

# Age and gender in assessing manual materials handling

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and

*The Dortmund Lumbar Load Study Group – DOLLY*



# Assessing manual materials handling

Min Lab Soc Aff – Recommendation 1981



**1981:**

Recommendation of Germany's

Ministry of Labour and Social Affairs:

Load-mass percentage  
(females to males)

27% ... 50%

Load-mass percentage  
(young/old to adult)

100% / 64-83%

## Tolerable load masses for lifting and carrying

age	occasionally		frequently	
	< 2 per hour		> 2-3 per hour	
	females	males	females	males
15-18 yrs.	15 kg	35 kg	10 kg	20 kg
19-45 yrs.	15 kg	55 kg	10 kg	30 kg
> 45 yrs.	15 kg	45 kg	10 kg	25 kg



# Assessing manual materials handling

European Directive 1990 – 90/269/EEC



1990: Minimum health and safety requirements for the manual handling of loads where there is a risk particularly of back injury to workers (cont.)

## ANNEX I:

### 1. Characteristics of the load

The manual handling of a load may present a risk particularly of back injury if it is:

- too heavy or too large,
- unwieldy or difficult to grasp,
- unstable or has contents likely to shift,
- ... to be held or manipulated at a distance from the trunk, or with a bending or twisting of the trunk ***etc.***



**1996:** Conversion to national regulation

**Key-indicator methods 2001 – Lifting and carrying**

Federal Institute for Occupational Safety and Health



Heben und Tragen  
ohne Schaden

**baua:**  
Bundesanstalt für Arbeitsschutz  
und Arbeitsmedizin

Lifting and carrying  
without harm

**SUMMARY – Lifting and carrying:**

Mass-related risk gender-specific  
(females to males)  
score doubled

Total-score evaluation age-related:  
overstrain risk at lower score



**1996:** Conversion to national regulation

**Key-indicator method 2002 – Pulling and pushing**

Federal Institute for Occupational Safety and Health

**SUMMARY – Pulling and pushing:**

Total score gender-specific  
(females to males):  
score 1.3

Total-score evaluation age-related:  
overstrain risk at lower score



Ziehen und Schieben  
ohne Schaden

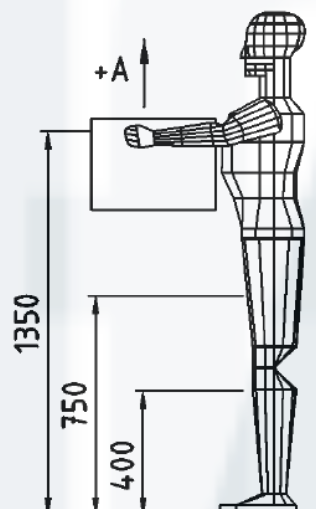
**baua:**  
Bundesanstalt für Arbeitsschutz  
und Arbeitsmedizin

Pulling and pushing  
without harm

# Assessing manual materials handling

Maximum force exertion – Standard in Germany



force direction	grasp height in mm	force percentiles	force values in N	
			females	males
	1350 grasping at sides	5. 10. 15. 50. 95.	123 134 144 186 268	268 305 323 417 570
	1100 grasping underneath	5. 10. 15. 50. 95.	153 176 190 248 353	353 393 419 541 784
...				
nf = 1113 33±10 yrs.  nm = 1967 34±10 yrs.	400 grasping at sides	5. 10. 15. 50. 95.	281 326 349 490 770	603 687 762 1108 1651
	150 grasping underneath	5. 10. 15. 50. 95.	256 301 338 470 689	587 678 736 971 1324

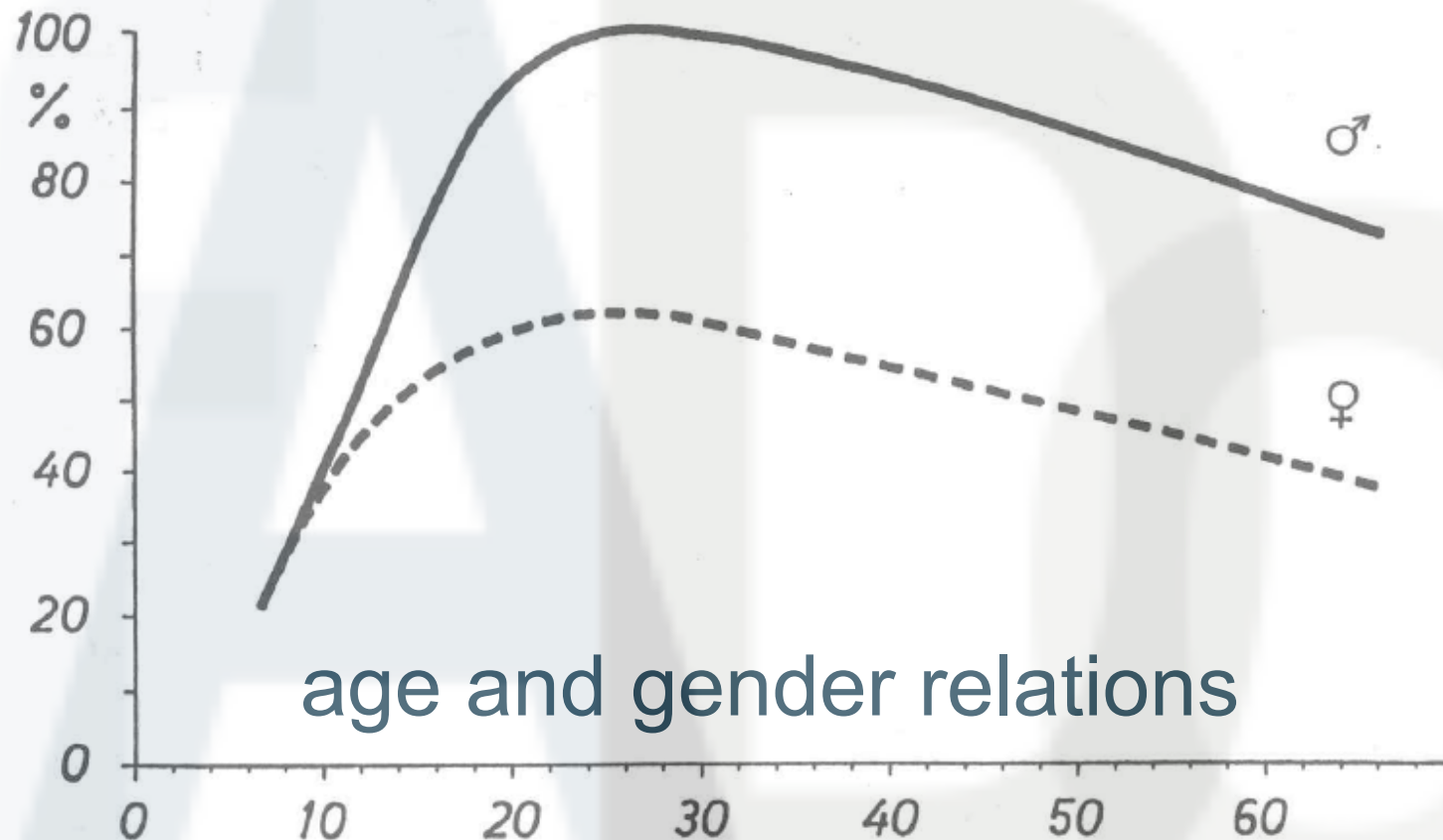
adapted from DIN 33411-5

# Assessing manual materials handling

Maximum force exertion – Age and gender



maximum isometric force in %



age and gender relations

max-force percentage  
(females to males)  
≈ 50 ... 60%

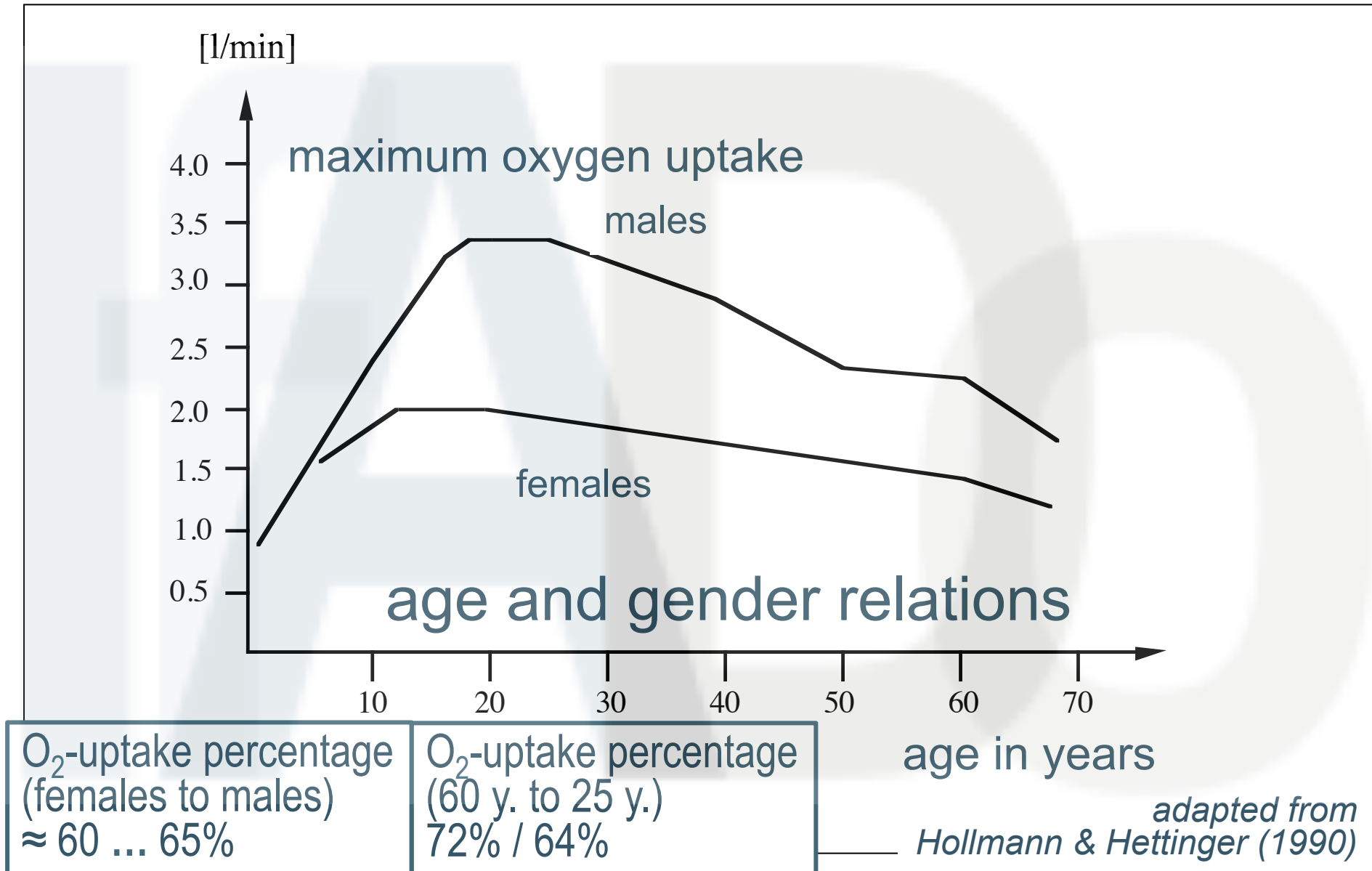
max-force percentage  
(60 yrs. to 25 yrs.)  
65% / 80%

age in years  
basis: 6.009 measurements –  
*adapted from Schmidtke (1993)*



# Assessing manual materials handling

Metabolic capacity – Age and gender







**Table A.1** Tolerabilities and capabilities in relation to lifted object mass  
– adult working population

Options	Psychophysical data indicating tolerability capacity	Measurements of forces indicating limits	Measurements on the maximum metabolic ability limits
10 kg	99 % (F + M)	99 % (F + M)	99 % (F + M)
	99 % F 99,9 % M -1%	99 % F 99,9 % M -1%	99 % F 99,9 % M -1%
20 kg	95 % (F + M)	95 % (F + M)	95 % (F + M)
	90 % F 99,9 % M -10%	90 % F 99,9 % M -10%	80 to 85 % F 99 % M -24+%
25 kg	85 % (F + M)	85 % (F + M)	85 % (F + M)
	75 % F 99,9 % M -25%	72 to 75 % F 99,9 % M -25+%	70 % F 99 % M -29%

... reduced for females related to males



**Table 1 — Reference mass ( $M_{ref}$ ) taking into consideration the intended user population**

Field of application	$M_{ref}$ [kg]	Percentage of (protected)			Population group	
		F and M	Females	Males		
Domestic use <sup>a</sup>	5	Data not available			Children and the elderly	Total population
	10	99	99	99	General domestic population	
Professional use (general) <sup>b</sup>	15	95	90 -10%* -10%**	99 -22%**	General working population, including the young and old	General working population
	25	85	70 -22%*	90	Adult working population	
Professional use (exceptional) <sup>c</sup>	30	Data not available			Special working population	Special working population
	35					
	40					

\*reduced protection for females related to males

\*\*reduced protection for adults (f+m) due to higher ref mass

<sup>a</sup> When designing a machine for domestic use, 10 kg should be used as a general reference mass in the risk assessment. If children and elderly are included in the intended user population, the reference mass should be lowered to 5 kg.

<sup>b</sup> When designing a machine for professional use, a reference mass of 25 kg should not be exceeded in general.

<sup>c</sup> While every effort should be made to avoid manual handling activities or reduce the risks to the lowest possible level, there may be exceptional circumstances where the reference mass might exceed 25 kg (e.g. where technological developments or interventions are not sufficiently advanced). Under these special conditions other measures have to be taken to control the risk according to EN 614-1 (e.g. technical aids, instructions and / or special training for the intended operator group).



Approach's components		
	short-term exposures	long-term exposures
lumbar load	biomechanical modelling <i>The Dortmund</i> (3-D dynamic)	time courses (3-D) + cumulative doses <i>The <u>D</u>ortmund <u>L</u>umbar <u>L</u>oad Study – DOLLY (1995-2000)</i>
lumbar load-bearing capacity	compressive-strength tests <i>The Dortmund Recommendations</i> (comp-force limits)	dose-response relations <i>German Spine Studies ('01-'14)</i> (epidem substantiation) <i>The Mainz-Dortmund Dose Model</i> (1999: OD evaluation)

## *The Dortmund Recommendations*

... regarding manual handling



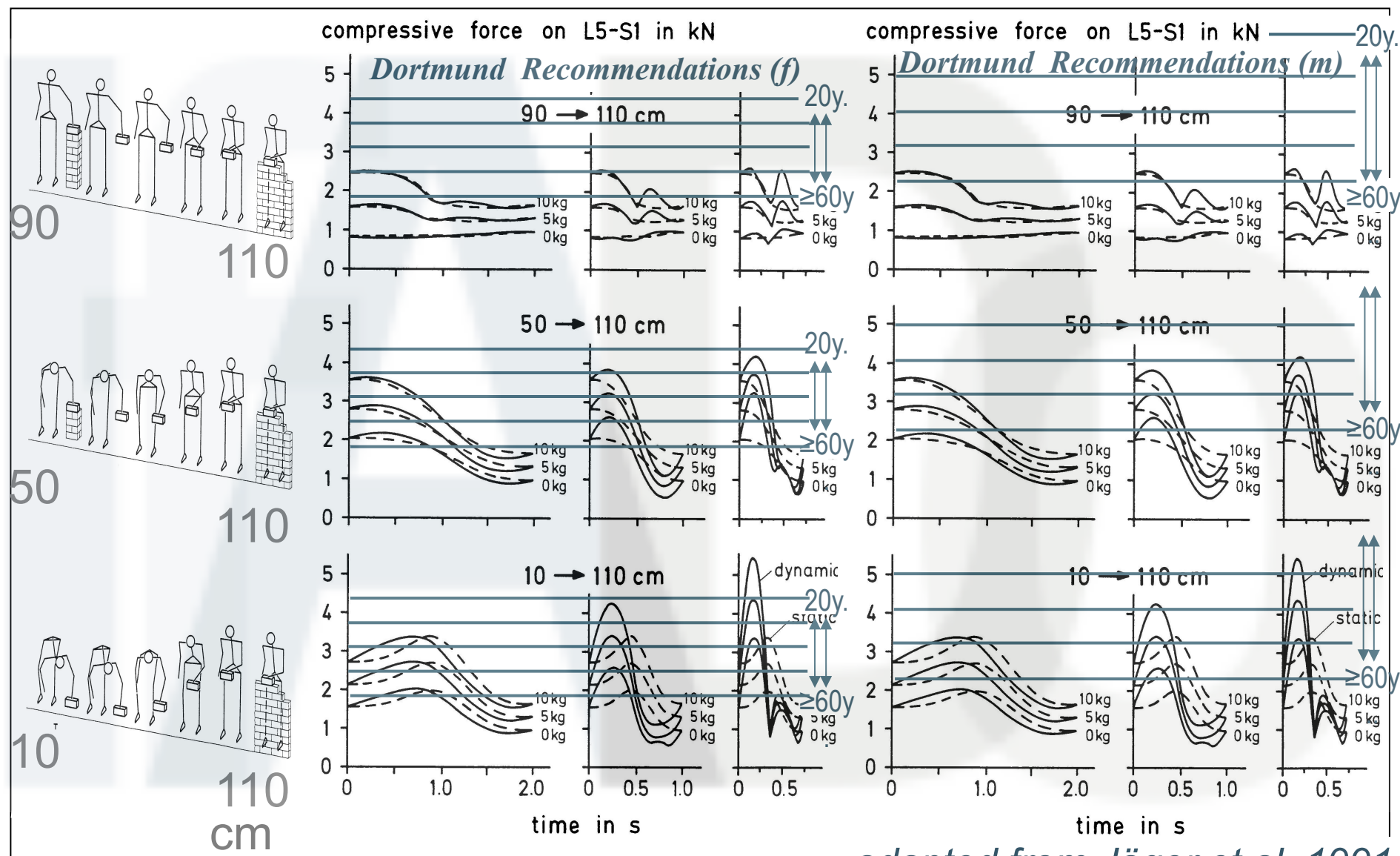
### Compressive-force limits on lumbar segments

Age	Female	Male
20 years	4.4 kN	6.0 kN
30 years	3.8 kN	5.0 kN
40 years	3.2 kN	4.1 kN
50 years	2.5 kN	3.2 kN
≥ 60 years	1.8 kN	2.3 kN

... considered in ISO 11228-2 (push +pull) and ISO/TR 12296 (man pat hand)

# Situative lumbar load – Evaluation

## L5-S1 compressive force vs. Recommended limits



adapted from Jäger et al. 1991





German early "legislation": **age + gender considered**

European legislation: no concrete recommendation (national governments!)

German conversion "Key-indicator methods": **age + gender considered**

Individual capabilities (e.g. max force production, metabolic capacity):

**strong dependencies on age + gender**

European standardization (e.g. lifting: NIOSH lifting Equation):

**protection** via **age-and-gender related** reference masses

Mechanical load-bearing capacity of the lumbar spine (short-term exposures):

**strong dependencies on age + gender** (cf. *The Dortmund Recomm.*)

Dose-response relations "cumul life-time lumbar load vs. degen. diseases":

**strong dependencies on gender** (cf. *The German Spine Study*)



You have seen  
many, many numbers  
( *you may forget !* )

The influences  
of **AGE + GENDER**  
on human  
abilities,  
capabilities,  
tolerabilities

*you  
should  
not  
forget,  
please !!*





# (my) main conclusion

**? Consideration of age + gender reasonable ?**

**!! YES !!**

**To protect working persons** *(on the one hand)*

and

**to avoid restricted productivity** *(on the other hand)*



# Age and gender in assessing manual materials handling



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