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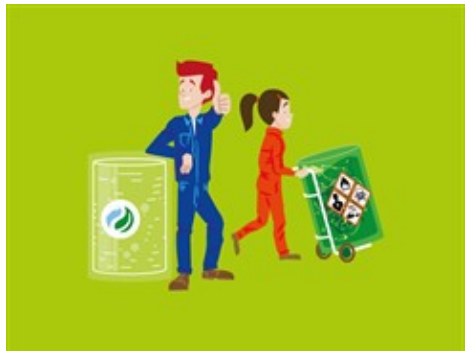
Safety interventions for the prevention of accidents at work (SIPAW)

'*Hvilke sikkerhetstiltak virker?*'



KundskabsArena:

Sikkerhetsledelse i prosjekter – Sikkerhetstiltak for forebygging av arbeidsulykker

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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,
Division for Safety Culture and Accident Research

SYSTEMATIC REVIEW / PUBLICATIONS

CAMPBELL SYSTEMATIC REVIEWS
Campbell Collaboration

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SYSTEMATIC REVIEW

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

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SYSTEMATIC REVIEW – OBJECTIVES

Preventing accidents at work – what works?

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

What is a safety intervention?

Safety interventions are defined as:

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

Such accidents may subsequently have consequences in terms of work absence, disability, and other personal or economic costs.

Types of safety interventions: Attitudinal approaches

Attitudinal approaches focus on the modification of attitudes and knowledge and their consequences for behavior and accidents (Lund & Aarø, 2004), which mainly explain behavior in terms of internal mental states and cognitive processes – also known as the **KAP model**: Knowledge-Attitudes-Practice model.

Types of safety interventions: Physiological modifications

Physiological modifications focus on improving the physiological capacity of individuals through various training methods, such as, endurance training, such as running, cycling, swimming, etc.; strength and resistance training, such as push-ups, pull-ups, weight training, interval training etc.; flexibility exercises, such as stretching to improve joint flexibility; which all aim to reduce the risk of injury.

Types of safety interventions: Behavior based approaches

Behavior based approaches is about modifying behavior by use of environmental antecedents and consequences, such as incentives for safe behavior or punishment for unwanted behavior (Luthans & Kreitner, 1985).

This approach originated from B. F. Skinner, who suggested that humans choose various responses to receive a particular consequence (+/-). This contingency is framed as the Antecedent-Behavior-Consequence (A-B-C) model.

Types of safety interventions: Safety climate

Safety climate approaches are about modifying the shared perceptions among employees in an organization or group to influence the relative priority of safety enacted within the organization or the group, for example, what kinds of behavior are being rewarded and supported with regard to a specific strategic focus, such as safety at work (Zohar, 2010).

Types of safety interventions: Safety culture

Safety culture interventions can be briefly defined as changes in the shared basic assumptions, values, and beliefs concerning safety that characterize a work setting and are taught, often informally, to newcomers as the proper way to think and feel about safety (Zohar & Hofmann, 2012). Safety culture is thus, compared to safety climate, changes in the deeper (tacit) taken for granted assumptions and values that govern organizational life (Schein, 2004; Schneider et al., 2013).

Types of safety interventions: Structural approaches

Structural approaches comprise varied modifications of:

The regulatory environment, such as enforcement and regulation;

The organizational environment, organizational approaches, such as introduction of internal control systems etc.

Engineering control, such as, introduction of machine safeguards, walkways, elimination of hazardous substances or materials.

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Types of safety interventions: Multifaceted approaches

Multifaceted approaches usually integrates several components in the prevention of accidents at work. Research has emphasized the importance of integrating these various components to achieve a higher level of safety at work (DeJoy, 2005; Guastello, 1993).

We identified three types of multifaceted:

- Multifaceted at the organizational level
- Multifaceted at the individual level
- Multifaceted across the levels

SYSTEMATIC REVIEW – STUDY SELECTION

Litterature 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 litterature.

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**

SIPAW: types of safety interventions in SIPAW

Main types of safety interventions		
Rækkenavne	**Number**	**Proportion**
1.1.0 Attitude modification	11	9%
1.2.0 Behaviour modification	7	6%
1.3.0 Modification of physical strength and resistanc	5	4%
2.1.0 Climate modifications	11	9%
2.2.0 Structural modifications	49	41%
3.0.0 Multifaceted interventions	37	31%
Total	120	100%

SIPAW: types of safety interventions in SIPAW

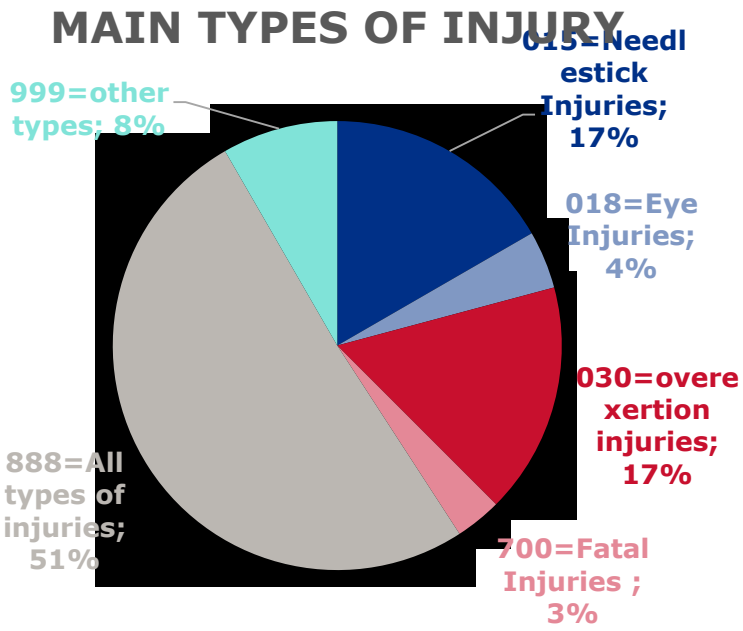
Structural safety interventions	Number	proportion
2.2.1 Legislative changes	10	20%
2.2.2 Economic incentives	2	4%
2.2.3 Soft regulation	3	6%
2.2.4 Engineering controls	19	39%
2.2.5 Administrative controls	2	4%
2.2.7 Enforcement of laws and regulations	12	24%
2.2.8 Social marketing and other approaches	1	2%
Total	49	100%

SYSTEMATISK REVIEW RESULTS

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

Number of studies for each study design for the five continents of the world.

Continent (study design: conduct):	RCT	CBA	ITS	Total
AFRICA		1		1
ASIA	4	2	1	7
AUSTRALIA	1	2	4	7
EUROPE	5	8	14	27
NORTH AMERICA	6	17	35	58
Number of studies	**16**	**30**	**54**	**100**



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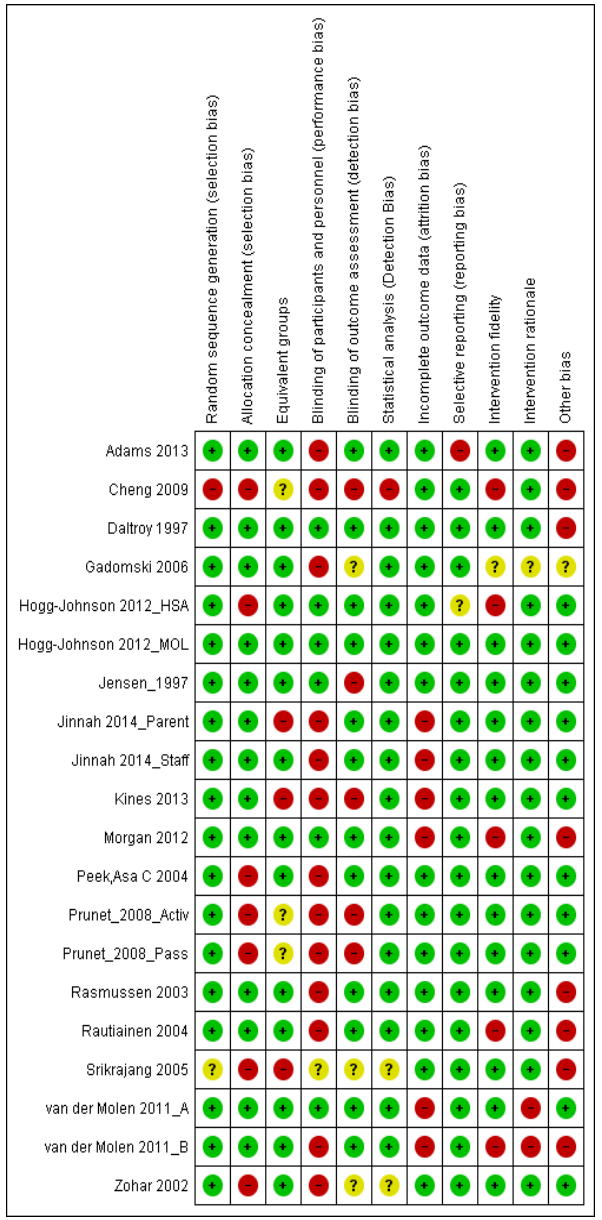
SYSTEMATIC REVIEW QUALITY ASSESSMENT

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

Not Campbell Collaboration standards, but used for the sake of communication

Baseret på: Tompa E, Dolinschi R, de Oliveira C, Irvin E. A systematic review of OHS interventions with economic evaluations. Toronto: Institute for Work & Health, 2007.



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SYSTEMATIC REVIEW QUALITY ASSESSMENT

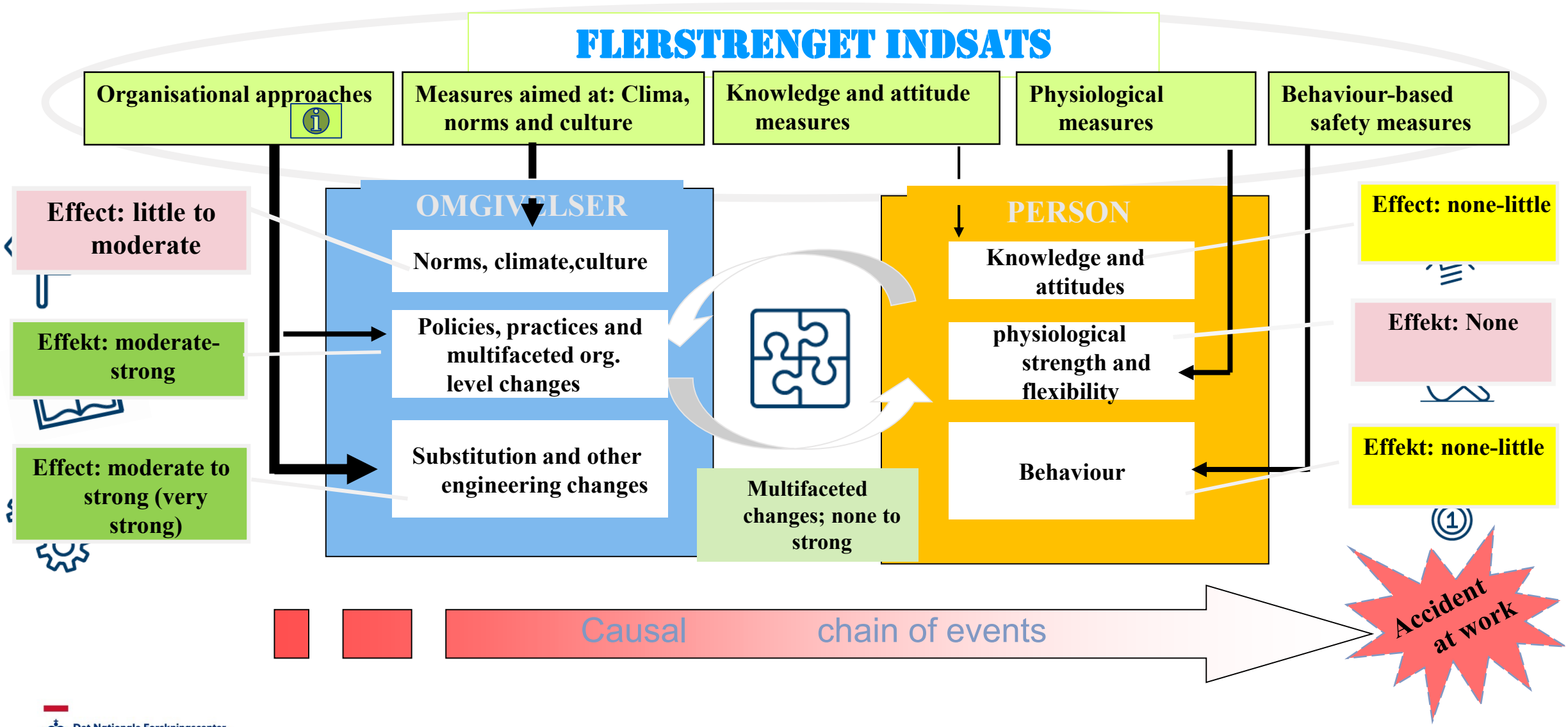
Effect sizes / intervals

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 dissimiation purposes.
- Campbell Collaboration standards is just using point estimates and confidens intervals

What works in accident prevention? OVERVIEW



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Conceptual model based on: Lund, J. and Aarø, L. E., (2004) Accident prevention, Safety Science

Johnny Dyreborg, Kent Nielsen, Pete Kines, Angelika Dziekanska, Karen Bo Frydendall, Elizabeth Bengtsen og Kurt Rasmussen. Review af ulykkesforebyggelse - - review af den eksisterende videnskabelige litteratur om effekten af forskellige typer sikkerhedstiltag til forebyggelse af arbejdsulykker.

Summary individual level approaches

- *Overall, this review found a weak link between individual level approaches and reducing accidents at work. It seems that knowledge and attitudes are overruled by the social or organizational 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 organisational level approaches

- *This review found 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 a moderate effect at long-term follow-up*

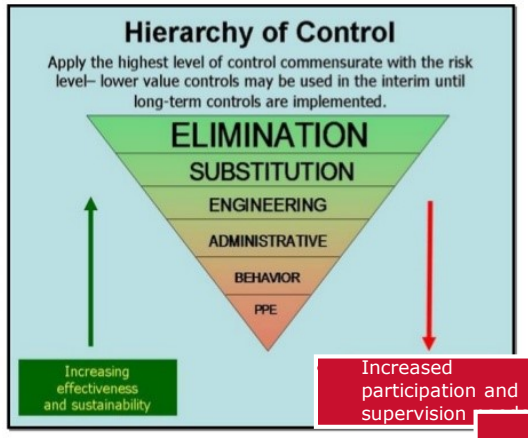
- *This review found that engineering controls overall provide moderate to strong effects on reducing accidents at work. Strong effects were in particular seen in cases where the safety intervention works independently of human decision making or work practices, or where the risks were "designed out."*

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



S — **Substitution**

1. Eliminate hazards
2. Replace dangerous with less dangerous

T — **Technical/ Engineering**

3. Combating risks where they arise
4. Engineering solutions

O — **Organisational level**

5. Adm. policies, and practices are changed, changes in the organisation of work,
6. Adaptation of the work to the person: layout, methods, machines and tools

P — **Personal level**

7. Individual measures and protection (behavioral)
8. Instructing workers, changing the individual's attitude and knowledge (PPE)

9. Multifaceted safety interventions, incl. several steps on the prevention latter

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Hierarhy of hazard control OR the prevention latter

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Eksternal control – LEGISLATION AND ENFORCEMENT

Number of studies

TABEL: Legislation and enforcement:

Main types of injury	Antal af tiltag
2.2.1 Legislative changes	**10**
888=All types of injuries	6
015=Needlestick Injuries	1
700=Fatal Injuries	3
2.2.7 Enforcement of laws and regulations	**12**
888=All types of injuries	10
030=overexertion injuries (dislocations, sprains and strains)	2
2.2.3 Soft regulation	**3**
888=All types of injuries	1
030=overexertion injuries (dislocations, sprains and strains)	2
Number of safety interventions	**25**

TABEL: Lovgivning og tilsyn fordelt på:

Main types of accident	Antal af tiltag
2.2.1 Legislative changes	**10**
1=All types of accident	1
2=contact with electrical voltage	1
4=Tripping, stumbling and falling	2
5=Collision and other horizontal impact on body	1
6=Trapped, crushed, struck by equipment or objects	1
7=contact with sharp or pointed materials or tools	1
9=Assault or violence at work.	2
(tom)	1
2.2.7 Enforcement of laws and regulations	**12**
1=All types of accident	7
5=Collision and other horizontal impact on body	2
6=Trapped, crushed, struck by equipment or objects	1
8=overexertion of the musculoskeletal system	2
2.2.3 Soft regulation	**3**
1=All types of accident	1
8=overexertion of the musculoskeletal system	2
Number of safety interventions	**25**

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)		
Types of safety interventions and follow-up periods	high quality	moderate quality	low quality	Total	RCT and CBA	RCT and CBA	RCT	CBA	I^2 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

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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

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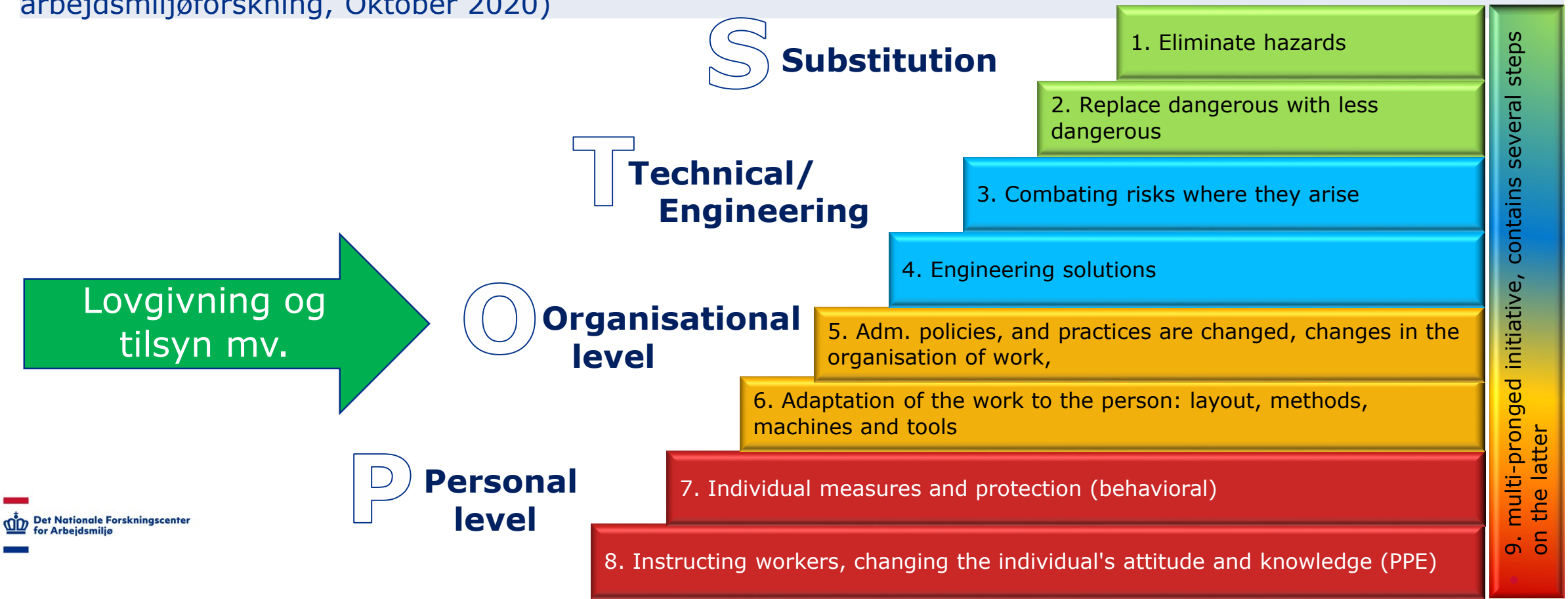
Eksternal Control
Prevention of accidents

Lovgivning og tilsyn

Virkemidler kan også være eksterne i form af lovgivning, tilsyn, 'soft law' (politiske aftaler, certificering, aktiviteter og handleplaner på brancheniveau etc.), som tilskynder virksomheder til indsatser eller konkrete handlinger til forbedring af arbejdsmiljøet (Beskæftigelsesministeriet: National strategi for arbejdsmiljøforskning, Oktober 2020)



SIPAW: SIZE OF POPULATION IN INCLUDED STUDIES

Tabel: Size of population for various types of structurel safety interventions

Rækkenavne	Sum af Code (firms)	Sum af Code2 (indiv)
2.2.0 Structural modifications	**392.611**	**31.827.506**
2.2.1 Legislative changes	8.193	16.215
2.2.2 Economic incentives	0	1.888
2.2.3 Soft regulation	174.162	0
2.2.4 Engineering controls	655	51.102
2.2.5 Administrative controls	22	312
2.2.7 Enforcement of laws and regulations	209.579	31.752.488
2.2.8 Social marketing and other approaches	0	5.501
Hovedtotal	**392.611**	**31.827.506**

- Even though effect sizes were modest, population-based impact can be considerable, given the number of work sites and workers that potentially can be affected through legislative interventions.

SIPAW

Thank you for listening!

- 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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