

What works in the prevention of accidents at work?

Results of a systematic review of OHS interventions

International Safety and Health Construction Coordinators Organization (ISHCCO)

Online, 17. Marts 2023

13.30 a.m. to 14.15

National Research Centre for the Working Environment Copenhagen, Denmark (NFA)

- The psychosocial working environment
- Musculoskeletal disorders and physical work load
- **Safety culture and Accidents**
- Chemical working environment, toxicology, nano safety and microbiology
- Interdisciplinary: Senior workers and young workers, and economic evaluations of interventions, R2P

About 164 employed at NFA



Johnny Dyreborg, Senior Researcher, MSc, PhD,
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SYSTEMATIC REVIEW / PUBLICATIONS

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SYSTEMATIC REVIEWS**
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SYSTEMATIC REVIEW

Safety interventions for the prevention of accidents at work: A systematic review

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Safety Interventions for the Prevention of Accidents at Work

Dyreborg J., Lipscomb H.J., Olsen O., Törner M., Nielsen K., Lund J., Kines P., Guldenmund F., Bengtsen E., Gensby U., Rasmussen K., Zohar, D.

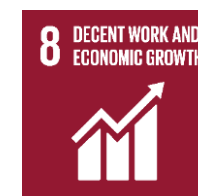
PROTOCOL

ID NO. SW2010-05

Protocol approval date: 10 March 2015



This research contributes to the fulfillment of the UN global goals



LYKKESFOREBYGGELSEN
DEN EKSISTERENDE
LIGE LITTERATUR OM
FORSKELLIGE TYPER
FOREBYGGELSE
LYKKER

FOR THE PREVENTION OF ACCIDENTS AT WORK)

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FORSKNINGS-CENTER

SYSTEMATIC REVIEW – STUDY SELECTION

Literature search: PubMed (1966), Embase (1980), CINAHL (1981), OSH ROM (NIOSHTIC 1977, HSELINE 1977, CIS-DOC 1974), PsycINFO (1806), EconLit (1969), Web of Science (1969) and ProQuest (1861), grey literature.

Identified references (assessed by two independent researchers)

- 60.466 references (total hits)
- 42.927 references (after removing duplets)
- 485 (after relevance screening)
- 194 studier (after quality assessment)
- 100 studier (Incl. RCT, CBA or ITS study designs)
- 120 safety interventions

Number of studies or safety interventions included, for each study design.

Study design	Studies included	Safety interventions
RCT	16	20
CBA	30	43
ITS	54	57
Total	100	120

SYSTEMATIC REVIEW QUALITY ASSESSMENT

Pairs of reviewers independently extracted and coded data from the included studies.

Levels of evidence	
Level	Definition
insufficient Evidence	If a safety intervention was only supported by one moderate quality study or any number of low quality studies
Limited evidence	At least one high-quality study or two studies of medium and/or high-quality, with consistent findings.
Moderate Evidence	at least two high-quality studies or three studies of medium and high-quality, with consistent findings
Strong evidence	A minimum of three studies with high-quality, and reporting consistent findings
Mixed evidence	If findings from medium and high-quality studies did not have consistent findings

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Equivalent groups	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Statistical analysis (Detection Bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Intervention fidelity	Intervention rationale	Other bias
Adams 2013	+	+	+	+	+	+	+	+	+	+	+
Cheng 2009	+	+	?	+	+	+	+	+	+	+	+
Daltroy 1997	+	+	+	+	+	+	+	+	+	+	+
Gadomski 2006	+	+	+	+	?	+	+	+	?	?	?
Hogg-Johnson 2012_HSA	+	+	+	+	+	+	?	+	+	+	+
Hogg-Johnson 2012_MOL	+	+	+	+	+	+	+	+	+	+	+
Jensen_1997	+	+	+	+	+	+	+	+	+	+	+
Jinnah 2014_Parent	+	+	+	+	+	+	+	+	+	+	+
Jinnah 2014_Staff	+	+	+	+	+	+	+	+	+	+	+
Kines 2013	+	+	+	+	+	+	+	+	+	+	+
Morgan 2012	+	+	+	+	+	+	+	+	+	+	+
Peek,Asa C 2004	+	+	+	+	+	+	+	+	+	+	+
Prunet_2008_Activ	+	+	?	+	+	+	+	+	+	+	+
Prunet_2008_Pass	+	+	?	+	+	+	+	+	+	+	+
Rasmussen 2003	+	+	+	+	+	+	+	+	+	+	+
Rautiainen 2004	+	+	+	+	+	+	+	+	+	+	+
Srikrajang 2005	?	+	+	?	?	?	+	+	+	+	+
van der Molen 2011_A	+	+	+	+	+	+	+	+	+	+	+
van der Molen 2011_B	+	+	+	+	+	+	+	+	+	+	+
Zohar 2002	+	+	+	+	?	?	+	+	+	+	+

SYSTEMATIC REVIEW QUALITY ASSESSMENT

Effect sizes / intervals

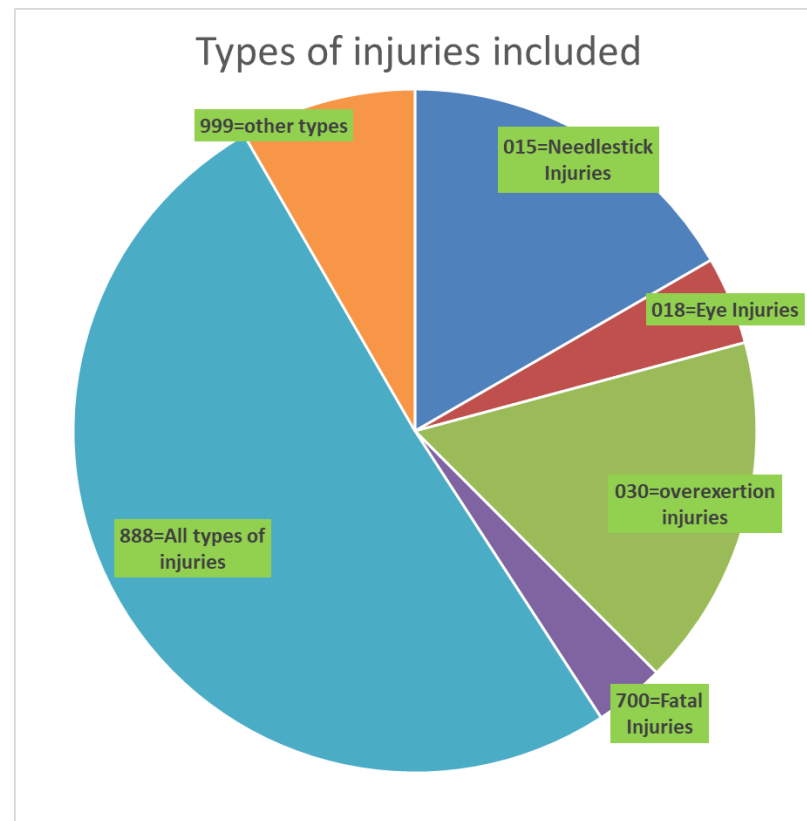
Strength of effect	
Effektstørrelse	Effect intervals (reduced risk) *)
None	From 0 - 5% reduction in accidents
Little	From 5 til 25 % reduction in accidents
Moderate	From 25-45% reduction in accidents
Strong	From 45-65% reduction in accidents
Very strong	More than 65% reduction in accidents
Not estimable	Not estimable

(*) ADJUSTED FROM MONSON 1990

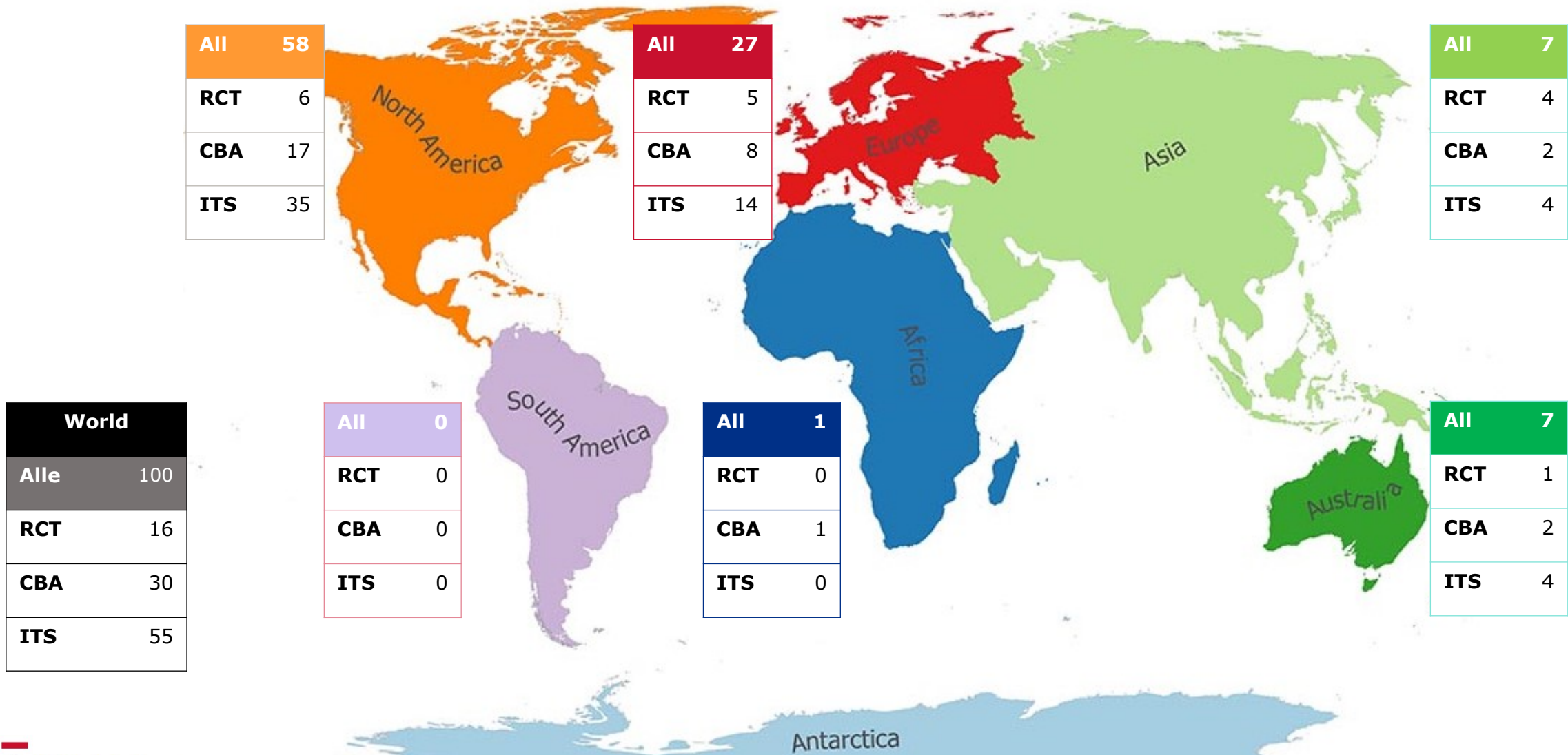
- This is not part of the Campbell Collaboration standards, but is for dissemination purposes.
- Campbell Collaboration standards is just using point estimates and confidence intervals

Proportion of studies by business activity and types of injuries

The proportion of safety interventions by business activity and study design				
Business activity	RCT	CBA	ITS	All
A - Agriculture, forestry and fishing	25%	9%	9%	12%
B - Mining and quarrying	5%	0%	2%	2%
C - Manufacturing	25%	19%	16%	18%
F - Construction	5%	5%	12%	8%
G - Wholesale and retail trade	5%	5%	2%	3%
H - Transporting and storage	5%	14%	7%	9%
N - Administrative and support service activities	0%	2%	0%	1%
O - Public administration and defence	0%	16%	5%	8%
Q - Human health and social work activities	30%	14%	40%	29%
All or mixed industries	0%	16%	7%	9%
All	100%	100%	100%	100%



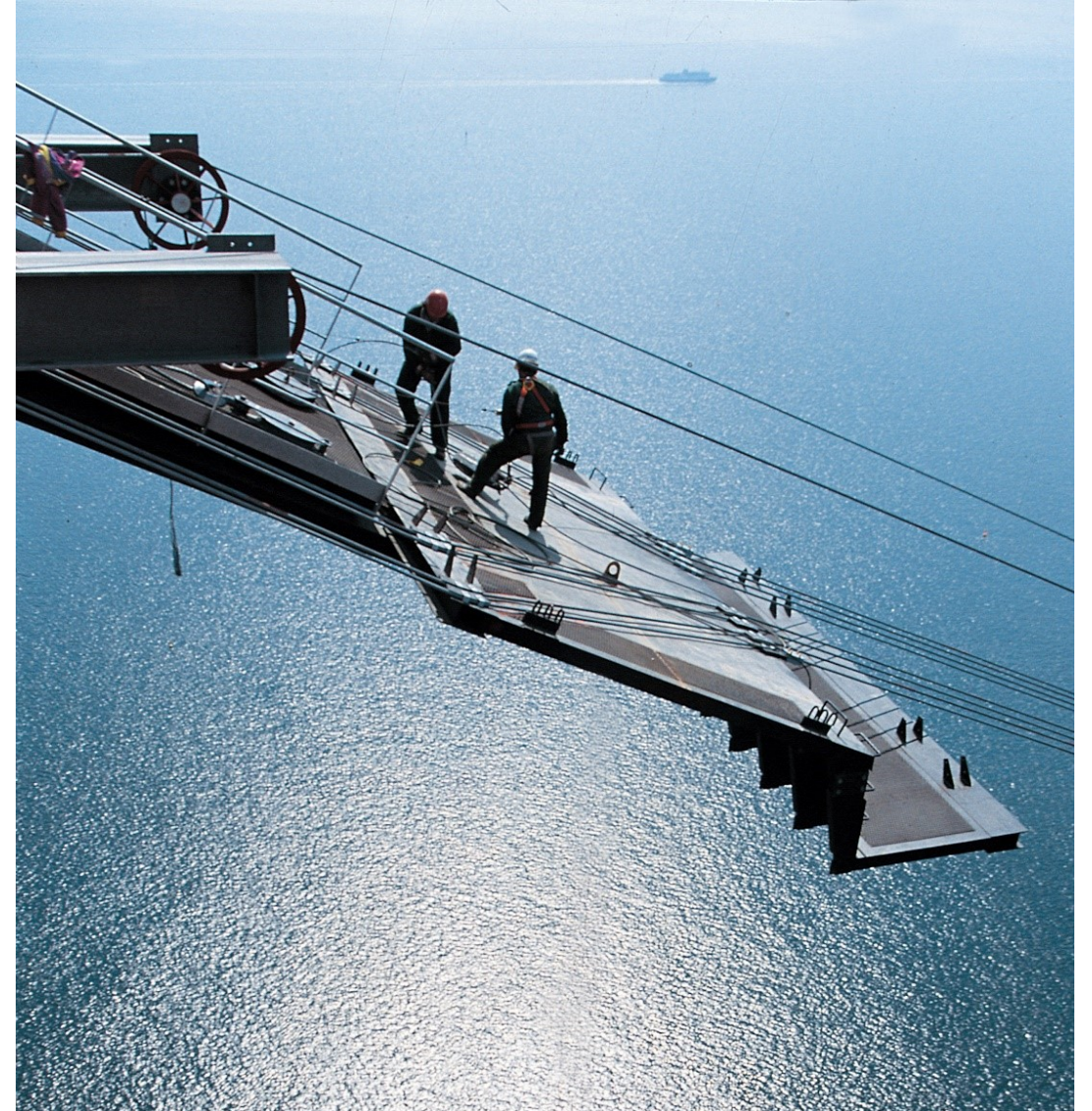
Number of studies spread across six continents



SYSTEMATIC REVIEW – Preventing accidents at work – what works?

OBJECTIVES:

- ❑ Evaluate effects of various types of safety interventions
- ❑ Identify effective components



What is a safety intervention?

Any attempt deliberately applied to promote safety and decrease the frequency or severity of accidents at work (Robson et al., 2001).

This includes also the initiatives that you implement in your industries or organisations.



WHAT TYPES OF SAFETY MEASURES DO WE HAVE IN THE TOOLBOX?

Attitude modification:



This may be achieved by means of information and persuasive messages in campaigns, leaflets, booklets, films, posters, direct mail, guidelines, by teaching or various counseling approaches. (Lund & Aarø, 2004).

Attitude modification mainly explains behaviour in terms of internal mental states and cognitive processes (e.g., knowledge-attitudes-behaviour).



The Great Belt Link

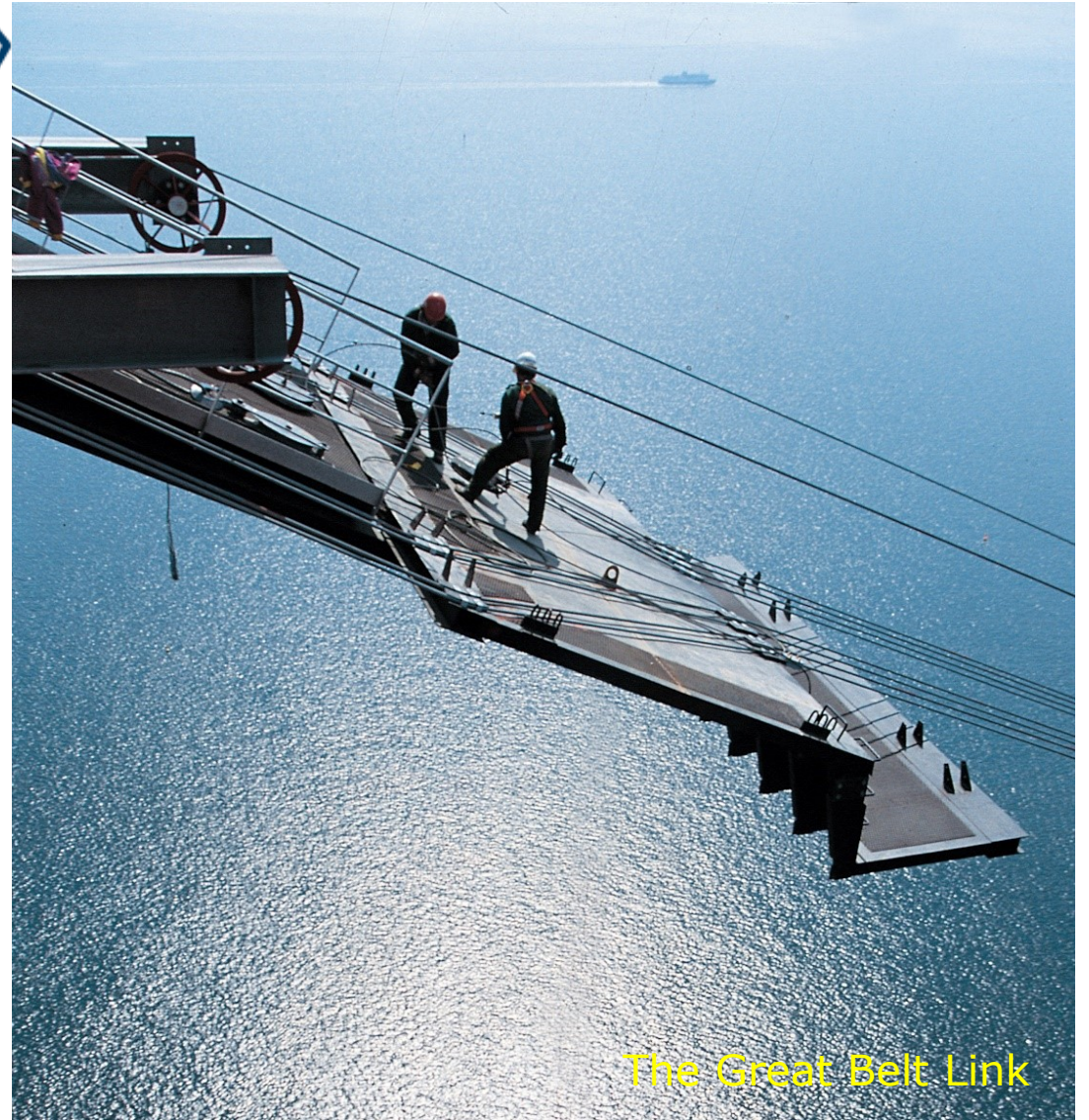
Behavior based approach

The so-called '*Stick & Carrot*'-method'. Is about changing behavior through influence from the environment, e.g. using incentives for safe behavior ('carrot') or punishment ('stick') for unwanted behavior (Luthans & Kreitner, 1985).

This approach originates from B. F. Skinner (1969), who proposed that a desired behavior (e.g. a safe work practice) is conditioned by certain incentives or consequences of action. This conditionality is formulated as the Antecedent-Behavior-Consequence (A-B-C)

model.

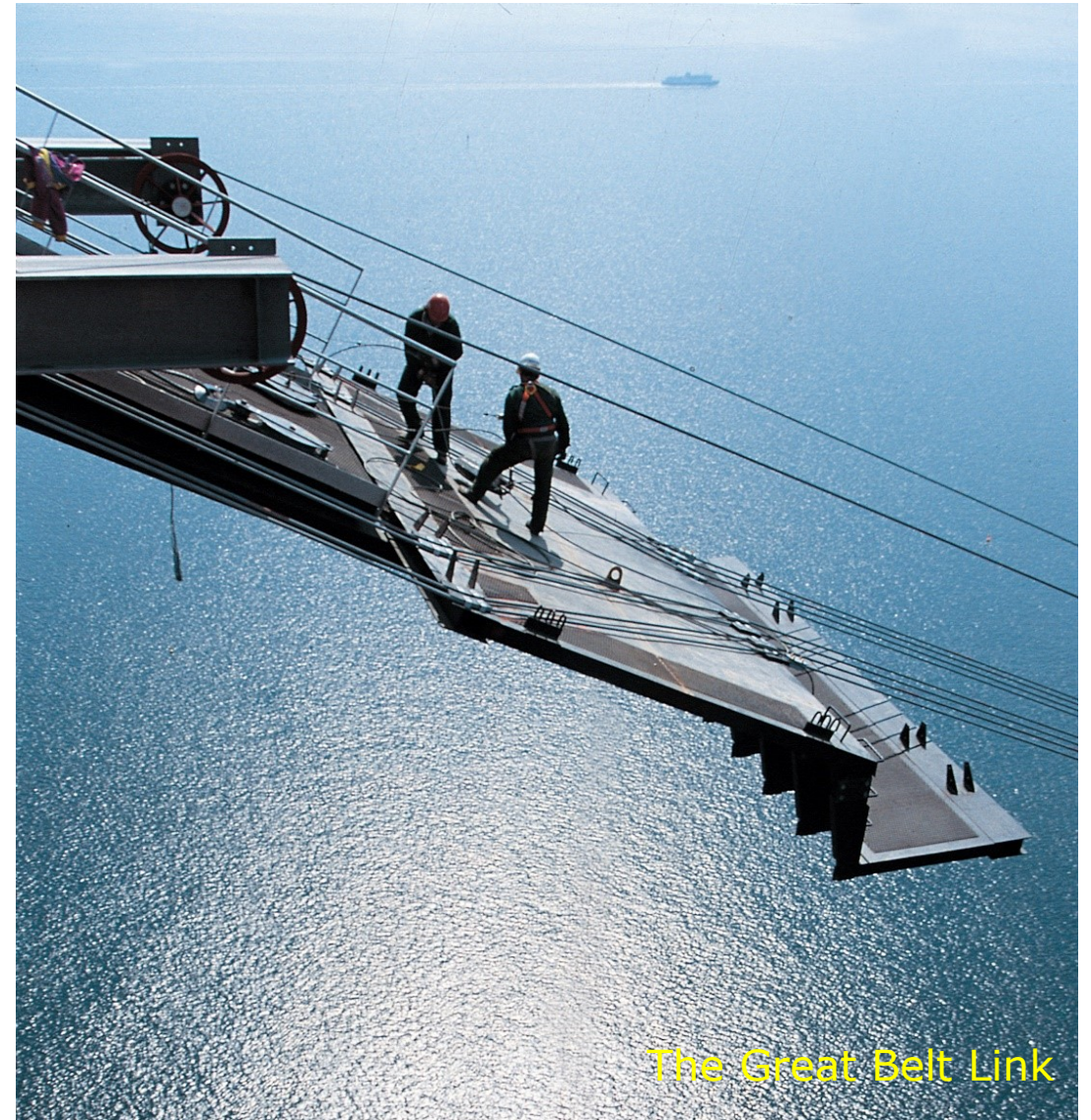
Det Nationale Forskningscenter
for Arbejdsmiljø



Fysiologiske tiltag

The physiological approaches are usually directed at individual workers, and are intended to increase workers' mobility and agility by use of various training methods.

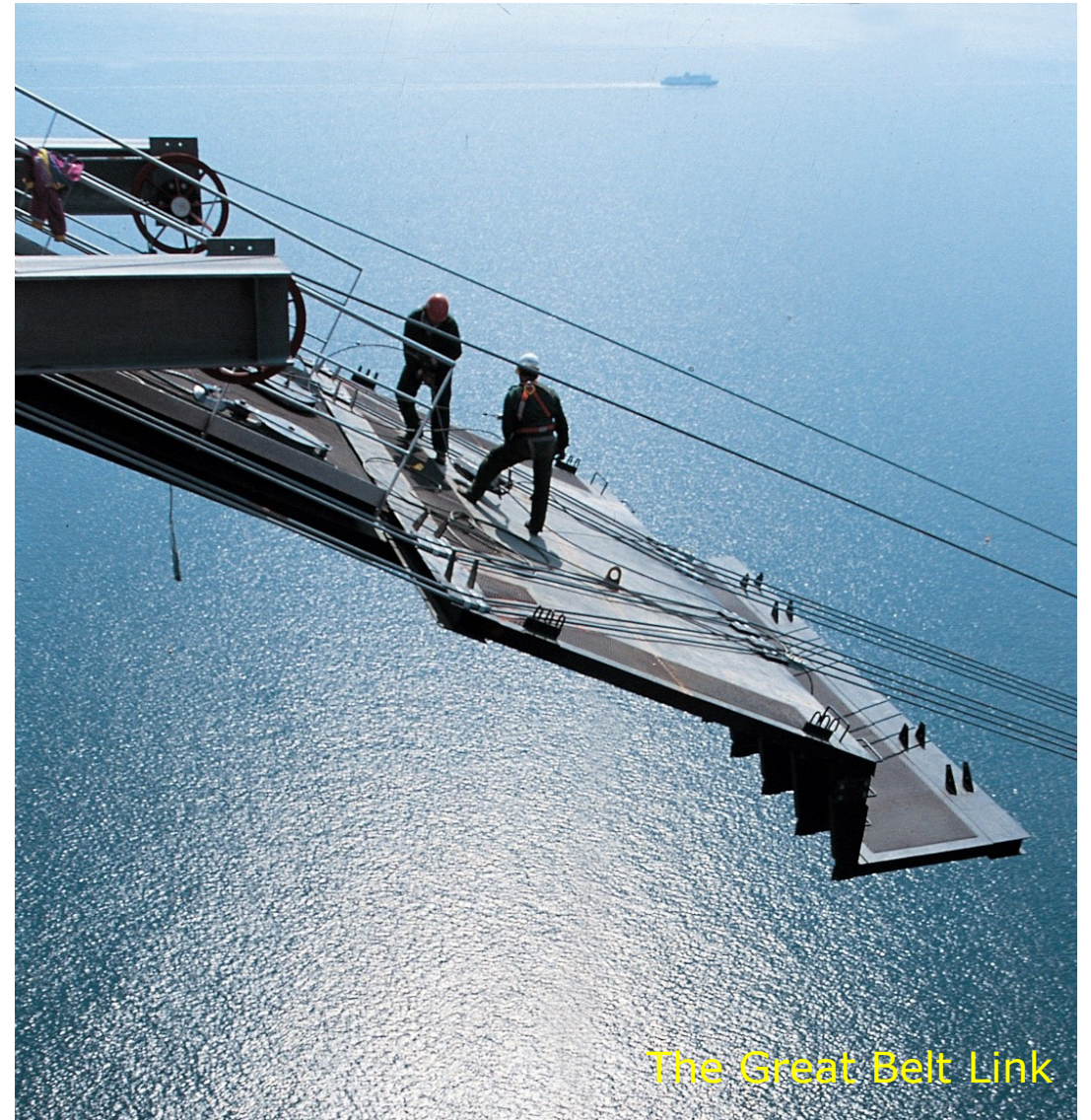
The underlying assumption of these training methods is that a stronger or more flexible body can better withstand loads and thus avoid a potential accidental injury.



Safety climate

This approach is aimed at changing the shared perceptions among managers and employees in an organization, or in a group, to influence the relative priority of safety adopted in the organization or in the group (Zohar, 2010).

We are talking about a good safety climate in the construction industry, when managers and employees give high priority to the adopted safety standards, even when things are busy!



The Great Belt Link

Organizational level approaches

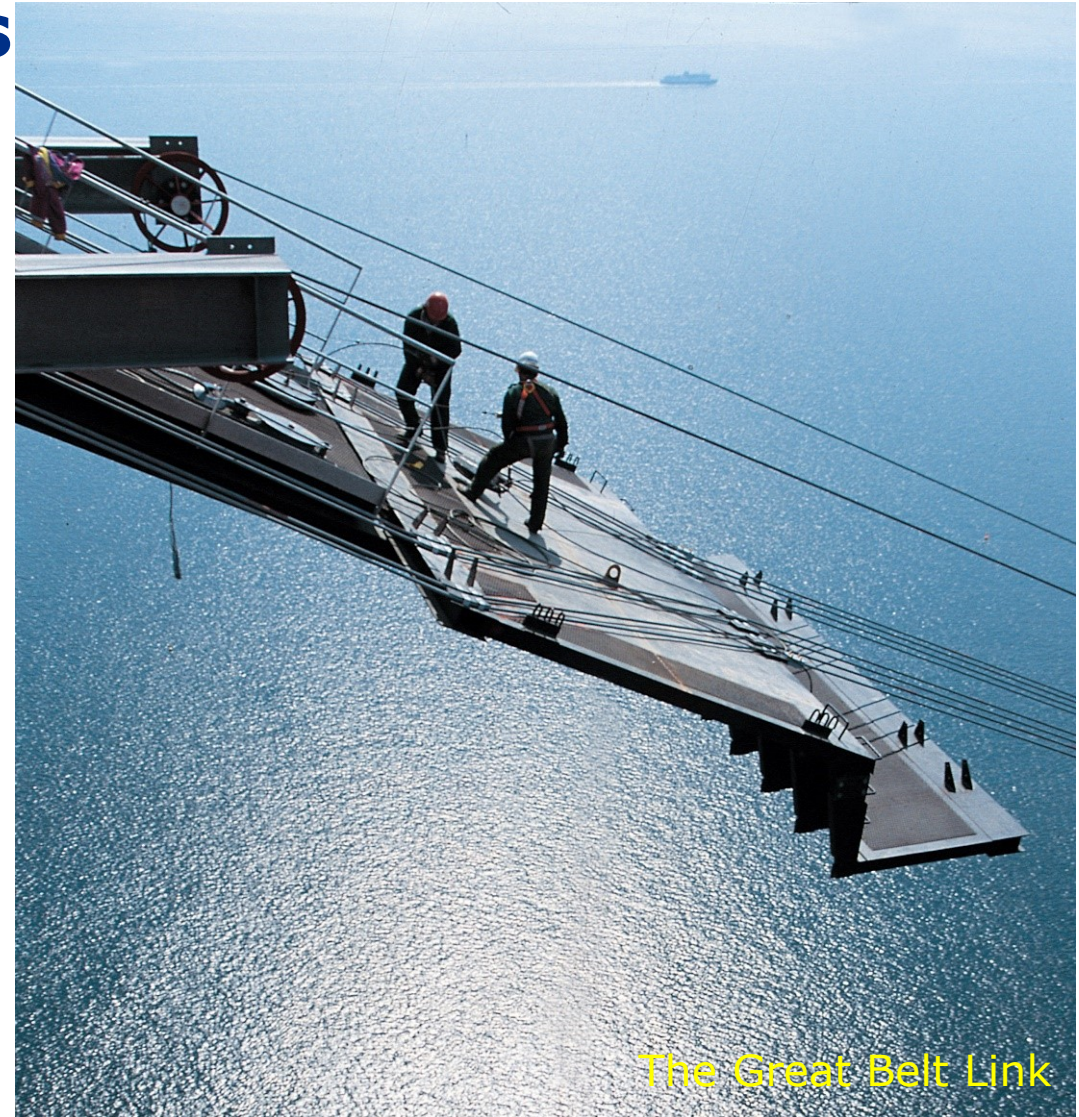
Organizational level efforts, such as improved design, work organization, policies, procedures, and strengthening of the systematic work environment efforts, etc.



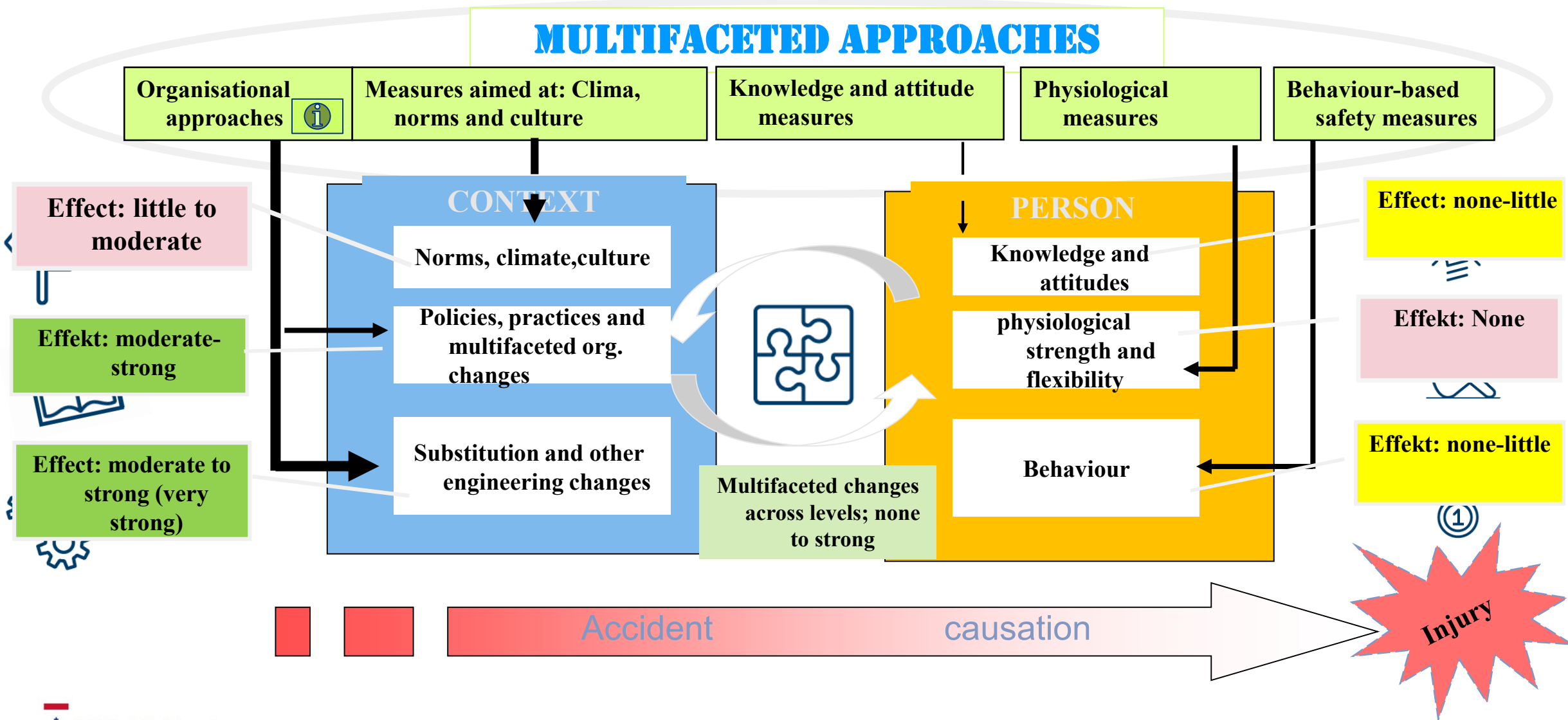
Technical measures, such as machine shielding, fall protection, elimination of hazardous substances or materials.



Multifaceted measures integrate two or more types of measures in the prevention of occupational accidents.



What works in accident prevention? OVERVIEW



Summary of approaches

- Overall, we only found a weak link between individual level approaches and reducing accidents at work. It seems that knowledge, attitudes or incentives, are overruled by the social or organisational practices at the workplace.
- We found limited evidence for a little to moderate effect of leader-based safety climate improvement and no effect of goal setting and feedback at group or organizational level.



Summary of approaches

- *This review shows that safety interventions combining group or organizational level components provide moderate evidence of a strong effect at medium-term follow-up, and limited evidence of moderate effect at long-term follow-up*
- *This review found that engineering controls overall provide moderate to strong effects on reducing accidents at work. Strong effects were in particular seen in cases where the safety intervention works independently of human decision making or work practices, or where the risks were “designed out.”*



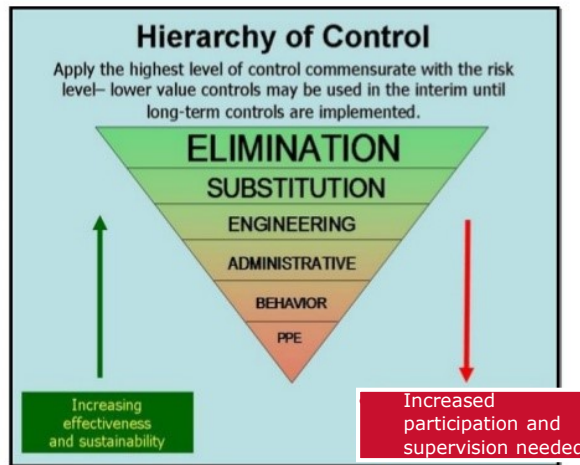
Prevention of accidents

Important principles in workplace prevention efforts

SIPAW results support the hierarchy of hazard controls
And the S.T.O.P. principle.



HIERARCHY OF CONTROLS



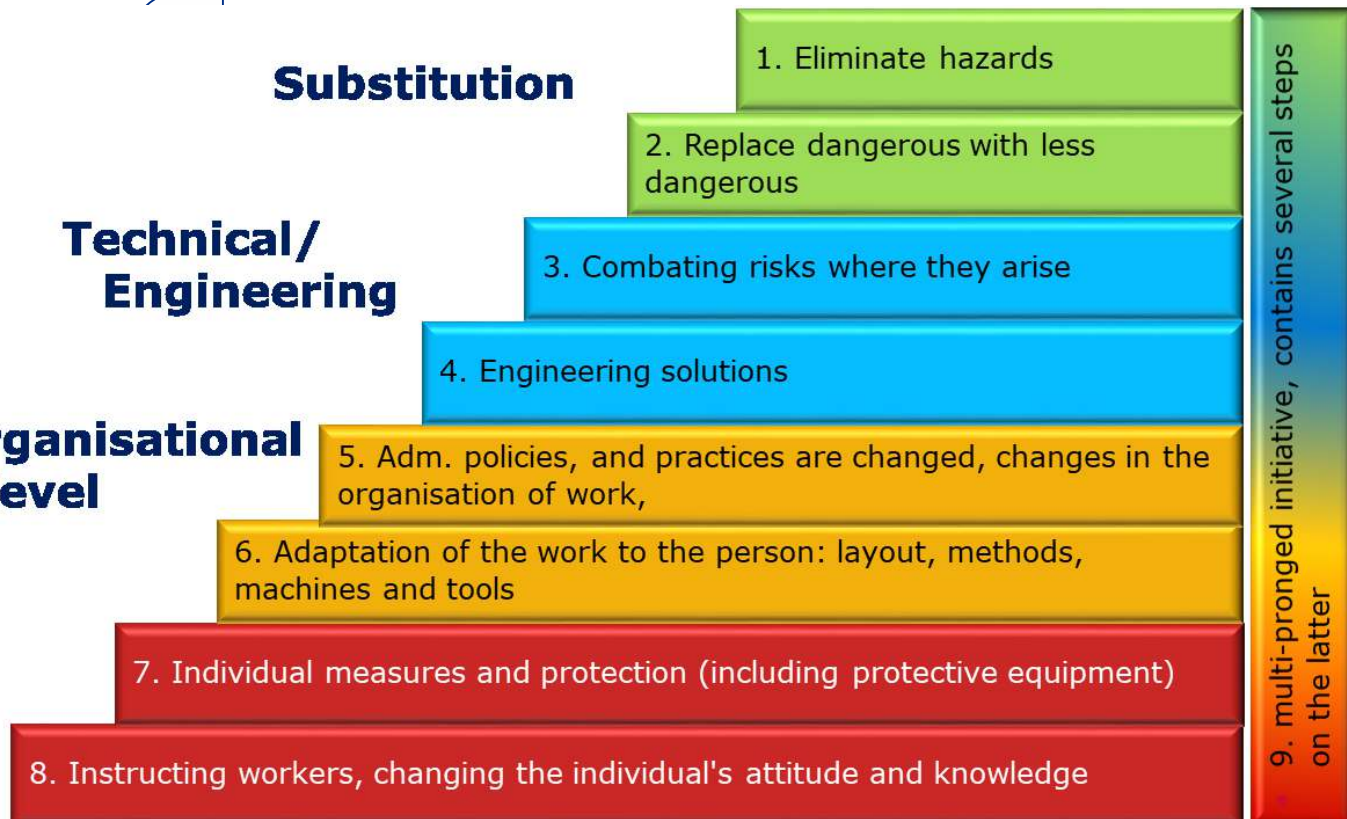
P

**Personal
level**

**Organisational
level**

**Technical/
Engineering**

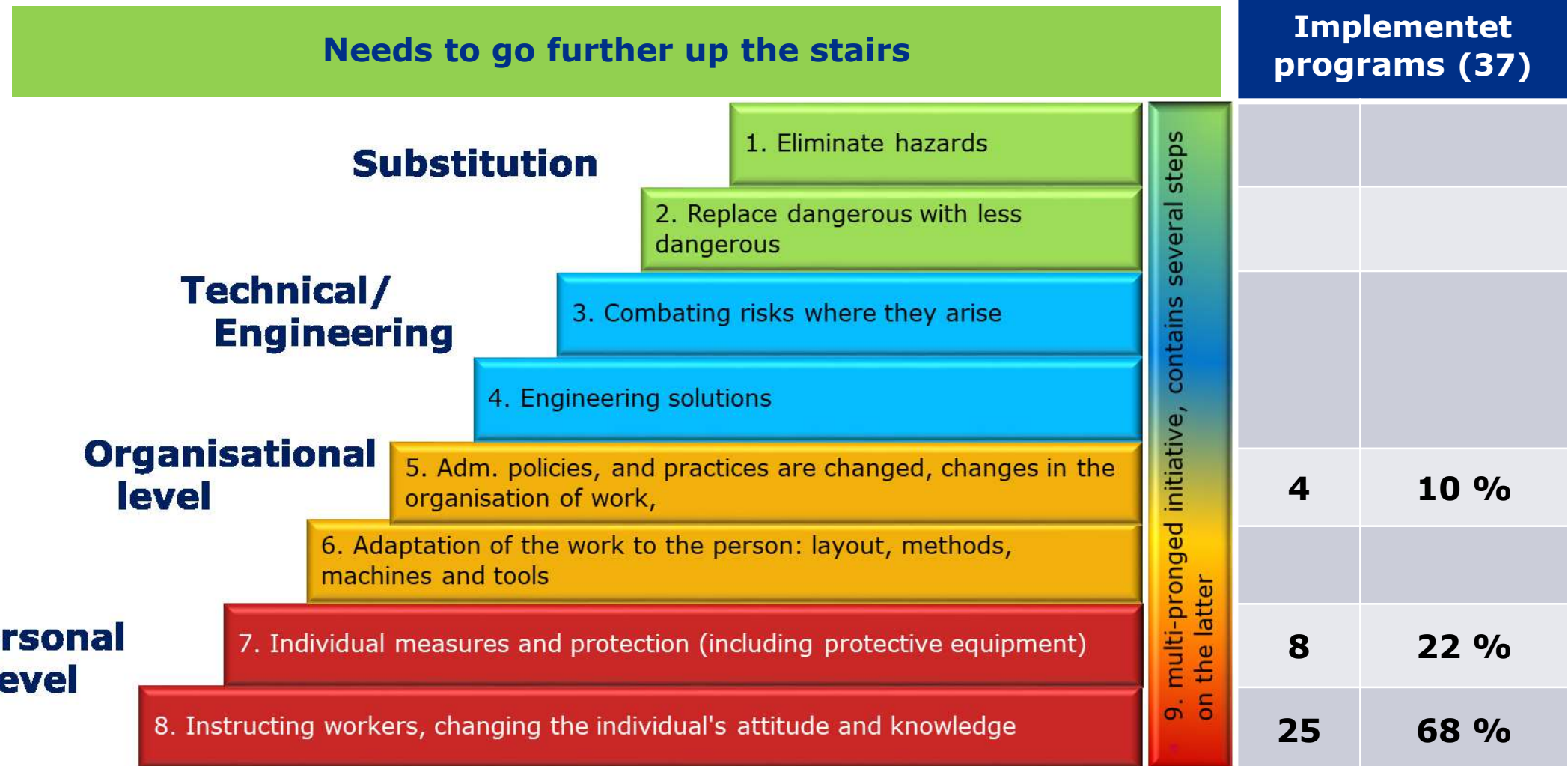
Substitution



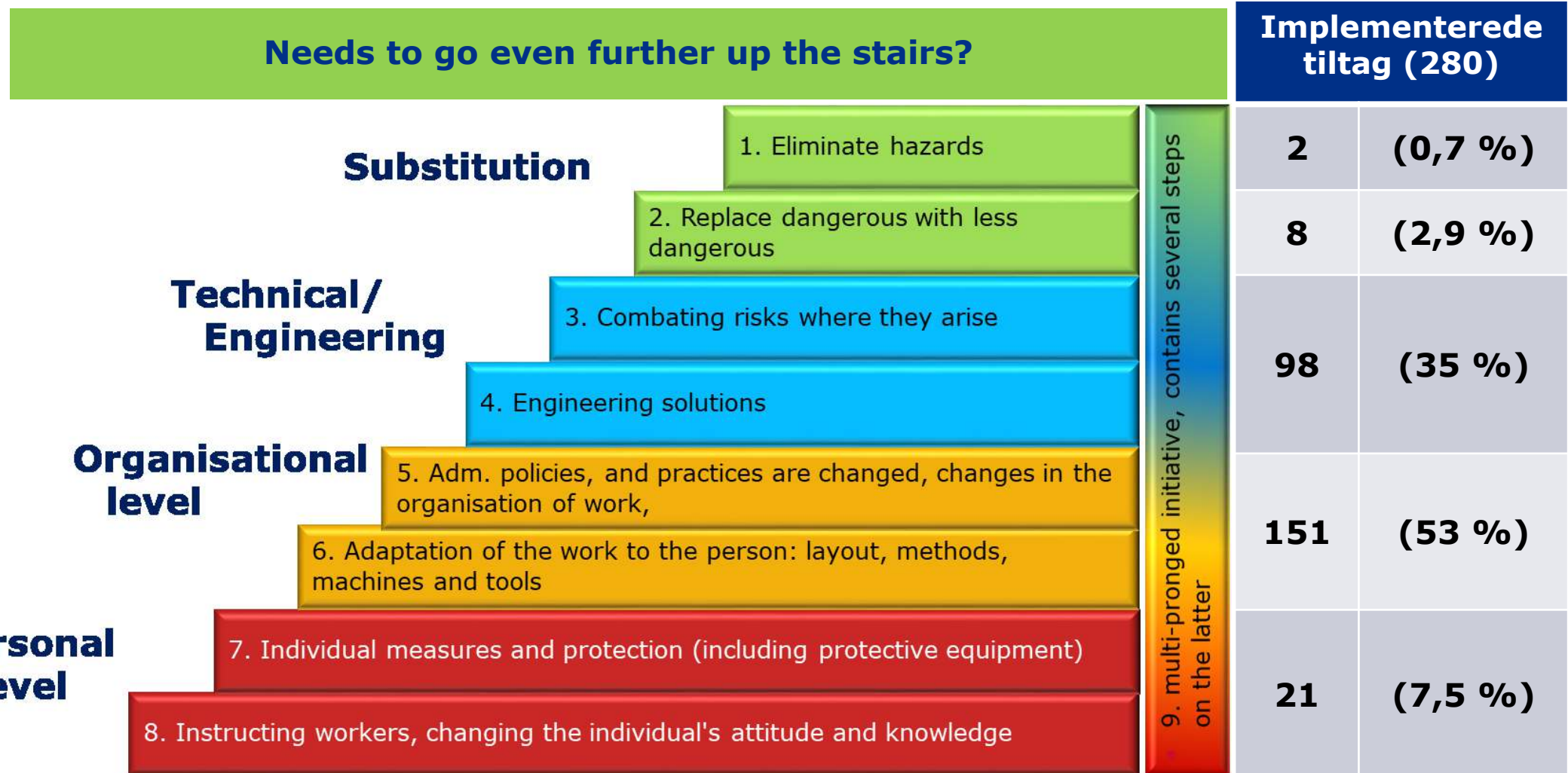
Hierarchy of hazard control OR the prevention ladder



37 prevention programs in Building industry – effective?



Safety coordinators in Building industry - effective approaches?



SYSTEMATIC REVIEW – Legislation and enforcement

Table 5.3: Summary of narrative analyses of safety interventions directed at group or organisational level, not included in meta-analysis, by quality assessment, level of evidence and evaluated strength of effect.

Number of safety interventions	Quality assessment				Level of evidence	Strength of Effect
Type of safety intervention and follow-up periods	high quality	moderate quality	low quality	Total	RCT, CBA and serial measures (ITS)	RCT, CBA and serial measures (ITS)
2.1.0. Climate, norms or culture modifications:						
2.1.1 Goal setting and FB at group or org. level		2	5	7		
2=Short-term (~12 months)		2	5	7	Limited	None
2.1.7 Leadership based safety interventions	1	2	1	4		
2=Short-term (~12 months)	1	2	1	4	Limited	Little to moderate
2.2.0. Structural modifications:						
2.2.1 Legislative changes	3	2	4	9		
4=Long-term (36- month)	1	0	8	9	Limited	Little to moderate
2.2.2 Economic incentives	2			2		
3=Medium-term (12-36 months)	1			1	Limited	Little to moderate
4=Long-term (36- month)	1			1	Limited	Not estimable
2.2.3 Soft regulation	1	2		3		
3=Medium-term (12-36 months)	1			1	Limited	None
4=Long-term (36- month)		2		2	Limited	None
2.2.4 Engineering controls	3	3	5	11		
2=Short-term (~12 months)			1	1	insufficient	Moderate
3=Medium-term (12-36 months)	3	1	1	5	Strong	Moderate
4=Long-term (36- month)		2	3	5	Limited	Little
2.2.5 Administrative controls		1	1	2		
2=Short-term (~12 months)		1		1	Insufficient	Not estimable
3=Medium-term (12-36 months)			1	1	Insufficient	Not estimable
2.2.7 Enforcement of laws and regulations	1	2	3	6		
4=Long-term (36- month)	1	2	3	6	Moderate	None to little
2.2.8 Social marketing and other approaches			1	1		
4=Long-term (36- month)			1	1	Insufficient	Very strong

Legislation

Enforcement

SYSTEMATIC REVIEW – Legislation and enforcement

Table 5.4: Summary of meta-analysis for a subset of structural safety interventions, directed at the organisational level, by type of safety intervention, quality assessment, level of evidence and strength of effect.

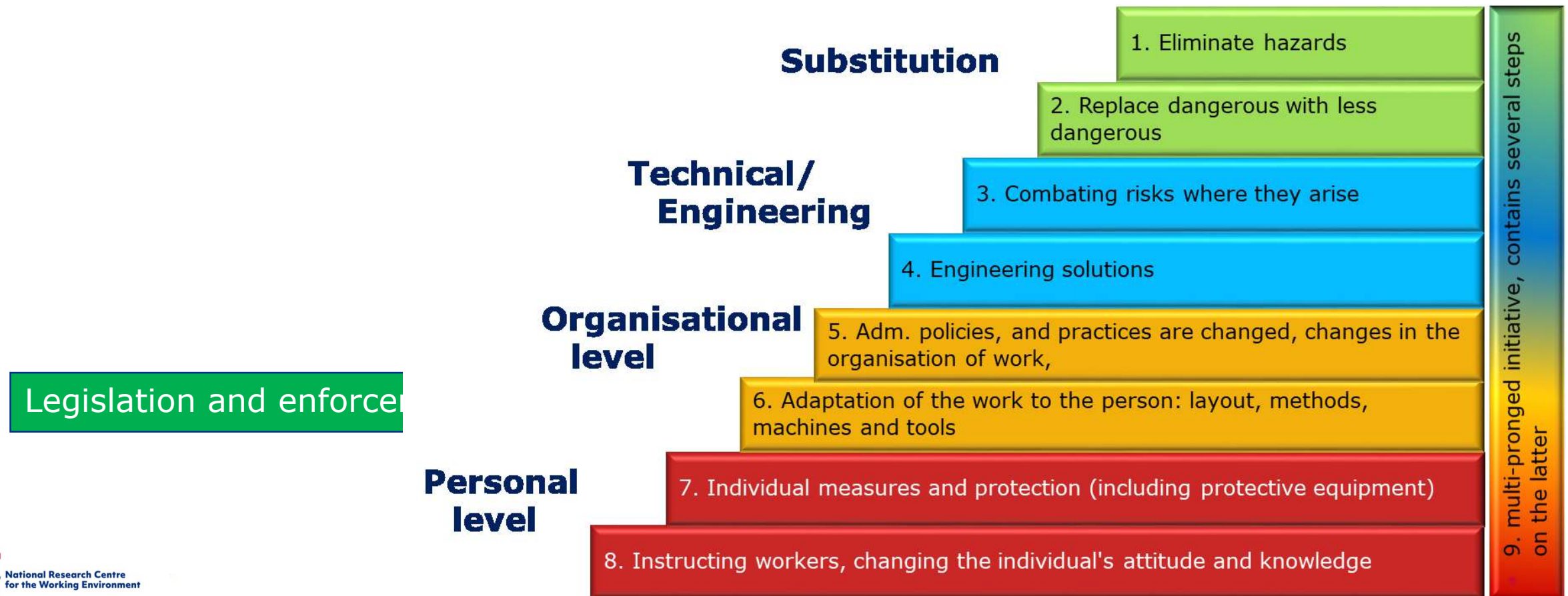
Number of safety interventions	Quality assessment				Level of evidence	Strength of effect	Meta-analysis (injury outcomes)			I ² RCT/CBA
Types of safety interventions and follow-up periods	high quality	moderate quality	low quality	Total	RCT and CBA	RCT and CBA	RCT	CBA		
2.2.0.: Structural safety interventions:										
2.2.4 Engineering controls	4	2		6						
1=Post-test	1			1	Limited	Strong to very strong	OR 0.33 [0.21, 0.51]			NA
2=Short-term (-12 months)	3			3	Strong	Moderate	OR 0.72 [0.29, 1.83]	OR 0.28 [0.10, 0.75]		NA/70%
3=Medium-term (12-36 months)		1		1	insufficient	Strong		OR 0.44 [0.26, 0.74]		NA
4=Long-term (36- month)		1		1	insufficient	Very strong		OR 0.27 [0.14, 0.52]		NA
2.2.7 Enforcement of laws and regulations	7		4	11						
2=Short-term (-12 months)	1			1	Limited	Little		OR 0.86 [0.77, 0.95]		NA
3=Medium-term (12-36 months)	2		4	6	Moderate	None to little	OR 0.99 [0.89, 1.10]	OR 0.95 [0.93, 0.97]		NA/0%
4=Long-term (36- month)	4			4	Strong	Little		OR 0.96 [0.93, 0.98]		0%
2.2.7 Enforcement of laws w/penalties	2			2						
3=Medium-term (12-36 months)	2			2	Moderate	None to little		OR 0.95 [0.92, 0.98]		0%

Enforcement →

Eksternal measures

Legislation and enforcement

Measures can also be external in the form of legislation, supervision, 'soft law' (political agreements, certification, activities and action plans at branch level, etc.), which encourage companies to take steps or concrete actions to improve the working environment.



Thank you!

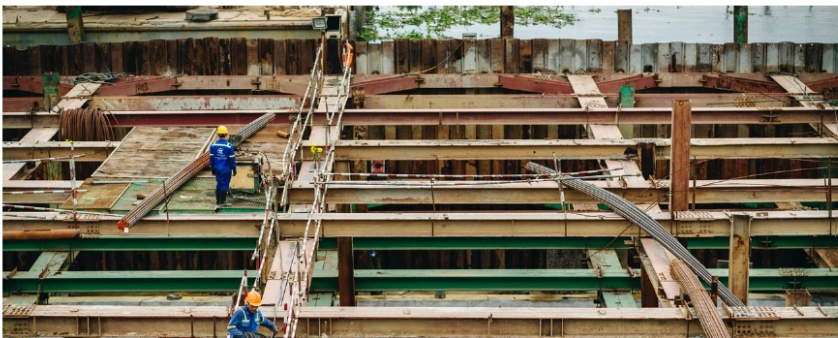
- Thanks to co-authors:
- [Hester Johnstone Lipscomb](#), [Kent Nielsen](#), [Marianne Törner](#), [Kurt Rasmussen](#), [Karen Bo Frydendall](#), [Hans Bay](#), [Ulrik Gensby](#), [Elizabeth Bengtsen](#), [Frank Guldenmund](#), [Pete Kines](#)

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Target the organization before the individual, when preventing accidents at work



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LATEST RESEARCH

If you want to prevent accidents at work – then think about social, cultural or organizational aspects – before the individual.

Plain Language Summary
Social Welfare

2022

Occupational safety interventions directed at the group or organisational level are more effective in preventing accidents than individual-level measures

Occupational safety interventions directed at the group or organisational level are more effective at improving safety and behaviour and reducing accidents at work than interventions directed solely at the individual level.

Multifaceted measures are particularly effective when they include elimination, substitution or other engineering controls. Safety regulation and enforcement contribute to the prevention of accidents at work, but with lesser effect.

Thank you for your attention!



Contact: Johnny Dyreborg
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