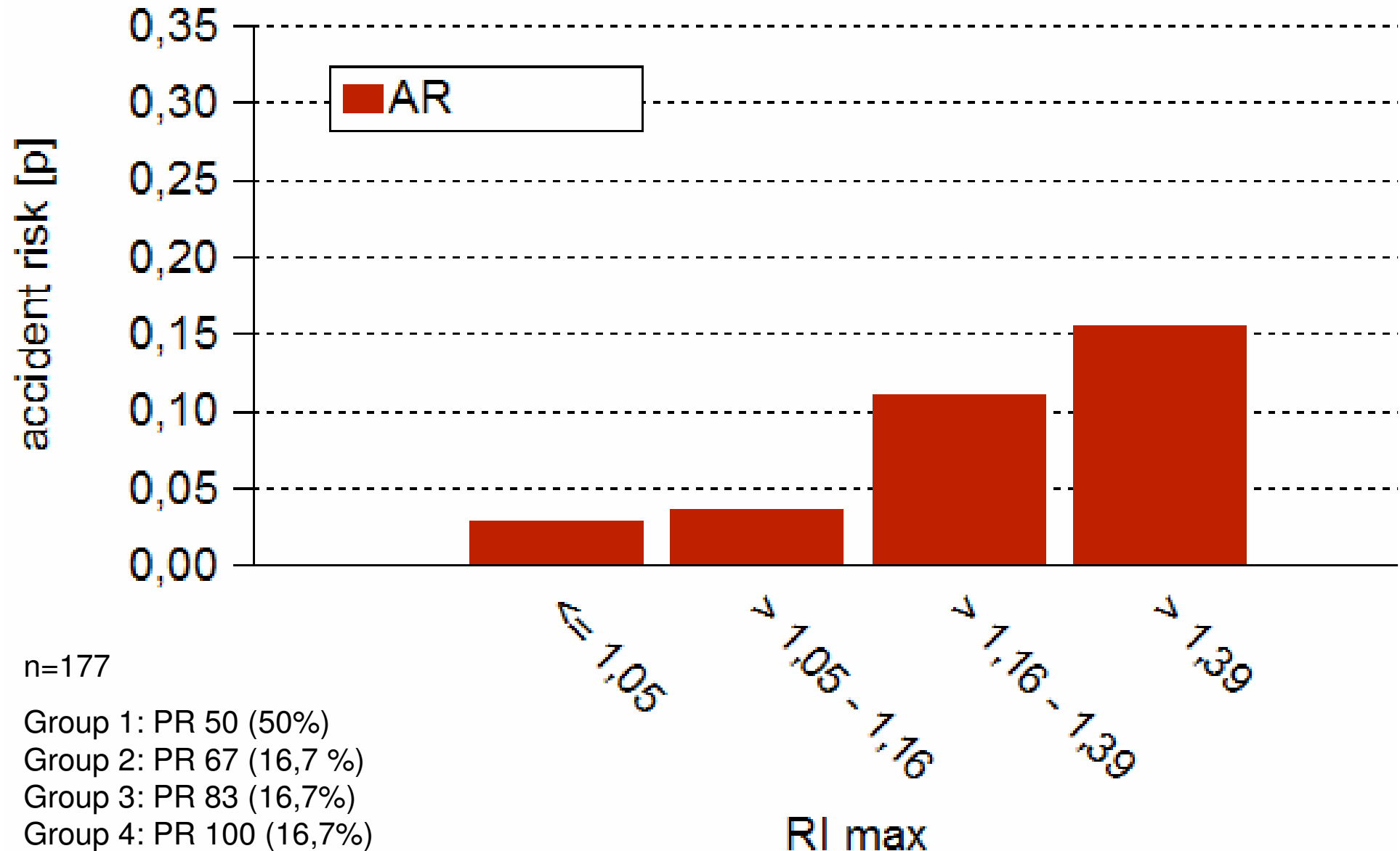
Shift schedule based aggregation



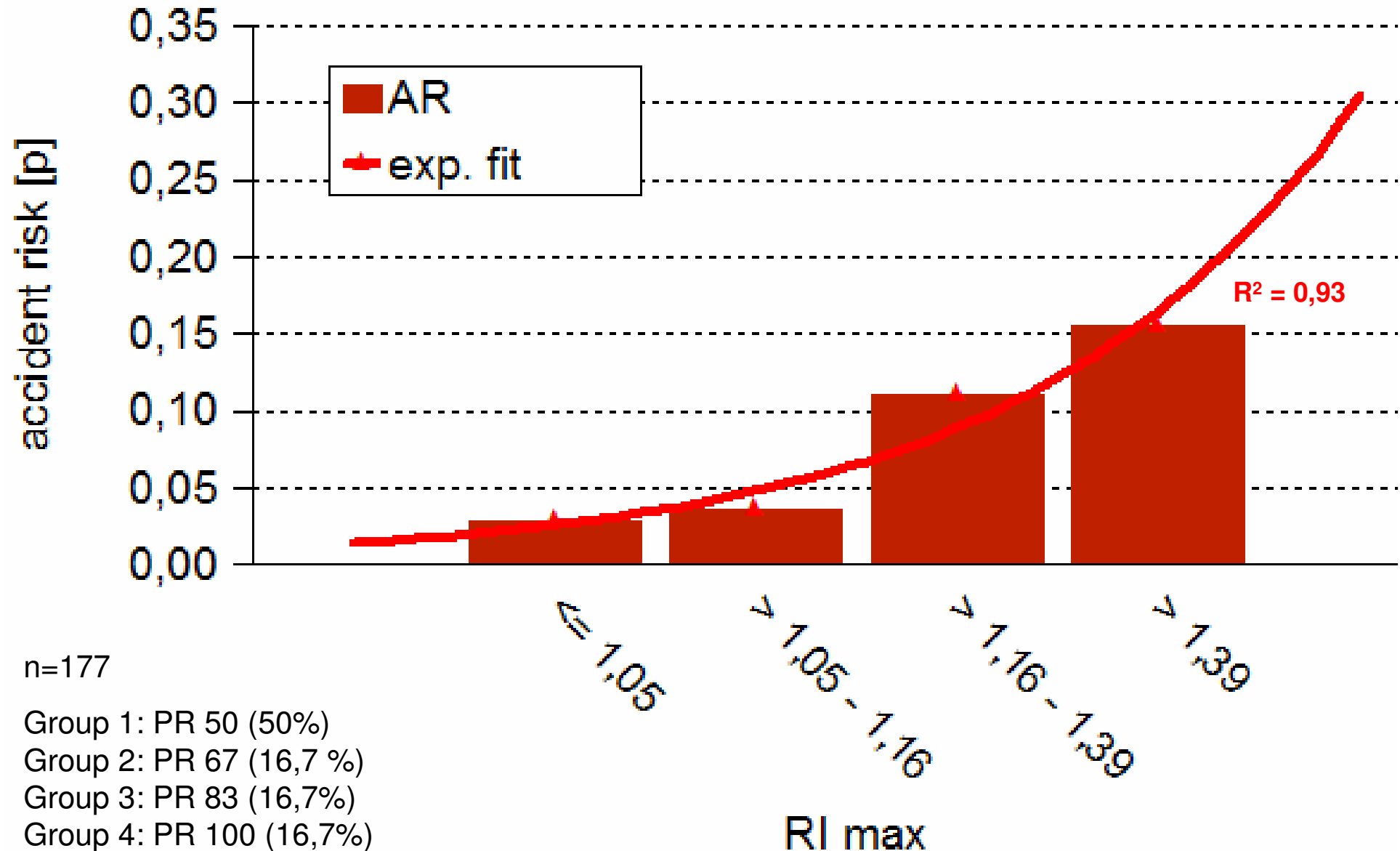
Distribution of sectors (% based aggregation)



Service sector only (% based aggregation)

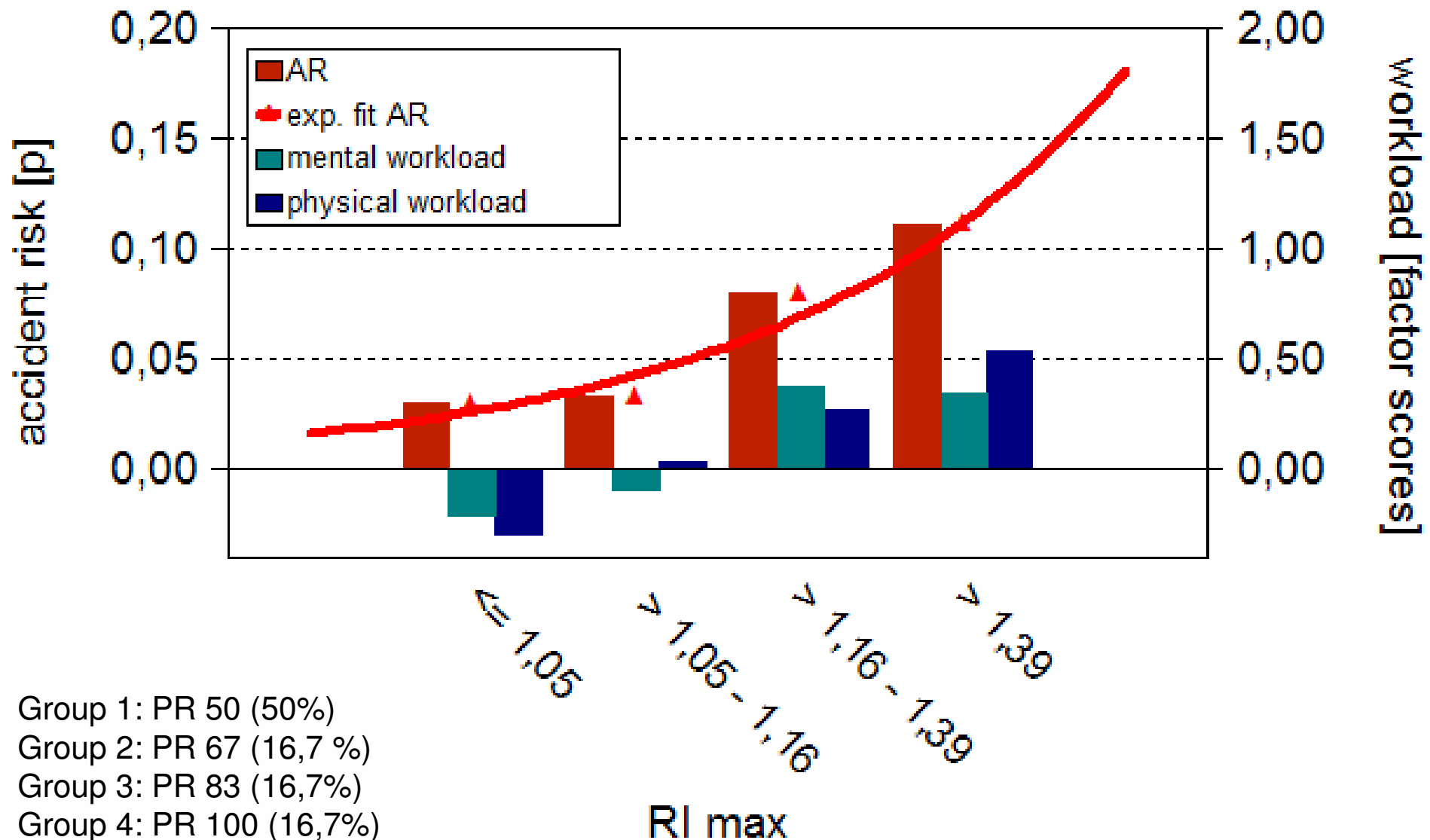


Service sector only (% based aggregation)

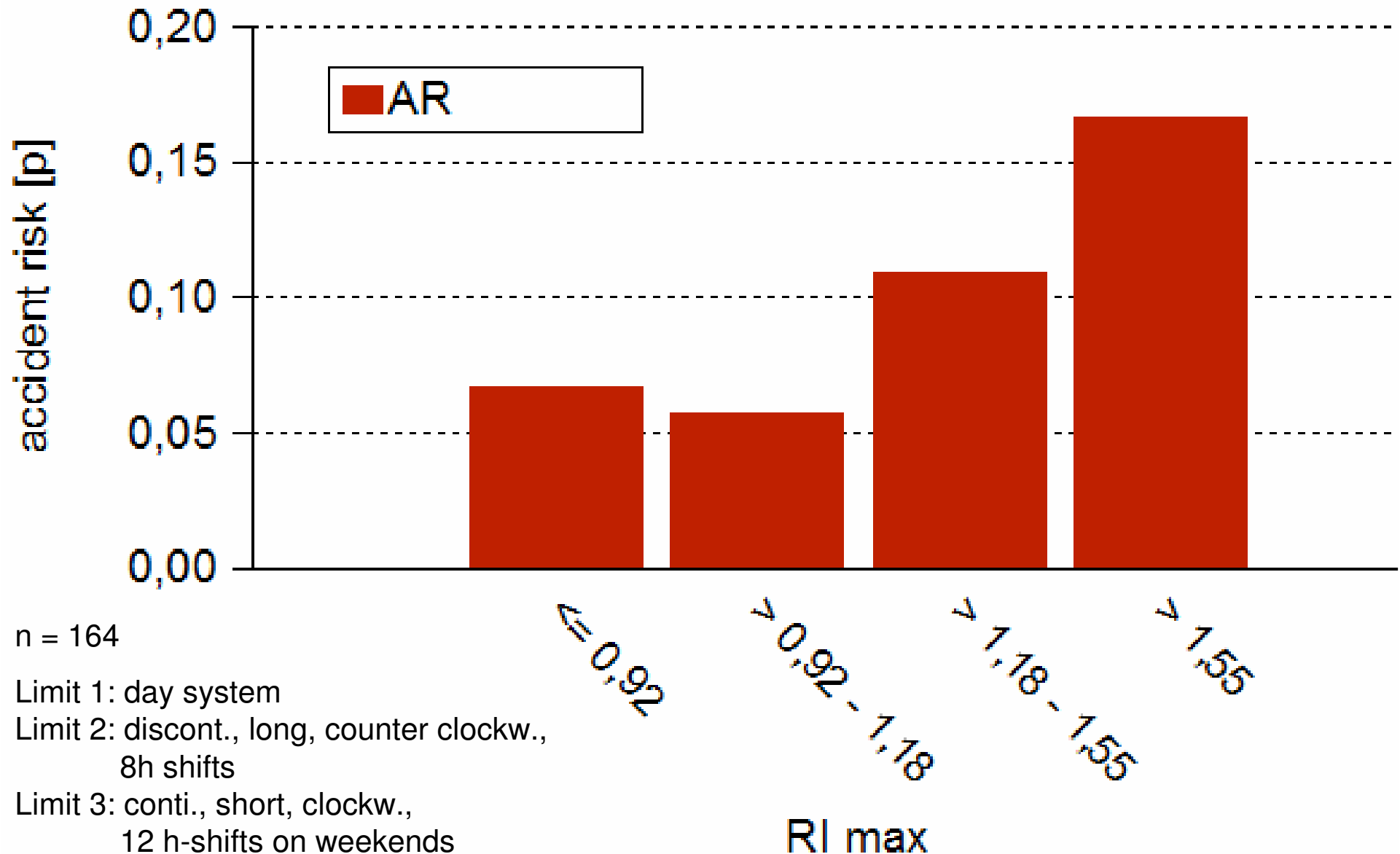


Accident risk and workload – EBA

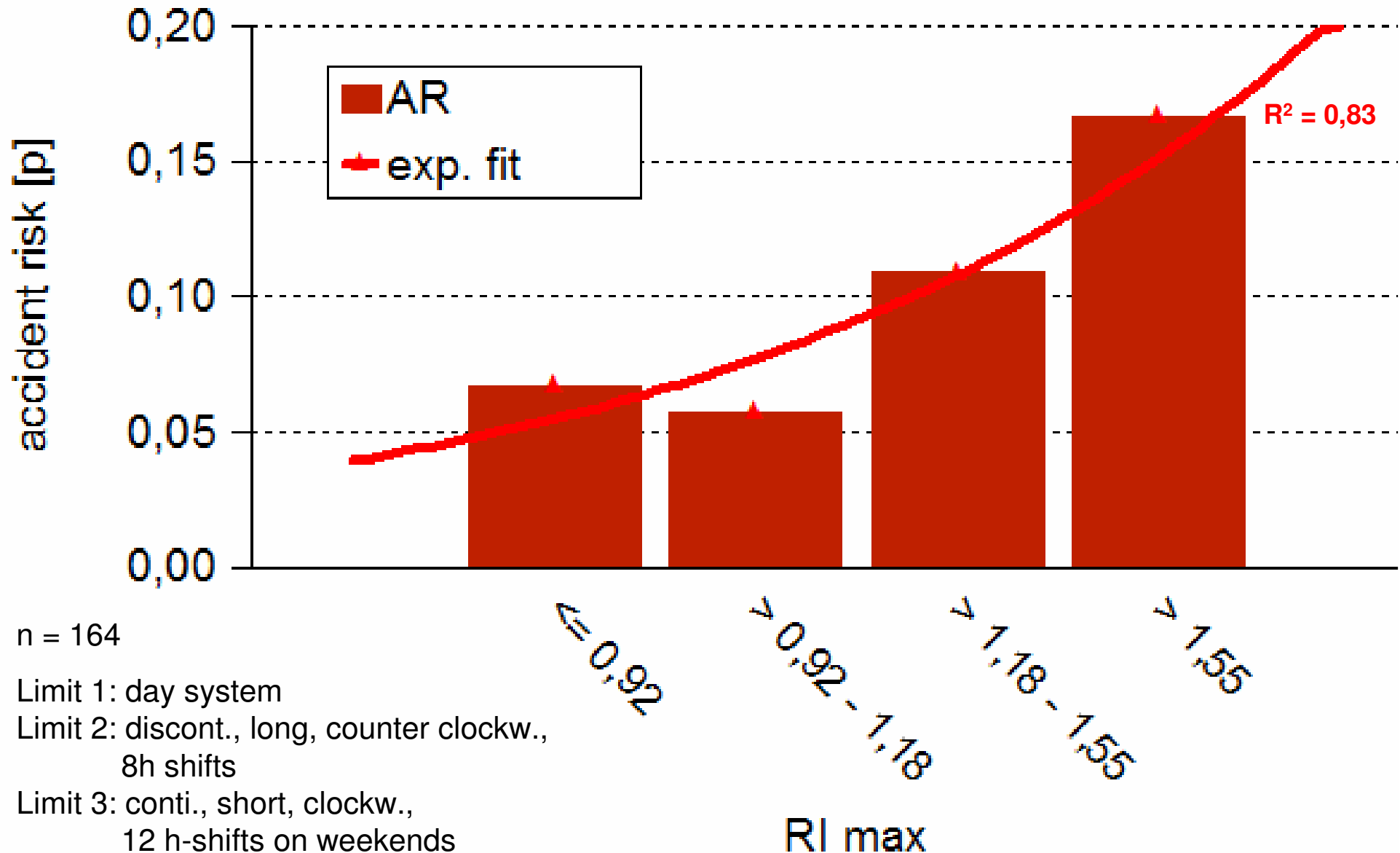
(% based aggregation)



High mental workload (shift based aggregation)



High mental workload (shift based aggregation)



n = 164

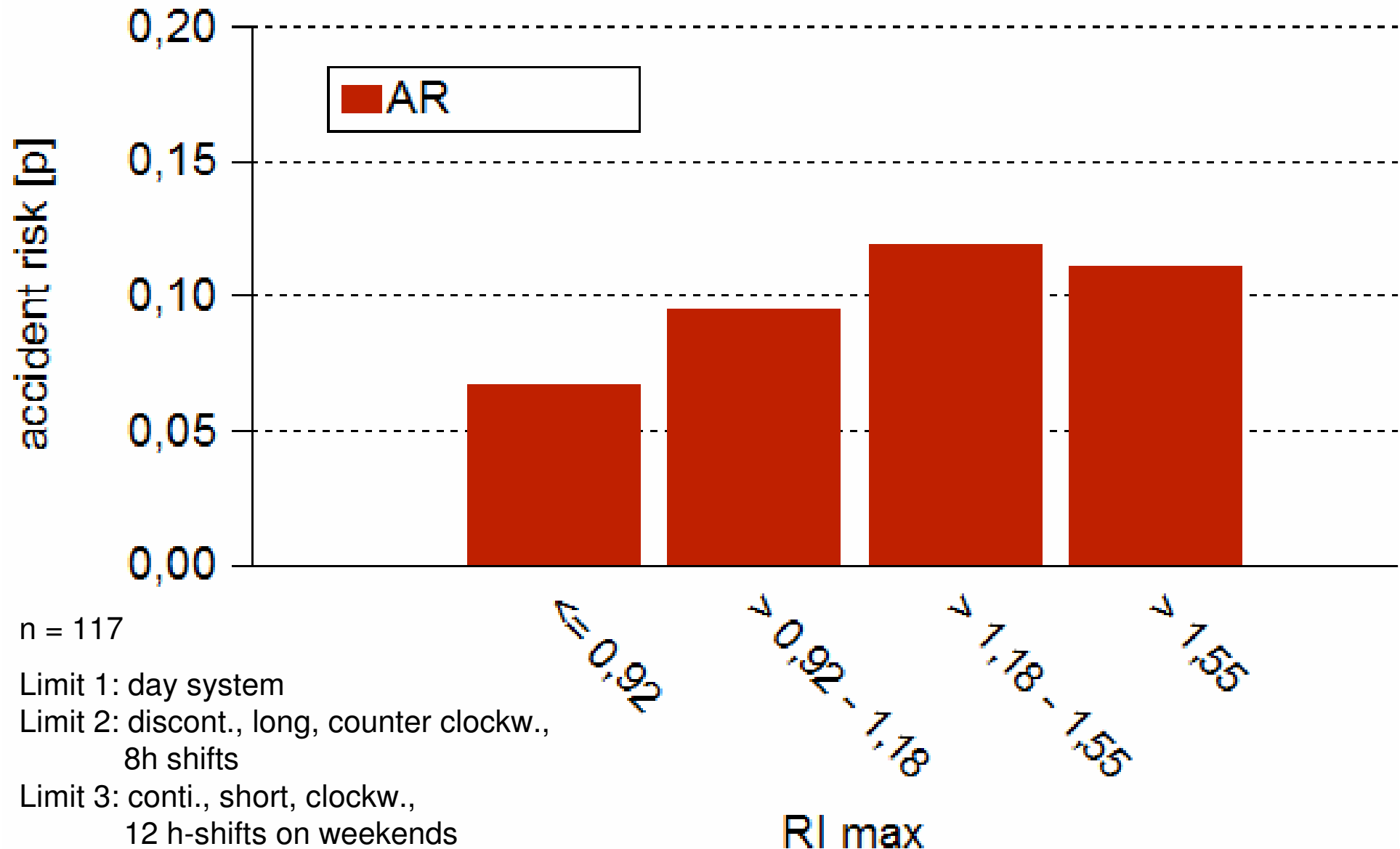
Limit 1: day system

Limit 2: discont., long, counter clockw.,
 8h shifts

Limit 3: conti., short, clockw.,
 12 h-shifts on weekends

RI max

High physical workload (shift based aggregation)



Discussion

- For all methods of aggregation exponential increase of the accident risk with higher RI
- Accident risk in the highest RI category in each case is a multiple of the risk in the lower categories
- Associations relatively independent of the method for aggregating the data
- Structural similar results when controlling for industrial sector or workload (where possible)
- ➔ **The results with aggregated data indicate a considerable higher validity of the RI than the analyses based on individual data**

Conclusion

- Tentative analyses based on aggregated data indicate a rather high validity of the RI
 - Estimation of the relative accident risk of different work schedules seems possible
 - Choose / design low-risk options
 - Aim: revision or further development of available indices to identify low-risk schedules with same operational time
- **Need for more systematic analyses with additional data / datasets!**

***Thank you
for your attention!***

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