Aggiornamento di procedure e di criteri di applicazione della Checklist OCRA Colombini et al. Med Lav 2011; 102

Figura 1 - Il sistema OCRA e i suoi tre strumenti
Figure 1 - *The OCRA system and its three tools*

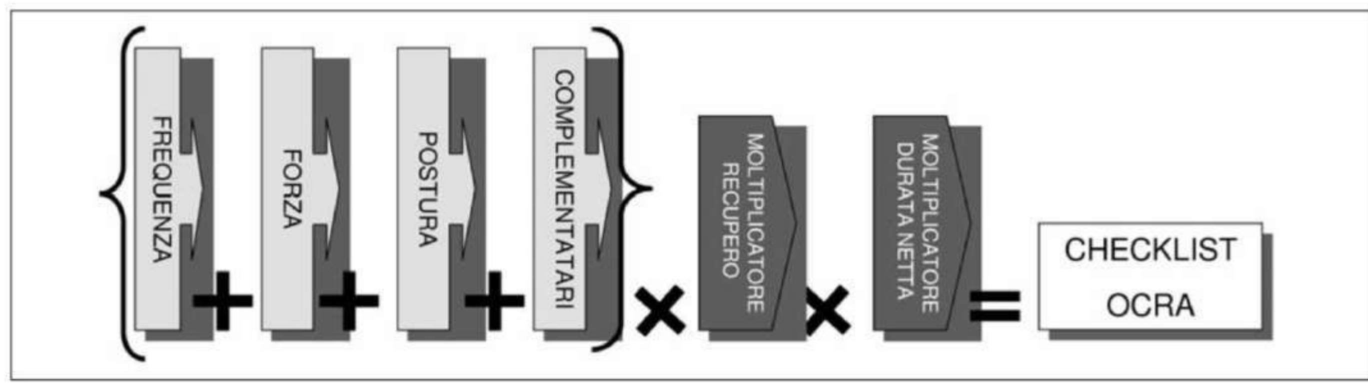


Figura 2 - La nuova procedura di calcolo finale della checklist OCRA
Figure 2 - *New calculation procedure to obtain final result of OCRA checklist*

Tabella 17 - Criteri di classificazione (per fasce di esposizione) dei valori finali dell'indice OCRA e della checklist OCRA e corrispondente stima della occorrenza attesa (%) di lavoratori con patologie degli arti superiori (UL-WMSDs)
Table 17 *- Classification criteria (by level of exposure) of final values of OCRA index and of OCRA checklist and corresponding forecast of expected prevalence (%) of workers affected by UL-WMSDs*

CHECK LIST	INDICE OCRA	FASCE	RISCHIO	Previsione dei patologici UL-WMSDs (%)
fino a 7,5	fino a 2,2	VERDE	RISCHIO ACCETTABILE	**Inf. a 5,3**
7,6 – 11,0	2,3 – 3,5	GIALLA	BORDERLINE O RISCHIO MOLTO LIEVE	**5,3 - 8,4**
11,1 – 14.0	3,6 - 4,5	ROSSO LEGGERO	RISCHIO LIEVE	**8,5- 10,7**
14,1 – 22,5	4,6 – 9,0	ROSSO MEDIO	RISCHIO MEDIO	**10,8- 21,5**
≥ 22,6	≥ 9,1	VIOLA	RISCHIO ELEVATO	**Sup. a 21,5**

I valori di riferimento basati sull'analisi del campione sopradescritto sono stati poi riproposti invariati, sia per OCRA Index sia per OCRA Check-list, in un più recente contributo metodologico pubblicato nel 2011

(*D. Colombini, E. Occhipinti, M. Cerbai, N. Battevi, M. Placci: Aggiornamento di procedure e di criteri di applicazione della Checklist OCRA Med Lav 2011; 102****).***

STRAIN INDEX (prima versione 1995)

Moore J.S., Garg A. The Strain Index: a proposed method to analyze jobs for risk of distal upper extremity disordersAm Ind Hyg Assoc J. 1995 May;56(5):443-58

- Stima sei variabili lavorative:
  1. Intensità dello sforzo
     Intensity of exertion
  2. Durata dello sforzo (%)
     Duration of exertion per cycle
  3. Sforzi al minuto
     Efforts per minute
  4. Posture mano/polso
     Wrist posture
  5. Ritmo di lavoro
     Speed of exertion
  6. Durata del compito (ore)
     Duration of task per day

- Metodo semiquantitativo
- Assegnazione di una valutazione su scala ordinale a ciascuna variabile
- Calcolo **dell’indice (SI)** secondo valori moltiplicativi attribuiti a ciascuna variabile (prodotto dei valori ottenuti dalla valutazione delle 6 variabili)
- Si ottiene lo “SI Score”:
- Interpretazione del risultato: lavori associati ad un aumentato rischio di patologie muscoloscheletriche della porzione distale dell’arto superiore hanno SI>5

Lavori probabilmente sicuri **SI <=3**
Lavori di incerta valutazione rispetto al rischio **3<SI<7**
Lavori probabilmente pericolosi **SI>=7**

TLV-ACGIH (prima versione 1997-2000)

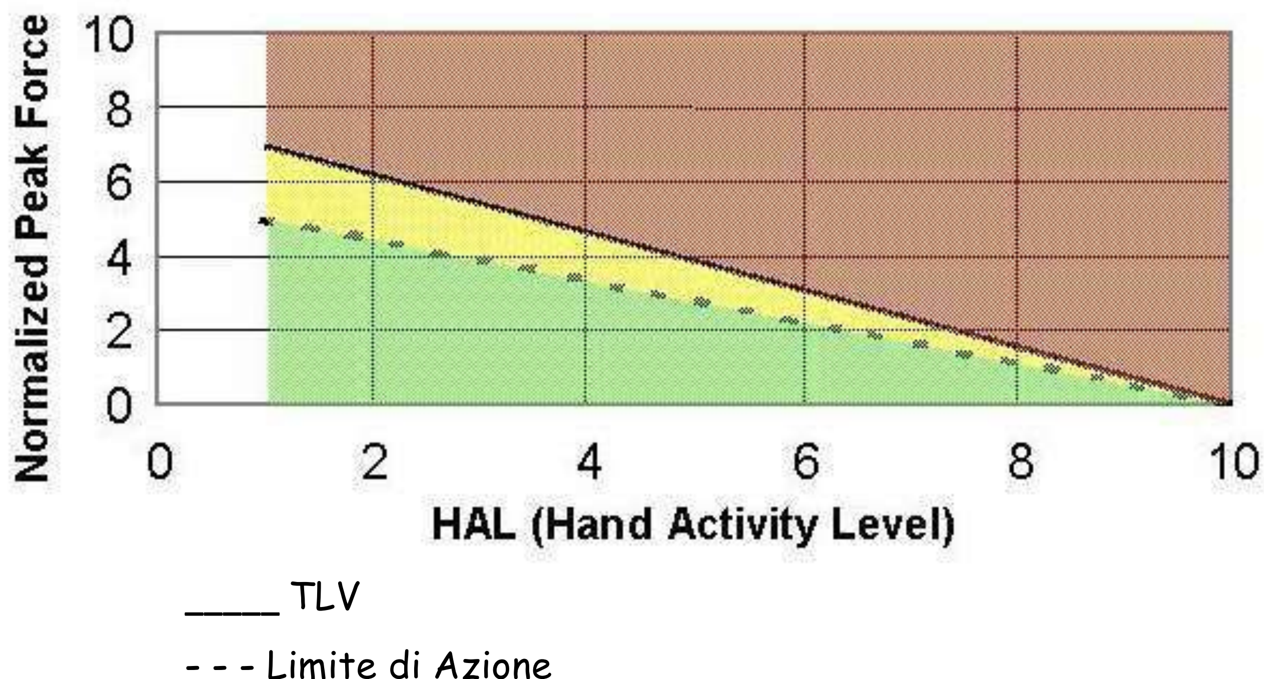
American Conference of Governmental Industrial Hygienists (ACGIH). TLVs and BEIs 2000: Threshold limit values foe chemical substances and chemical agents. Cincinnati (OH)

Latko WA, Armstrong TJ et al. Development and evaluation of an observational method for assessing repetition in hand tasks. Am Ind Hyg Assoc J 1997; 58: 278-85

- Metodo quantitativo
- Riferito al distretto mano-polso-avambraccio
- Applicabile a "mono task job" che comportino l'esecuzione di movimenti ripetitivi per almeno 4 ore al giorno
- Definisce un limite di esposizione (TLV) e un limite di azione (AL) per i compiti manuali

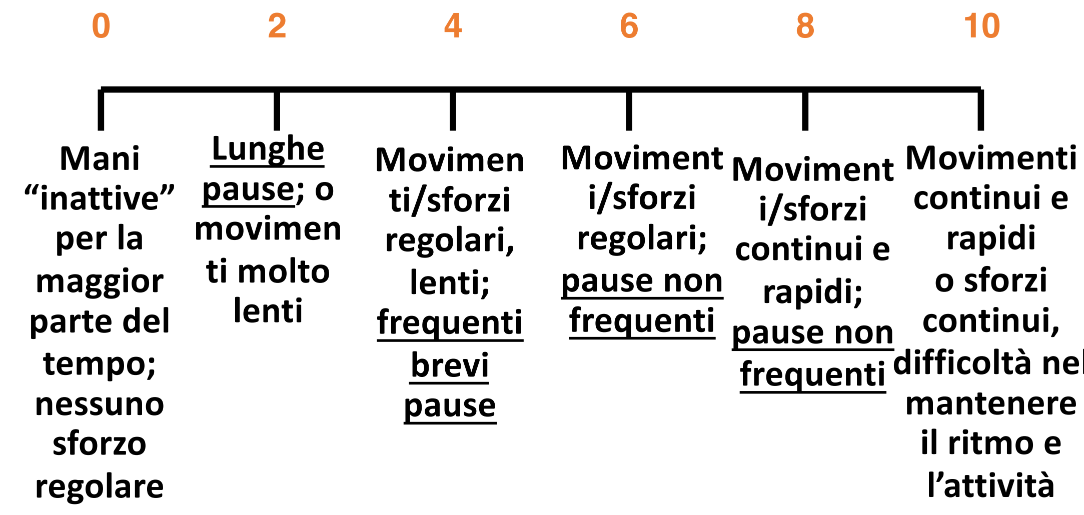
- TLV ottenuto dalla combinazione di due fattori:
  - ➡ Livello di attività manuale media (HAL)
  - ➡ Picco di forza normalizzato (Pf)
- Rimanda altri fattori al giudizio professionale

TLV-ACGIH



TLV-ACGIH

HAL *Hand Activity Level*
“Average Hand Activity Level is based on **The Frequency of Hand Exertions and the Duty Cycle** (distribution of **work and recovery periods**) Using a 0-10 scale for **Steady motions / Exertions**”



HAL is related to Exertion frequency and Duty Cycle (% of work cycle where **force is greater than 5% of maximum**)

Freq. exertion/s	Period s/exertion	Duty cycle (%)				
		0-20	20-40	40-60	60-80	80-100
0.125	8.0	1	1	--	--	--
0.250	4.0	2	2	3	--	--
0.5	2.0	3	4	5	5	6
1.0	1.0	4	5	5	6	7
2.0	0.5	--	5	6	7	8

TLV-ACGIH

PF
Normalized
Peak Force

Bassa **1-3**	**Media** **4-6**	**Alta** **7-9**
• Sforzi rilassati, movimenti fluidi, apparentemente senza resistenza • Tenere o sollevare un oggetto leggero (piccoli pezzi o utensili, etc.) • Scrivere a computer	• Avvitare con avvitatori pneumatici • Cucire tessuti spessi o pellame • Effettuare cablaggi	• Uso del peso del corpo, tensione dei muscoli, mimica facciale • Dare colpi • Tenere o sollevare oggetti pesanti • "Lanciare oggetti"

Strain Index e TLV - ACGIH

Validazione   ***(external validity)***
- Violante et al. **Carpal tunnel syndrome** and manual work: a **longitudinal study**. J Occup Environ Med. 2007.   -Burt S et al. Workplace and individual risk factors for **carpal tunnel syndrome**. Occup Environ Med. 2011   - Harris C, Eisen E, Goldberg R, et al. Workplace and individual factors in **wrist tendinosis a**mong blue-collar workers: The San Francisco study. Scand J Work Environ Health 2011;37(2):86–98.   -Garg A et al. The Strain Index (SI) and Threshold Limit Value (TLV) for Hand Activity Level (HAL): risk of **carpal tunnel syndrome (CTS)** in a **prospective cohort**. Ergonomics. 2012   -- Bonfiglioli et al. Validation of the ACGIH TLV for hand activity level in the OCTOPUS cohort: a two-year **longitudinal study** of **carpal tunnel syndrome**. Scand J Work Environ Health 2013   - Kapellusch JM et al. Exposure-response relationships for the ACGIH threshold limit value for hand-activity level: results from **a pooled data study** of carpal tunnel syndrome. Scand J Work Environ Health. 2014 Sep 30   -- Garg A et al. The strain index and TLV for HAL: risk of **lateral epicondylitis** in a **prospective cohort.** Am J Ind Med. 2014   -- Kapellusch JM et al. The Strain Index and ACGIH TLV for HAL: risk **of trigger digit** in the WISTAH **prospective cohort**. Hum Factors. 2014.   - Harris-Adamson C, et al. Biomechanical risk factors for **carpal tunnel syndrome**: a **pooled study of 2474** workers. Occup Environ Med. 2015   - Violante FS, Farioli A, Graziosi F, Marinelli F, Curti S, Armstrong TJ, et al. **Carpal tunnel syndrome** and manual work: the OCTOPUS cohort, results of **a ten-year longitudinal study**. Scand J Work Environ Health 2016;42(4):280-90.

Validazione metodi per la valutazione del rischio da sovraccarico biomeccanico dell'arto superiore

Capacità dei metodi di stimare il rischio di sviluppare:

- Sindrome del tunnel carpale (carpal tunnel syndrome)
- Tendiniti mano-polso

Kozak A et al. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: an overview of systematic reviews and a meta-analysis of current research. BMC Musculoskeletal Disorders 2015, 16:231

- Overview of systematic reviews (SRs) and current primary studies assessing the relationship between occupational biomechanical factors and **Carpal tunnel syndrome CTS** in working populations
- Quantify the dose-response relationship using the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) for hand-activity level (HAL) model

Kozak A et al. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: an overview of systematic reviews and a meta-analysis of current research. BMC Musculoskeletal Disorders 2015, 16:231

- There is high evidence for an increased risk of CTS in activities requiring a high degree of repetition and forceful exertion
- The evidence for vibration is moderate
- The evidence for an association between non-neutral wrist postures and CTS is low (results are inconsistent). It may nevertheless be assumed that, in practice, flexion and extension of the wrist mostly occur in combination with other biomechanical factors
- There is no further evidence that CTS is caused by working with a computer keyboard or mouse.

Kozak A et al. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: an overview of systematic reviews and a meta-analysis of current research. BMC Musculoskeletal Disorders 2015, 16:231

	CTS in exposed (>AL<TLV)		CTS in unexposed (<AL)			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
Bonfiglioli et al. 2013	24	518	34	1235	61.6%	1.68 [1.01, 2.81]
Burt et al. 2011	3	23	13	180	9.0%	1.81 [0.56, 5.87]
Burt et al. 2013	1	10	5	102	2.7%	2.04 [0.26, 15.79]
Garg et al. 2012	12	160	7	98	26.6%	1.05 [0.43, 2.58]
Total (95% CI)		**711**		**1615**	**100.0%**	**1.54 [1.02, 2.31]**
Total events	40		59			

Heterogeneity: $Chi^2 = 0.96$, $df = 3$ ($P = 0.81$); $I^2 = 0\%$

Test for overall effect: $Z = 2.06$ ($P = 0.04$)

Risk Ratio M-H, Fixed, 95% CI

0.01 0.1 1 10 100

protective effect harmful effect

- ACGIH TLV for HAL score
- Forest plot of TLV for HAL – below AL versus **between AL and the TLV.** Outcome: **CTS**
- RR 1,5 95% CI 1,02-2,31

Kozak A et al. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: an overview of systematic reviews and a meta-analysis of current research. BMC Musculoskeletal Disorders 2015, 16:231

	CTS in exposed (>TLV)		CTS in unexposed (<AL)			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
Bonfiglioli et al. 2013	26	442	34	1235	36.8%	2.14 [1.30, 3.52]
Burt et al. 2011	41	242	13	180	30.6%	2.35 [1.30, 4.25]
Burt et al. 2013	23	235	5	102	14.3%	2.00 [0.78, 5.11]
Garg et al. 2012	16	171	7	98	18.3%	1.31 [0.56, 3.07]
Total (95% CI)		**1090**		**1615**	**100.0%**	**2.03 [1.46, 2.82]**
Total events	106		59			

Heterogeneity: $Chi^2 = 1.28$, df = 3 (P = 0.73); $I^2 = 0\%$

Test for overall effect: Z = 4.24 (P < 0.0001)

Risk Ratio M-H, Fixed, 95% CI

0.01 0.1 1 10 100

protective effect harmful effect

- ACGIH TLV for HAL score
- Forest plot of TLV for HAL – below AL versus **TLV and above**. Outcome: **CTS**
- RR 2,0 95% CI 1,46-2,82

Studi longitudinali sulla validazione di Strain Index e HAL – *Tendinosis*

- 413 workers at four industries followed for 28 months
- questionnaires and physical examinations every 4 months to identify incident cases of right wrist tendinosis
- exposure assessment of force and repetition were based on field measurements and video analysis to determine repetition rate and the percent time (% time) in heavy pinch (>1 kg-force) or power grip (>4 kg-force)

Harris C, Eisen EA, Goldberg R, Krause N, Rempel D. 1st place, PREMUS best paper competition: workplace and individual factors in wrist tendinosis among blue-collar workers--the San Francisco study. Scand J Work Environ Health. ***2011***

Studi longitudinali sulla validazione di Strain Index e HAL – *Tendinosis*

- 26 incident cases of **right wrist tendinosis** [incidence rate (IR) 5.40 cases per 100 person-years]

Factors	**Hazard ratio***
% time spent in heavy pinch	5.01 [1.27-19.79]
ACGIH-TLV for the medium-exposure group	3.95 [1.52-10.26]

Adjusted for age and gender

- The % time spent in power grip was not a significant predictor, nor were any measures of repetition. SI>7 HR increased but not specific.

Harris C, Eisen EA, Goldberg R, Krause N, Rempel D. 1st place, PREMUS best paper competition: workplace and individual factors in wrist tendinosis among blue-collar workers--the San Francisco study. Scand J Work Environ Health. ***2011***

Risultati studi US cohort

US cohort: strong dose-dependent associations were found between incident CTS and

- **peak hand force (Borg CR10 >3**),
- forceful repetition rate **(>3 exertions per minute of >9N pinch force or 45N power grip**),
- proportion of **time spent in forceful exertion (>11%)**
- **hand exertions should be considered in risk assessment models if they are above 10% of posture specific strength.**

Multivariate Proportional Hazard Regression Model including ACGIH-TLV® categories
The OCTOPUS ITALIAN COHORT (Violante et al. Scand J Work Environ Health 2016)

Characteristics		CTS symptoms			CTS confirmed by NCS		
		Cases (n=431)	HR	95%CI	Cases (n=126)	HR	95%CI
Sex	Male	116	1.00	Ref.	31	1.00	Ref.
	Female	315	1.98	1.53–2.56	95	1.91	1.26–2.90
Age (years)	≤35	117	1.00	Ref.	20	1.00	Ref.
	36–45	170	1.65	1.42–1.92	51	2.20	1.32–3.67
	46–55	128	1.89	1.62–2.21	51	3.85	2.10–7.08
	<55	16	3.17	1.86–5.40	4	4.89	2.86–8.37
Body mass index (kg/m²)	<25	261	1.00	Ref.	60	1.00	Ref.
	25.0–29.9	127	1.42	1.19–1.70	45	2.04	1.48–2.81
	≥30.0	43	1.47	0.85–2.53	21	3.04	1.48–6.23
Predisposing diseases	None	378	1.00	Ref.	107	1.00	Ref.
	At least one	53	1.65	1.21–2.24	19	1.52	0.82–2.83
ACGIH TLV® categories	<AL	187	1.00	Ref.	51	1.00	Ref.
	AL–TLV	107	2.18	1.86–2.56	36	1.93	1.38–2.71
	>TLV	137	2.07	1.52–2.81	39	1.95	1.27–3.00

Cox regression models - Covariates retained in the multivariate model (backward deletion strategy): sex, age, BMI, presence of pathologies predisposing CTS onset

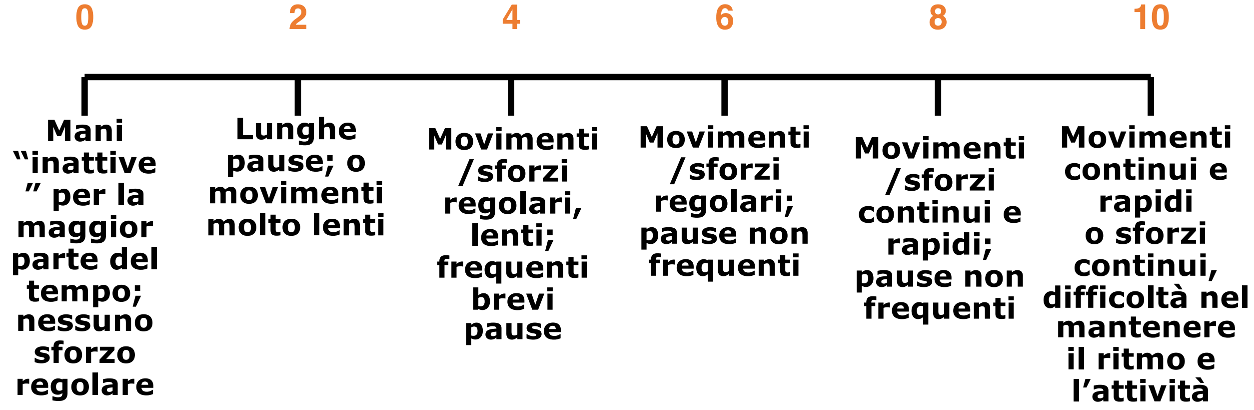
I risultati degli studi hanno creato i presupposti per la revisione del TLV ACGIH per il segmento mano-braccio

- ACGIH Threshold Limit Value for Hand Activity (TLV for HAL) predicted CTS, and current 'action limit' is too high to adequately protect workers
- efforts to reduce workplace exposures should focus on jobs requiring high hand force and repeated or prolonged forceful exertions

TLV-ACGIH 2018 Hand Activity

- Il metodo ACGIH individua un valore limite (TLV) attraverso la combinazione di 2 parametri: il Livello di Attività Manuale (Hand Activity Level – HAL) e il Picco di Forza Normalizzato.
- HAL può essere determinato valutando la **frequenza media dei movimenti della mano** e la **durata del "Duty cycle"** (distribuzione del lavoro effettivo e dei periodi di recupero/riposo)

TLV-ACGIH 2018 Hand Activity
invariata la scala ma ….



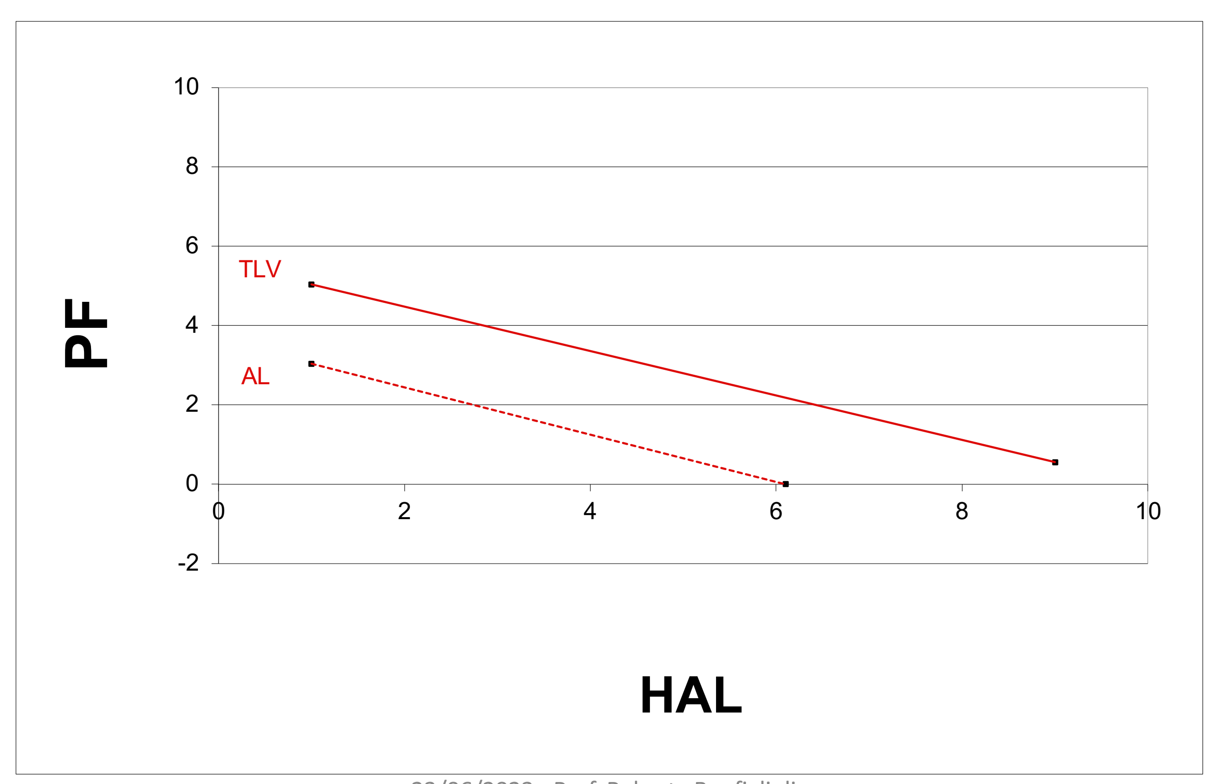
"Average Hand Activity Level is based on
The Frequency of Hand Exertions and the Duty Cycle
(distribution of work and recovery periods)
Using a 0-10 scale for **Steady motions / Exertions**"

TLV-ACGIH 2018 Hand Activity

HAL is related to Exertion frequency and Duty Cycle
(% of work cycle where ~~**force is greater than 5% of maximum**~~)
hand exertions should be considered in risk assessment models if they are above 10% of posture specific strength.

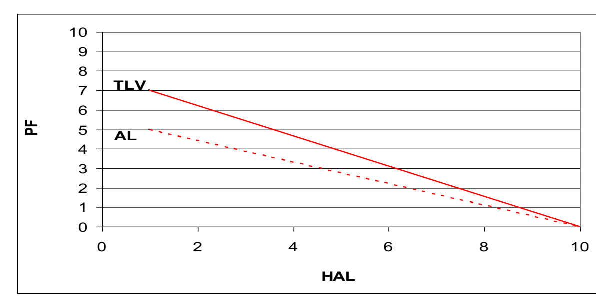
Freq. exertion/s	Period s/exertion	**Duty cycle (%)**				
		0-20	**20-40**	**40-60**	**60-80**	**80-100**
0.125	8.0	1	1	--	--	--
0.250	4.0	2	2	3	--	--
0.5	2.0	3	4	5	5	~~6~~ 5
1.0	1.0	4	5	~~5~~ 6	~~6~~ 7	7
2.0	0.5	--	~~5~~ 6	~~6~~ 7	~~7~~ 8	8

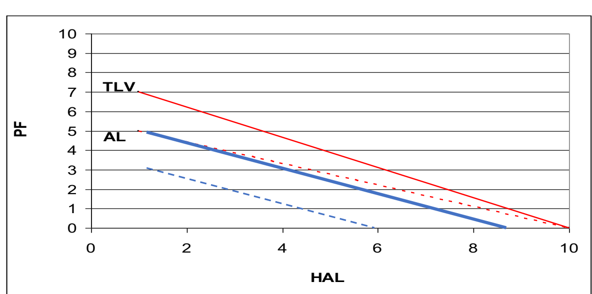
TLV-ACGIH 2018 (aggiornamento)



ACGIH-TLV® recommendations

- **ACGIH Threshold Limit Value (TLV) for Hand Activity**
- *Hand Activity Level (HAL)* and *normalized Peak of Force (PF)*
- The TLV identifies an Action Level (caution) and a higher Threshold Limit Value (immediate action recommended).





- The Hand Activity TLV was modified in 2018
  Threshold Limit Values for chemical substances and physical agents and Biological Exposure Indices. Cincinnati, OH: ACGIH Worldwide; 2019.

I risultati degli studi hanno creato i presupposti per la revisione anche del metodo Strain Index

STRAIN INDEX 1995 (prima versione)

- Stima sei variabili lavorative:
  1. Intensità dello sforzo
     Intensity of exertion
  2. Durata dello sforzo (%)
     Duration of exertion per cycle
  3. Sforzi al minuto
     Efforts per minute
  4. Posture mano/polso
     Wrist posture
  5. Ritmo di lavoro
     Speed of exertion
  6. Durata del compito (ore)
     Duration of task per day

REVISED STRAIN INDEX 2017 (aggiornamento)

1. Intensity of Exertion
2. Duration per Exertion (sec)
3. Frequency of Exertion
4. Hand/Wrist Posture (fl/ex)
5. /
6. Hours per Day

Revised Strain Index (RSI)

Garg A, Moore JS, Kapellusch JM. The Revised Strain Index: an improved upper extremity exposure assessment model. Ergonomics. 2017 Jul;60(7):912-922

minimises complicated measurement decisions and improves upon the 1995 SI by:

(1) using % maximum voluntary contraction (or Borg CR-10 equivalent) for applied hand force,

(2) using duration per exertion (in seconds) rather than duty cycle

(3) distinguishing between flexed and extended wrist postures.

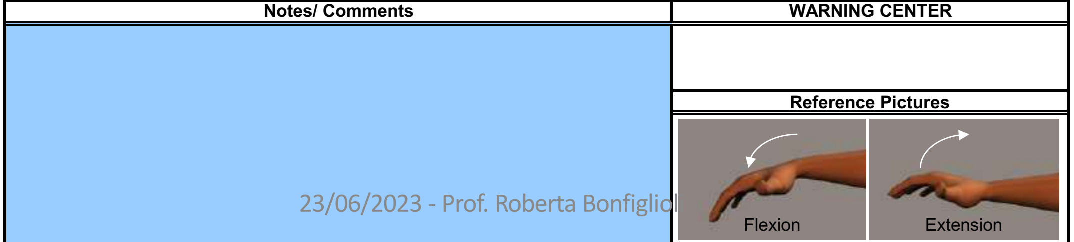
Thus **the stress from each effort of a task** (i.e., each sub task) can be individually quantified by the RSI and compared to other efforts in a cycle, or alternative efforts in the case of task intervention.

Revised Strain Index

Date:		Task:	
Company:		Supervisor:	
Dept:		Evaluator:	

Risk Factor	Observation			Left	Left Score	Right	Right Score
Intensity of Exertion (Borg Scale - BS)	Light: Barely noticeable or relaxed effort (BS: 0-2)						
	Somewhat Hard: Noticeable or definite effort (BS: 3)						
	Hard: Obvious effort; Unchanged facial expression (BS: 4-5)						
	Very Hard: Substantial effort; Changes expression (BS: 6-7)						
	Near Maximal: Uses shoulder or trunk for force (BS: 8-10)						
Efforts Per Minute		Left	Right				
	Total Number of Exertions Observed						
	Total Obervation Time (sec.)						
Duration Per Exertion	Average Single Exertion Time (sec.)	% Duration of Exertion ≤ 100% ?					
		Left	Right				
Hand/Wrist Posture		Left	Right				
		Flexion (degrees)	Flexion (degrees)				
		Extension (degrees)	Extension (degrees)				
Duration of Task Per Day	Duration of task per day (hours)						
Results Key	SI ≤ 10	Job is probably safe					
	SI > 10	Job is probably hazardous					

Notes/ Comments	WARNING CENTER
	Reference Pictures



Multifattorialità e malattie muscoloscheletriche

- Integrazione dei dati di esposizione a fattori biomeccanici con altri fattori (definire e valutare strategie preventive)

- Considerazioni sull'utilizzo dei dati di esposizione a fattori biomeccanici nel percorso di gestione del lavoratore che svolge compiti manuali

Work-related musculoskeletal disorders: **why are they still so prevalent?** Evidence from a literature review (2020)

- The reported rates of MSDs across the Member States of the EU (EU-28) **increased from 54.2 % in 2007 to 60.1 % in 2013** (according to the results of the EU Labour Force Survey carried out in those years).
- Data from the European Working Conditions Survey do not show a significant reduction in the incidence *of musculoskeletal pain in the lower limbs or upper limbs* or *of back pain* between 2010 and 2015
- Possible causes?

European Agency for Safety and Health at Work

Work-related musculoskeletal disorders: why are they still so prevalent? Evidence from a literature review (2020)

- *The impact of **digitalisation and information and communications technology (ICT)***
- ***New forms of employment**, including the gig and platform economies, have the potential to reduce workers' level of occupational safety and health (OSH) protection.*
- *Previously high prevalence in one sector may **move to a different sector***
- *The effect of changing workplace policies such as no-lift policies **shifts the exposure site** from the back to the shoulders, **or just-in-time manufacturing***
- ***Unhealthy lifestyles**, physical inactivity and rising obesity*
- *The impact of **changing workforce demographics** (an older workforce, pre-existing MSDs)*
- *The importance **of psychosocial risks is increasing**.*
- *A **growing proportion of sedentary jobs***
- ***Failure to reduce physical workplace hazards***
- ***Different socio-economic contexts**, classifications of diseases, insurance arrangements have an impact **on MSD reporting**.*
- *There are **gaps in risk assessment and prevention practices.***

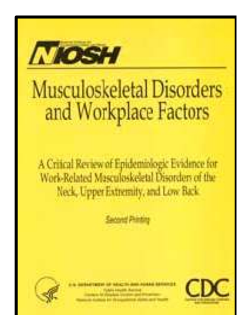
Musculoskeletal disorders (MSDs)

Physical and biomechanical risk factors	Organisational and psychosocial risk factors	Individual risk factors
Handling loads, especially when bending and twisting Repetitive or forceful movements Awkward and static postures Vibration, poor lighting or cold working environments Fast-paced work Prolonged sitting or standing in the same position	High work demands and low autonomy Lack of breaks or opportunities to change working postures Working at high speed, including as a consequence of introducing new technologies Working long hours or on shifts Bullying, harassment and discrimination in the workplace	Age Genetics Prior medical history Physical capacity Lifestyle and habits (e.g. smoking, lack of exercise)

Musculoskeletal Disorders and Workplace Factors
A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back - ***USA NIOSH (Bernard, 1997)***

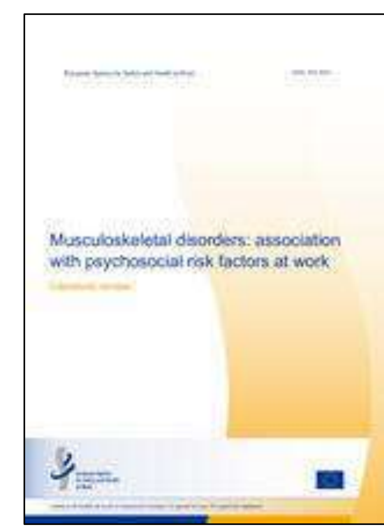
- The relationship between exposure to physical work factors and the development and prognosis of a particular MSDs **may be affected by psychosocial factors**

1. Psychosocial demands may produce increased **muscle tension** and exacerbate task-related biomechanical strain.
2. Psychosocial demands may affect **awareness and reporting of musculoskeletal symptoms**, and/or perceptions of their cause.
3. Initial episodes of pain based on a physical insult may trigger a chronic nervous system dysfunction, physiological as well as psychological, which perpetuates a **chronic pain process.**
4. Changes in psychosocial demands may be associated **with changes in physical demands and biomechanical stress**



Musculoskeletal disorders: association with psychosocial risk factors at work - EU OSHA 2021

- **Clear evidence exists that psychosocial risk factors play a causal role in the development of musculoskeletal disorders (MSDs) in the workplace**
- They do not act in isolation but their effect combines with (and often exacerbates) the effects of physical risk factors (it is not possible to identify consistent patterns in those associations) **[direct / indirect effect]**
- *Thus, although factors such as **high workload** or a **lack of social support** can be shown to contribute to the development of MSDs, it is not possible to relate these or other particular psychosocial risk factors to specific MSDs*



European Agency for Safety and Health at Work Review of studies published 2006 onwards

https://osha.europa.eu/en/publications/musculoskeletal-disorders-association-psychosocial-risk-factors-work

Musculoskeletal disorders: association with psychosocial risk factors at work - EU OSHA 2021

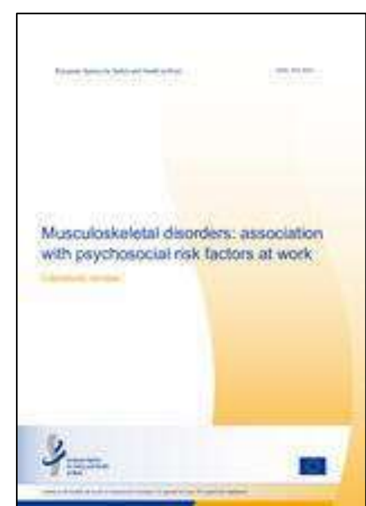
- **The negative association between psychosocial risk factors and MSDs can work both ways**

Potential **two-way nature** of the relationships and influences between **MSDs ↔Psychosocial factors** can be regarded as a *'dynamic equilibrium' (individual level)*

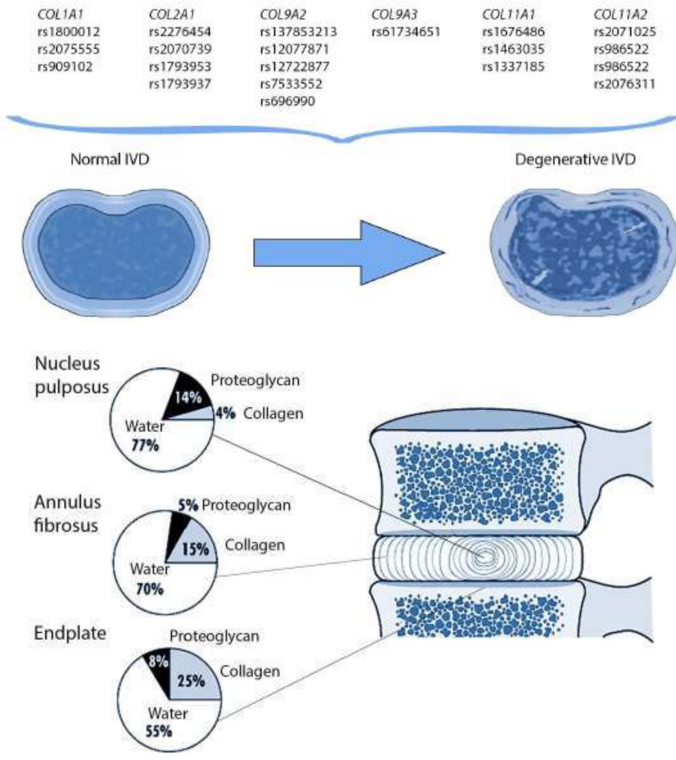
Factors acting on the worker and responses to those (factors) feeding back to further moderate any relationship

Psychosocial risk factors can materially **contribute to the causation of MSDs**

Having an **MSD can exacerbate or accentuate the perception of some psychosocial factors.**



MSDs are multifactorial in nature
Individual risk factors – Disc disease

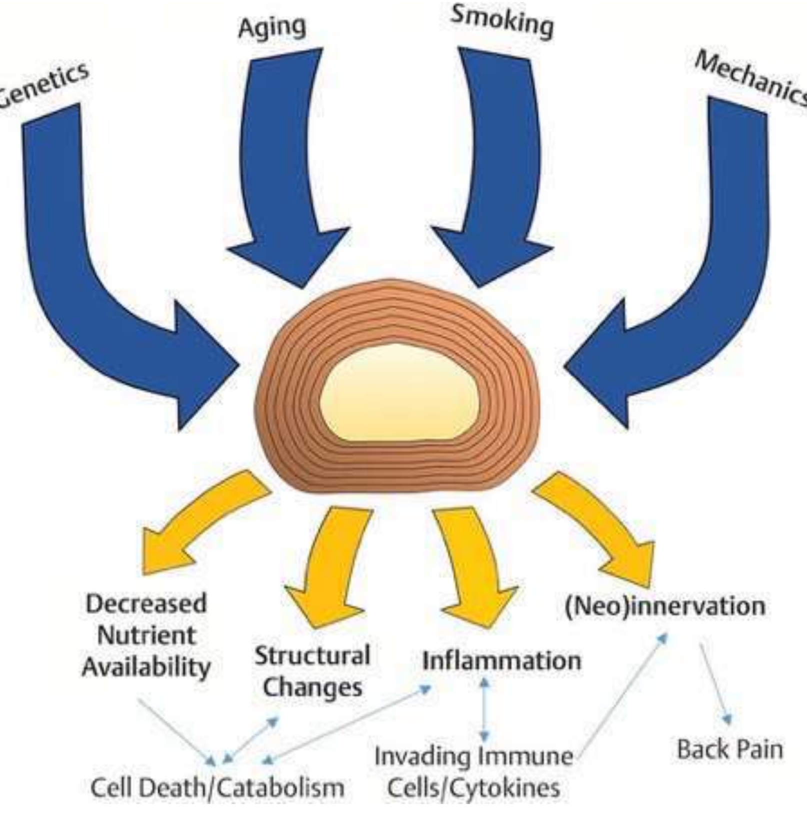


Trefilova VV, et al The Role of Polymorphisms in Collagen-Encoding Genes in Intervertebral Disc Degeneration. Biomolecules. 2021; 11(9):1279

Role of genetics

Sambrook et al. 1999: 73-74%;

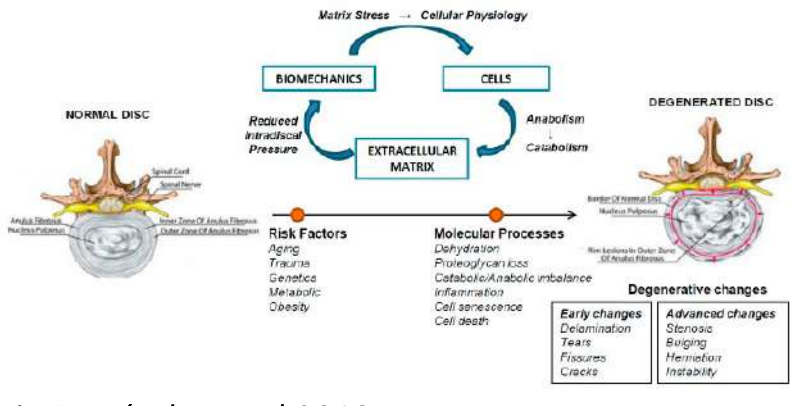
Kalichman and Hunter 2008: 34-61%

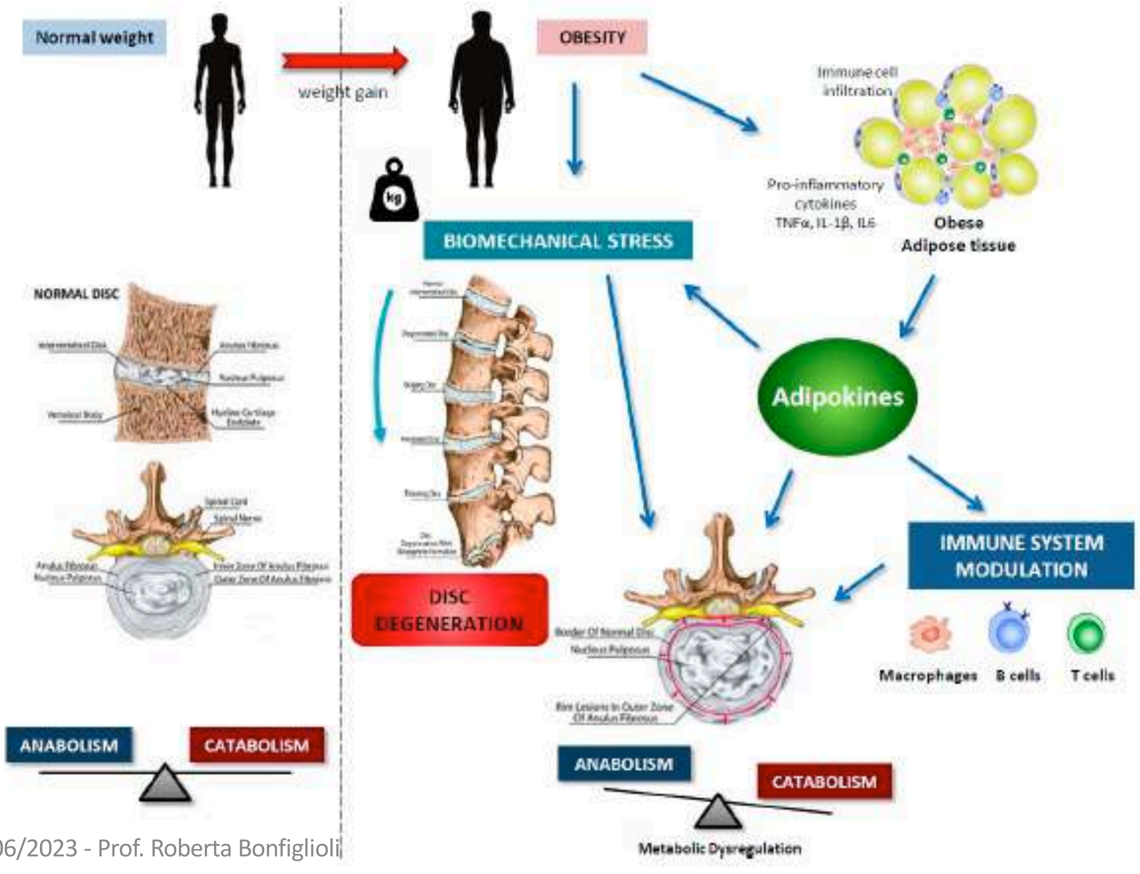


Kirnaz S, et al Pathomechanism and Biomechanics of Degenerative Disc Disease: Features of Healthy and Degenerated Discs. Int J Spine Surg. 2021 Apr;15(s1):10-25

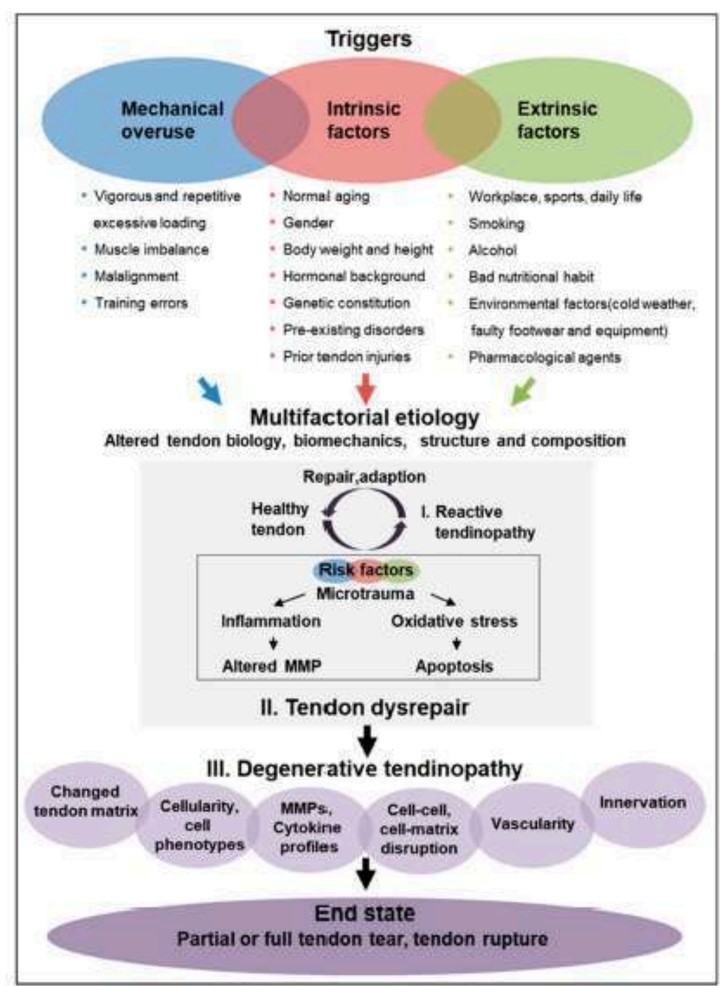
MSDs are multifactorial in nature
Obesity and degenerative disc disease

The interrelationships among inflammation, obesity and the pathogenic mechanisms involved in the disc disease, with particular emphasis on the contribution of adipokines





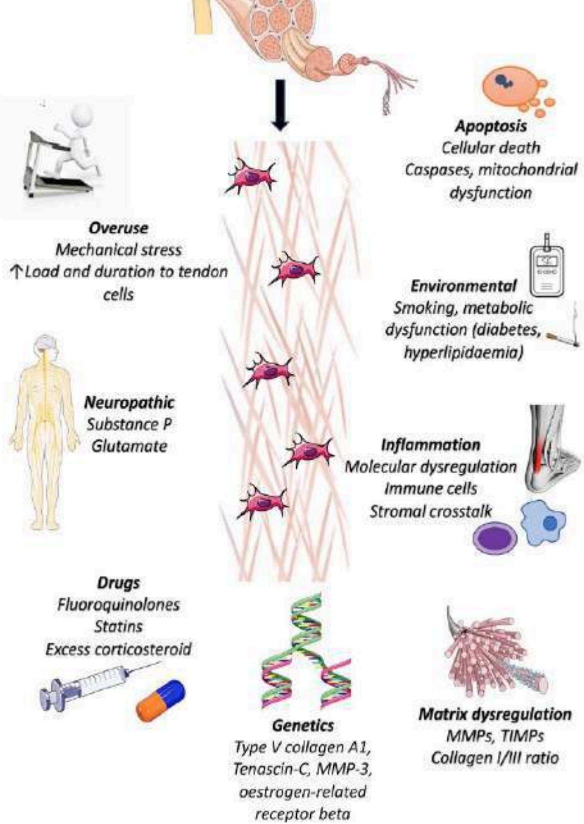
Ruiz-Fernández et al 2019



MSDs are multifactorial in nature

Individual risk factors

Tendinopathies



Tendinopathies are no longer suggested to be an **overuse injury** per se, but **other promoting factors**, alone or in combination, must be considered as well

Steinmann et al. Spectrum of Tendon Pathologies: Triggers, Trails and End-State. Int J Mol Sci. 2020;21(3):844

Definiti i limiti dei metodi di valutazione dell'esposizione a fattori biomeccanici - Applicazioni

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Rapid entire body assessment (REBA).
Hignett S, et al. Appl Ergon. 2000. PMID: 10711982

Application of the Rapid Entire Body Assessment (REBA) in assessing chairside ergonomic risk of dental students.
Raman V, et al. Br Dent J. 2020. PMID: 32801322

Es. REBA, numerose pubblicazioni recenti ⇒

International Journal of
Environmental Research and Public Health

Review

An Overview of REBA Method Applications in the World

Manuel Hita-Gutiérrez [1], Marta Gómez-Galán [1], Manuel Díaz-Pérez [1] and Ángel-Jesús Callejón-Ferre [1,2,*]

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Abstract: The objective of this work is to review literature, worldwide, in which the Rapid Entire Body Assessment (REBA) ergonomic assessment method was applied and count the number of times that REBA was applied together with other methods and subsequent incidence. The database used was the "Web of Science—Core Collection". Only scientific articles and bibliographic reviews were included, analysing a total of 314 documents and selecting only 91. The use of the REBA method is indicated in terms of knowledge, country, year and journal sectors. It was most used in the knowledge areas of "Manufacturing" (24.18%), "Agriculture, forestry and fishing" (21.98%) and in "Other activities" (19.78%). One of the benefits of REBA is that it evaluates different body parts: upper limbs (arm, forearm and wrist), lower extremities, trunk and neck. It is a useful method to identify the forced postures adopted by workers to thus develop improvement measures if necessary. It is concluded that REBA method use has increased over the last decade, probably due to the digitization of knowledge. It is almost always applied in combination with other methods, and its use can be a positive indicator of company sustainability.

Contesto di applicazione

An overview

Hita-Gutiérrez et al., 2020

- Manufacturing 24.18%
- Agriculture forestry fishing 21.98%
- Other activities 19.78%

REBA - Benchmarking

Ref.	Study design	Objective/ Field	Conclusion (REBA score)
Abdollahzade et al. 2016 (Iran)	Observational Cross-sectional	Ergonomic evaluation **Nurses operating room** (n.147)	Overall mean (SD) REBA score 7.7(1.9) (high risk)
Abaraogu et al. 2016 (Nigeria)	Observational Cross-sectional	Ergonomic evaluation MSD Nordic Q **Beverage bottling workers** (n.301)	REBA score high to very high risk
Çakıt 2018 (Turkey)	Observational Cross-sectional	Ergonomic evaluation (REBA, 3DSSPP, NASA TLX) **Airport Shuttle drivers, baggage storing and retrieval** (n.4)	REBA Score 6 (medium)-11(very high) according to shelf level
Jahanimoghadam et al., 2018 (Iran)	Observational Cross-sectional	Ergonomic evaluation **Dental professionals** (n.90)	90% moderate or high risk
Schwartz et al. 2019 (USA)	Observational Cross-sectional	Ergonomic evaluation Q (Injuries) **Janitors** (n.30)	All average REBA scores were in high risk Workload related to injury
Unal and Cifcili 2020 (Turkey)	Observational Cross-sectional	Ergonomic evaluation Cornell MS Discomfort Q **Visual artists** (n.197)	Overall mean REBA score 5.2 (medium) Higher score Sculptors

REBA - Benchmarking

Ref.	Study design	Objective/ Field	Conclusion (REBA score)
Lim et al. 2021 (Malaysia)	Observational Cross-sectional	Ergonomic evaluation + prevalence MSD (Nordic Q) **Landscape workers** (n.55)	71% medium risk 29% high risk
Aaron eta l. 2021 (USA)	Observational Cross-sectional	Ergonomic evaluation **Surgeons** (REBA n.91; n.167/389 Questionnaire MSD)	Intra-operative REBA obs scores are reported across specialities Medium-High risk
Anand et al. 2021 (India)	Observational Cross-sectional	Ergonomic evaluation **Robotic surgery** (n.5)/ **laparoscopic surgery** (n.11) "Vescicoscopic ureteric reimplantation"	Robotic medium risk Laparoscopic very high risk
Andriani et al. 2021 (Indonesia)	Observational Cross-sectional	Ergonomic evaluation MSD (Nordic Q) **Metal-based SME** (n.272)	3.6% low risk 25% medium risk 60.7% high risk 10.7% very high risk
Ćwirzeń and Wagner 2022 (Poland)	Observational Cross-sectional	Ergonomic evaluation **Dental hygienists** (n.272)	0.7% negligible risk 5.5% low risk 33.1% medium risk 49.3% high risk 11.4% very high risk

REBA - Benchmarking

Ref.	Study design	Objective/ Field	Conclusion (REBA score)
Das et al. 2022 (India)	Observational Cross-sectional	Ergonomic evaluation MSD (Q) **Floor sitting precision handicraft workers (gemstone cutting, miniature painting, metal craft making)**	Overall mean grand score RULA 5.82; REBA 8.04 (high risk) Gemstone cutters (8.28 REBA)
Oliver-Hernandez et al. 2023 (Spain)	Observational Cross-sectional	Ergonomic evaluation **Nursing assistants and orderlies** (n.39)	Overall mean REBA score 9.0 (high risk) Moving the patient at the head of the bed 9.8 More than two subjects increase the score
Maniam et al. 2023 (UK)	Observational Cross-sectional	Ergonomic evaluation of different surgical set up **Anterior skull base surgery**	REBA score 3 to 8 (low to high risk)
Gumasing et al. 2023 (Philippines)	Observational Cross-sectional	Ergonomic evaluation (+ noise, heat and air pollution) Nordic MS Q **Traffic enforcers** (n.120)	84.2% medium risk 15.8% high risk
Purohit et al. 2023 (Iran)	Observational Cross-sectional	Ergonomic evaluation **Physioterapists treating neurologic patients**	>50% moderate or high risk

REBA - Interventions

Ref.	Intervention	Objective/ Field	Conclusion
Abdollahi et al. 2020 (Iran)	**Ergonomic educational program** - Quasi-RCT REBA – Nordic Questionnaire	Risk and MSDs reduction Assessed in two weeks intervals over a period of three months **Nursing staff Operating Room** (74,2 hosp.)	Reduction of the risk and the prevalence of MSDs in the intervention group
Khan et al. 2020 (Canada)	Simulation-based **Ergonomics Training Curriculum (ETC)** Vs. Simulation-based Training (no ergonomic training)	Risk reduction Assessed with REBA and RULA scores baseline, immidiately after treatment and 4 to 6 weeks after training **Novice endoscopists (colonscopy)**	Reduction of the risk (REBA score) after ETC but still medium risk
Gholami et al. 2020 (Iran)	**Ergonomic training** intervention (face to face educat. meetings) REBA Nordic Q	To test the change in REBA score pre-post intervention (after training) **Concrete form workers** (n.144)	Significant decrease REBA score (however not to acceptable level)
Sim et al. 2021 (Korea)	**Digital sound feedback linked with a smartphone application** REBA	To test the change in working posture after training (four weeks, 30' per week) **Dental hygiene students** (n.28)	Significant decrease REBA score (total, neck and trunk) 2-3 weeks after intervention
Teixeira et al. 2022 (Brazil)	Introducing **a packaging machine** (“Guzzetti”) REBA SI S Rodger	To assess a new packaging workstation	Reduction of the risk Moderate to low

REBA - Interventions

Ref.	Intervention	Objective/ Field	Conclusion
Lim et al. 2022 (Korea)	Device: **medical augmented reality glasses (ARG)** REBA sEMG NASA-TLX	To compare medical augmented reality glasses (ARG) / Conventional monitors in video assisted surgery **Thoracic, laparoscopic, thyroid surgery**	ARG assisted with correction of bad posture in surgeons during video-assisted surgery
Sirisawasd et al. 2022 (Thailand)	**Device for manual height adjustment** of the hospital bed REBA sEMG Satisfaction	To assess a new device for manual height adjustment of the hospital bed **Nurses** (n.56)	Reduction of the risk (REBA score) for both left and right Vs. hand crank
Nourollahi-Darabad et al. 2022 (Iran)	**Climbing device** REBA, Nordic Q, Multidimensional Fatigue Inventory, System Usability Scale	To assess a new Climbing device **Date (datteri) palm farmers** (n.70)	Significant decrease REBA score, MS discomfort and fatigue
Boudreaux et al. 2023 (USA)	Using **a tubular-based digital camera system** (vs. a standard neurosurgical operative microscope without stretched arms)	To test the change in REBA score using a tubular-based digital camera system (vs. a standard) **Neurosurgery** (posterior cervical decompression) (n.2 surgeons different stature)	Improvement using the tubular-based digital camera system Reduction of the risk (REBA score) from 5-6 (medium risk) to 3 (low risk)

REBA - Comparison

Ref.	Comparison	Objective/ Field	Conclusion
Coyle 2005 (New Zeland)	REBA New Zeland Manual Handling 'Hazard Control Record'	**Comapare methods to assess, plan and implement changes in manual handling practices** Supermarket industry	REBA useful to compare pre/post ergonomic interventions (score) New Zeland MHHCR includes other area (task, load, environment, people and management factors)
Motamedzade et al. 2011 (Iran)	REBA Quick Exposure Assessment (QEC)	**Compare methods for ergonomic assessment** Engine oil company (40 jobs)	Classification low/medium/high risk REBA 15%/60%/25% QEC 20%/50%/30%
Cremasco et al. 2019 (Italy)	REBA RULA	**Compare methods for ergonomic assessment** Ergonomic evaluation Forestry worker manually feeding wood-chipper (cippatrice)	Both REBA and RULA are suitable RULA tend to be more precautionary
Kong et al. 2018 (Korea) & Choi et al. 2020 (Korea)	16 Ergonomic experts assessment (gold standard) RULA REBA OWAS ALLA	**Validation of ALLA (Agricultural Lower Limb Assessment)** 196 working postures from real agricultural tasks	ALLA is an appropriate assessment tool to estimate risk factors for lower limb postures AlLLA better agreement with expert evaluation than others Hit rate 48,6% ALLA (33,3% RULA, 30,1% REBA, 34,4% OWAS)

Plogging activity: an environment friendly trash workout (jogging with litter collection)

REBA Score Mean±SD

- **Full squat** (5.13±0.59) and **lunge** (6.64±1.15) posture was found to have lesser risk score in comparison with the other two postures such as **stoop** (10.31±0.88) and **semi-squat** (8.11±1.40)

Polar M430 optical heart rate monitor

- Physical activity Plogging vs. Jogging: similar energy expenditure but the fat percentages of calories burned is more in plogging ($p < 0.05$). Howerver plogging can be considered as a strenous activity as the % Cardiovascular strain of the activity had a mean value of (99.261%).

Ergonomic interventions are needed to play a vital role in minimizing the musculoskeletal related injuries and the physical strain of the task.

Raghavan R, Panicker VV, Emmatty FJ. Ergonomic risk and physiological assessment of plogging activity. Work. 2022;72(4):1337-1348

Panhale VP, Walankar PP, Sridhar A. Analysis of Postural Risk and Pain Assessment in Bharatanatyam Dancers. Indian J Occup Environ Med. 2020 May-Aug;24(2):66-71.

***Natyarambham**,* the most commonly attained posture by the Bharatanatyam dancer, is the combination of the *araimandi* position along with arm movements and hand gestures. Dancers are instructed to maintain this position for a prolonged period of time in order to build the strength and stamina necessary to perform longer dances.

- Bharatanatyam dance form is an amalgamation of emotion, rhythm, expression, and sculpturesque poses that demand high levels of physical and psychological power during a performance.
- **To explore musculoskeletal pain and analyze risk factors in Bharatanatyam dancers.**
- The level of injury risk for the "*Natyarambham*" posture adopted by dancers was also assesse (REBA) 62.5% Bharatanatyam dancers (*n* = 25/40, 62.5% [95% CI 0.22, 0.53]) were in the category of high risk for injury and 37.5% dancers were in the medium-risk category
- Out of 40 female Bharatanatyam dancers, 30 (75%) reported experiencing musculoskeletal pain

Could wearable sensors and Artificial Intelligence (AI) help ergonomics?

REBA - “New” Technologies

Ref	Technology	Objective/ Field	Conclusion
Kim et al. 2019 (Korea)	REBA + Gait Analyzer, plantar pressure	**To compare working posture (REBA) and physical balance (Gait Analyzer, plantar pressure)** Dental Hygienists (n.24)	Subjects with poor posture (REBA>=4 7/8 parts of the sole showed different plantar P right vs. left feet (left anterior part)
Dwyer et al. 2020 (USA)	Xbox connect camera **Kinetisense software 3D motion capture**	**Comparison Kinetisense / REBA RULA** Kinetisense SW measured position of the head, shoulders, mid-spine, hips, knees (for 30’ one image was captured every 30’’) in cm behind or in front to a central (plomb) line – Average Kinetisense values vs. NORMAL values Robotic general surgeons (n. 4)	Pilot study Average REBA RULA scores medium risk The average RULA score for the four surgeons was 4.75 (range 3–6). The average REBA score for the four surgeons was 7 (range 5–8)
Li et al. 2020 (China)	**Convolutional pose machines (CPM) «Quick capture system»**	To validate the feasibility and reliability of the CPM-based REBA system Vs. motion capture system for posture analysis (gold standard) Vs. REBA score from three experts	«Quick capture system» could be applied for a rapid and real time on-site-assessment

sensors

MDPI

Article

An Evaluation of Posture Recognition Based on Intelligent Rapid Entire Body Assessment System for Determining Musculoskeletal Disorders

Ze Li [1], Ruiqiu Zhang [1], Ching-Hung Lee [2] and Yu-Chi Lee [1,*]

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2 School of Public Policy and Administration, Xi'an Jiaotong University, Xi'an 710000, China; leechinghung@xjtu.edu.cn
* Correspondence: liyuqi@scut.edu.cn; Tel.: +88-6987-868-483

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Abstract: Determining the potential risks of musculoskeletal disorders through working postures in a workplace is expensive and time-consuming. A novel intelligent rapid entire body assessment (REBA) system based on convolutional pose machines (CPM), entitled the Quick Capture system, was applied to determine the risk levels. The aim of the study was to validate the feasibility and reliability of the CPM-based REBA system through a simulation experiment. The reliability was calculated from the differences of motion angles between the CPM-based REBA and a motion capture system. Results show the data collected by the Quick Capture system were consistent with those of the motion capture system; the average of root mean squared error (RMSE) was 4.77 and the average of Spearman's rho (ρ) correlation coefficient in the different 12 postures was 0.915. For feasibility evaluation, the linear weighted Cohen's kappa between the REBA score obtained by the Quick Capture system and those from the three experts were used. The result shows good agreement, with an average proportion agreement index (P_0) of 0.952 and kappa of 0.738. The Quick Capture system does not only accurately analyze working posture, but also accurately determines risk level of musculoskeletal disorders. This study suggested that the Quick Capture system could be applied for a rapid and real-time on-site assessment.

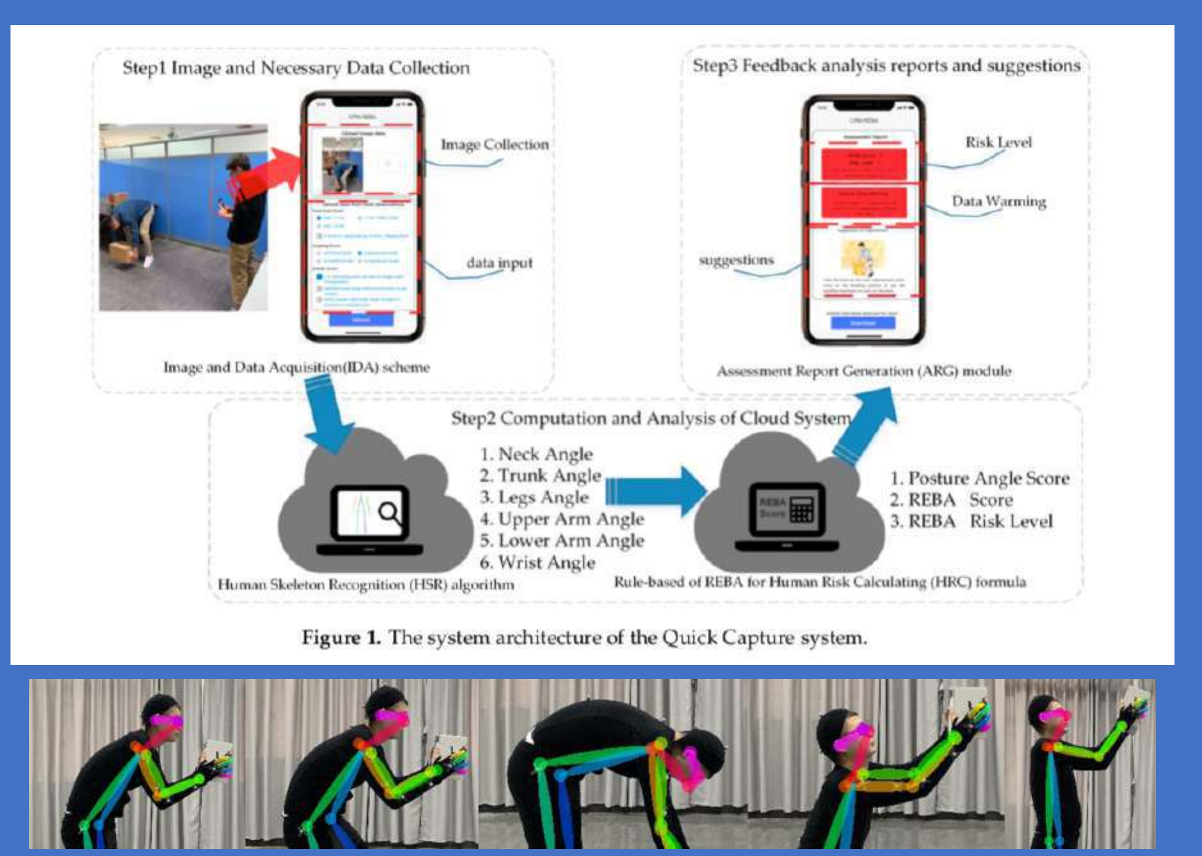

Figure 1. The system architecture of the Quick Capture system.

Convolutional pose machines (CPM) «Quick capture system» Vs. motion capture system for posture analysis (gold standard)

REBA - “New” Technologies

Ref	Technology	Objective/ Field	Conclusion
Chatzis et al. 2022 (Greece)	**Automatic algorithmic methods Processing of RGB images**	Model human posture to estimate REBA score	Experimental results in Two datasets demonstrates the ability of the method to achieve high accuracy and robustness
Fan et al. 2022 (China)	**Light-sensor Azure Kinect, a depht camera for real-time depht sensing and motion capture**	Automated assessment Posture capture and recognition by tracking the skeleton (45° viewing angle, 2.0 mt distance, 1.2 m height) Joint angles data are converted into REBA Scores data. Physioterapists (n.29, 224 treatments)	The study creates an automatic tool to assess the ergonomic risk of physiotherapy practices Out of 224 cases 49.6% were at high risk and 33% were at high risk. Critical issues: positioning of the physiotherapist, paediatric physiotherapy

Article

Automatic Ergonomic Risk Assessment Using a Variational Deep Network Architecture

Theocharis Chatzis *, Dimitrios Konstantinidis and Kosmas Dimitropoulos

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Abstract: Ergonomic risk assessment is vital for identifying work-related human postures that can be detrimental to the health of a worker. Traditionally, ergonomic risks are reported by human experts through time-consuming and error-prone procedures; however, automatic algorithmic methods have recently started to emerge. To further facilitate the automatic ergonomic risk assessment, this paper proposes a novel variational deep learning architecture to estimate the ergonomic risk of any work-related task by utilizing the Rapid Entire Body Assessment (REBA) framework. The proposed method relies on the processing of RGB images and the extraction of 3D skeletal information that is then fed to a novel deep network for accurate and robust estimation of REBA scores for both individual body parts and the entire body. Through a variational approach, the proposed method processes the skeletal information to construct a descriptive skeletal latent space that can accurately model human postures. Moreover, the proposed method distills knowledge from ground truth ergonomic risk scores and leverages it to further enhance the discrimination ability of the skeletal latent space, leading to improved accuracy. Experiments on two well-known datasets (i.e., University of Washington Indoor Object Manipulation (UW-IOM) and Technische Universität München (TUM) Kitchen) validate the ability of the proposed method to achieve accurate results, overcoming current state-of-the-art methods.

Automatic Ergonomic Risk Assessment Using a Variational Deep Network Architecture
Chatzis et al., 2022

Table 6. Ground truth and predicted REBA risk level distribution on the UW-IOM and TUM Kitchen datasets.

REBA Risk Level	UW-IOM		TUM Kitchen	
	Ground Truth	Predicted	Ground Truth	Predicted
Negligible	0%	0%	0%	0%
Low	12.32%	3.84%	12.07%	6.24%
Medium	79.34%	89.23%	76.44%	83.79%
High	8.32%	6.91%	11.42%	9.89%
Very High	0.02%	0.02%	0.07%	0.08%

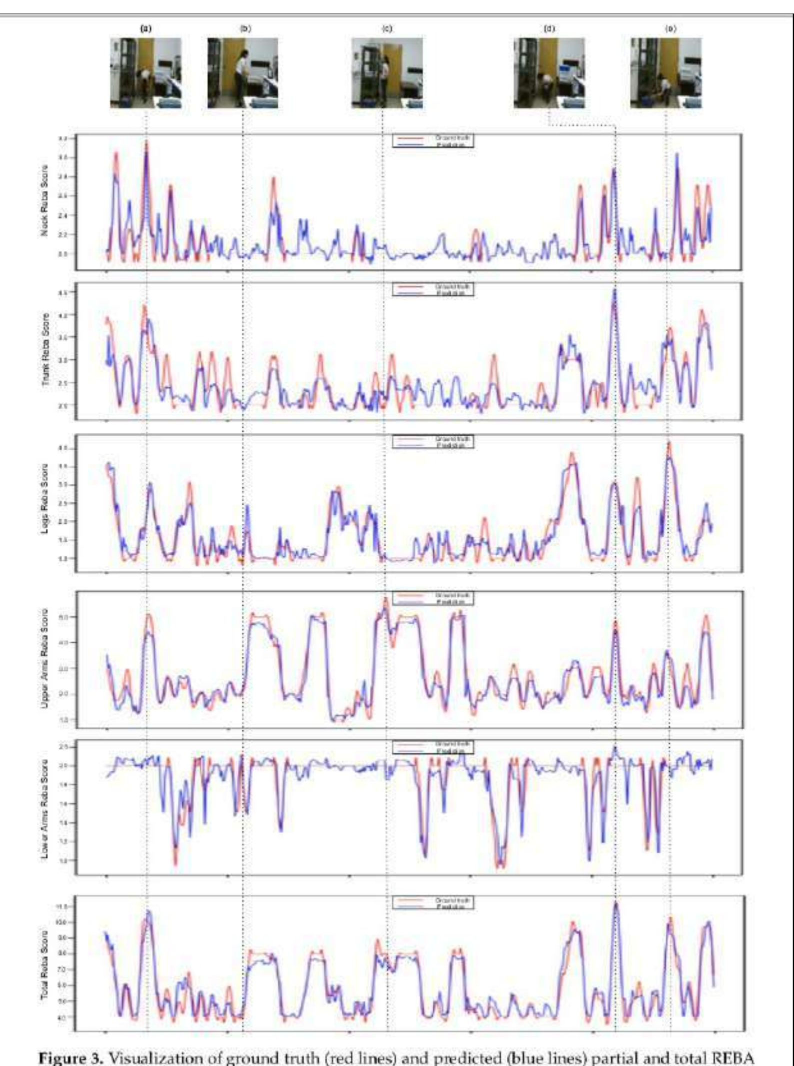

Figure 3. Visualization of ground truth (red lines) and predicted (blue lines) partial and total REBA scores on a video sequence from the UW-IOM dataset. At the top, five frames (**a**–**e**) that correspond to extreme postures with high ergonomic risks are displayed, while REBA scores for individual body parts and the whole body follows.

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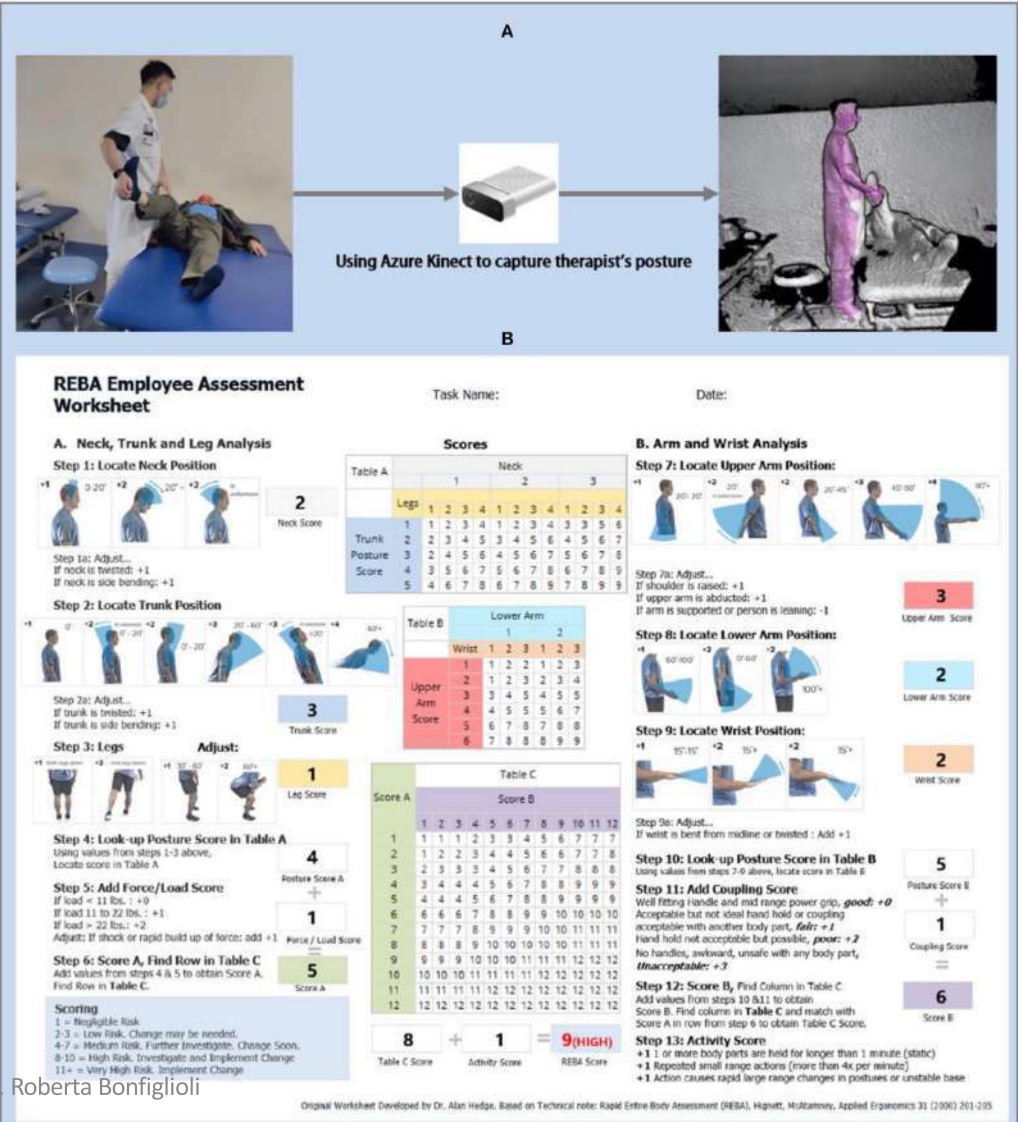
Ergonomic risk factors and work-related musculoskeletal disorders in clinical physiotherapy

L. J. Fan[1†], S. Liu[2†], T. Jin[3], J. G. Gan[4], F. Y. Wang[5], H. T. Wang[2] and T. Lin[1*]

To quantify and assess the ergonomic risk in clinical physiotherapy from the perspective of motion analysis, based on the Rapid Entire Body Assessment (REBA) scale, with the assistance of **structured light sensor-Azure Kinect**, and combined with subjective Perceived Physical Exertion (RPE).



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Ergonomic risk factors and work-related musculoskeletal disorders in clinical physiotherapy

L. J. Fan[1†], S. Liu[2†], T. Jin[3], J. G. Gan[4], F. Y. Wang[5], H. T. W
and T. Lin[1*]

Structured light sensor-Azure Kinect to track the therapist's treatment posture during physiotherapy.

Azure Kinect is a depth camera for real-time depth sensing and motion capture, which can be used for posture capture and recognition by tracking the skeleton

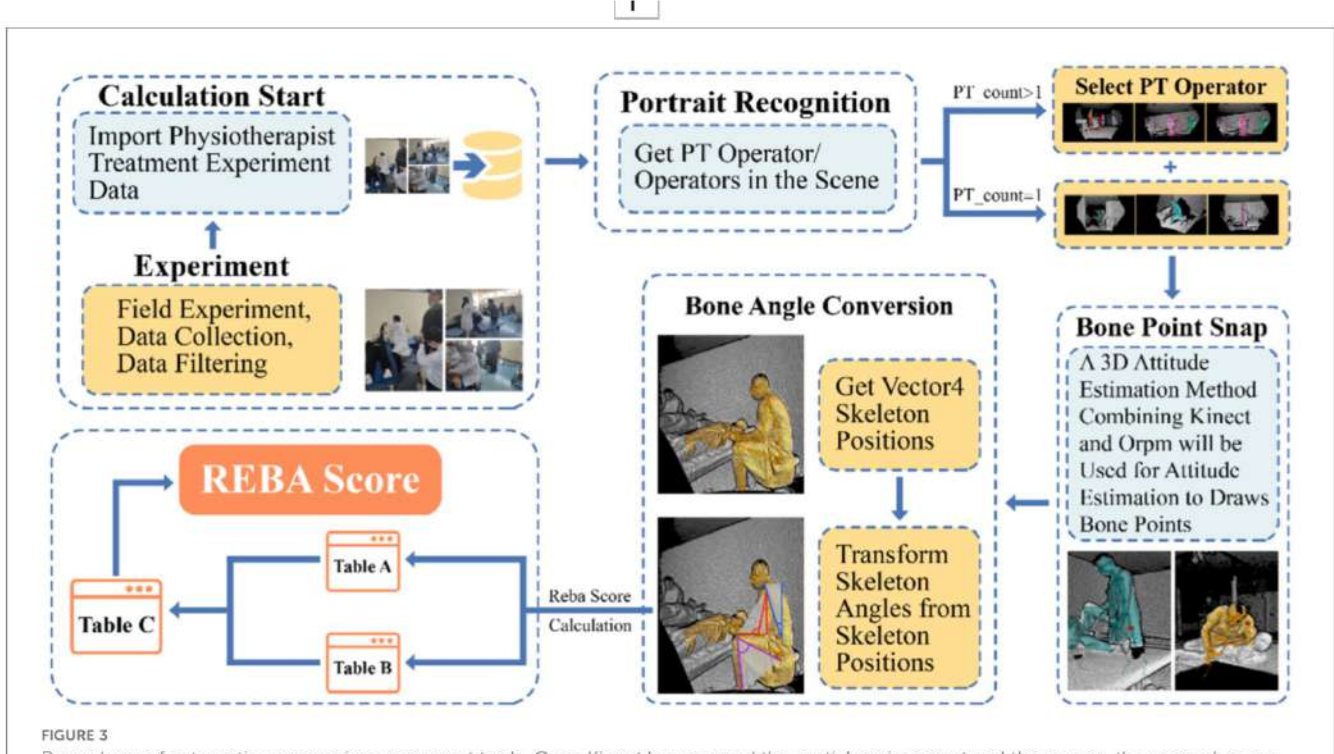

FIGURE 3
Procedures of automatic ergonomics assessment tools. Once Kinect has scanned the spatial environment and the person, the researcher can select the person index to capture the motion of the specified person within the scene. Confirming the capture object, the automated algorithm will calculate the angle value based on the bone joints and bone length, which finally corresponds to the REBA score "+" (The REBA score is a combination of REBA Table A and REBA Table B). The generated data will be saved to the local port in real time.

Altre applicazioni

Article

On the OCRA Measurement: Automatic Computation of the Dynamic Technical Action Frequency Factor

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Abstract: OCRA (OCcupational Repetitive Action) is currently one of the most widespread procedures for assessing biomechanical risks related to upper limb repetitive movements. Frequency factor of the technical actions represents one of the OCRA elements. Actually, the frequency factor computation is based on workcycle video analysis, which is time-consuming and may lead to up to 30% of intra-operator variability. This paper aims at proposing an innovative procedure for the automatic counting of dynamic technical actions on the basis of inertial data. More specifically, a threshold-based algorithm was tested in four industrial case studies, involving a cohort of 20 workers. Nine combinations of the algorithm were tested by varying threshold values related to time and amplitude. The computation of frequency factor showed an average relative error lower than 5.7% in all industrial-based case studies after the appropriate selection of the time and amplitude threshold values. These findings open the possibility to use the threshold-based algorithm proposed here for the automatic computation of OCRA frequency factor, avoiding the time efforts in video analysis.

Keywords: OCRA; technical actions; upper limb musculoskeletal disorders; threshold-based algorithm; inertial sensors

Linear accelerations and angular velocities were gathered from 17 wearable inertial sensors (MVN Biomech Awinda, Xsens Technologies, The Netherlands)

The algorithm was based on two threshold values, related respectively to the time and the amplitude of the action identified in joint angle curves of the upper limbs.

Automatic computation OCRA Technical Actions

International Journal of
Environmental Research and Public Health

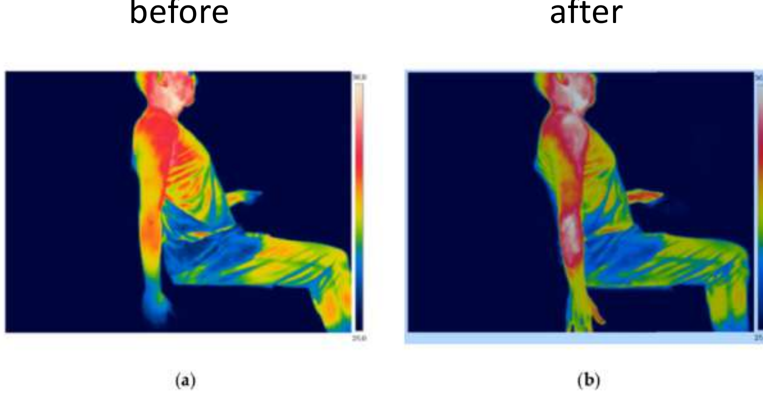
Article

Occupational Risk Evaluation through Infrared Thermography: Development and Proposal of a Rapid Screening Tool for Risk Assessment Arising from Repetitive Actions of the Upper Limbs

André Luiz Soares [1,*], Antonio Augusto de Paula Xavier [2] and Ariel Orlei Michaloski [2]

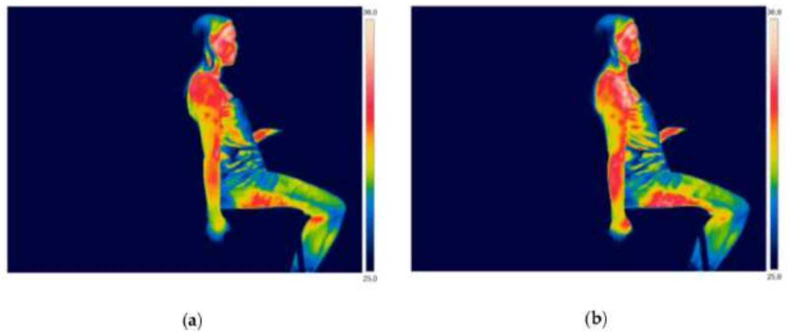
To develop a rapid tool for assessing the risk of developing Work-Related Musculoskeletal Disorders (WMSDs) arising from repetitive actions of the upper limbs, while using a thermographic camera to measure skin temperature variation.

before after



(a) (b)

Figure 3. Thermographic image of a male participant: (**a**) before performing the high-risk repetitive task; and, (**b**) after performing the high-risk repetitive task.



(a) (b)

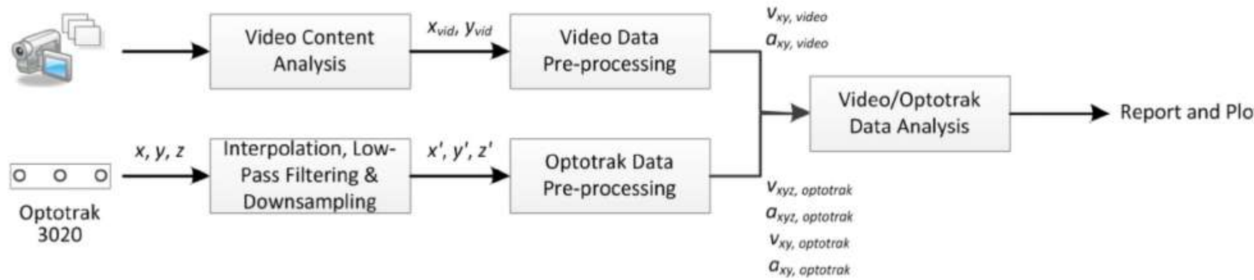
Figure 4. Thermographic image of a female participant: (**a**) before performing the high-risk repetitive task; and, (**b**) after performing the high-risk repetitive task.

Equation for calculating the OCRA Index formulated using as independent variables: air temperature (Ta) and forearm skin temperature variation (ΔT_F):

$$OCRA = -10.173 + (0.567Ta) + (2.083\Delta T_F)$$

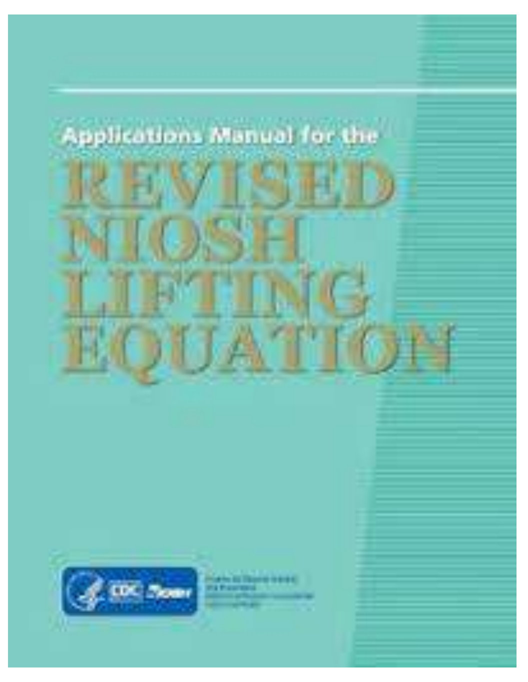
The **Predicted OCRA Index** can be applied as a screening tool for large numbers of workers in the same company or sector, due to its speed of application and the determination of risk level, but it does not replace the original OCRA Index.

Chen et al. The accuracy of conventional 2D video for quantifying upper limb kinematics in repetitive motion occupational tasks. Ergonomics. 2015;58(12):2057-66



- This study demonstrated that 2D video tracking had sufficient accuracy to measure HAL for ascertaining the American Conference of Government Industrial Hygienists Threshold Limit Value® for repetitive motion when the camera is located within ±30 degrees off the plane of motion when compared against 3D motion capture for a simulated repetitive motion task.

RNLE dal manuale .....



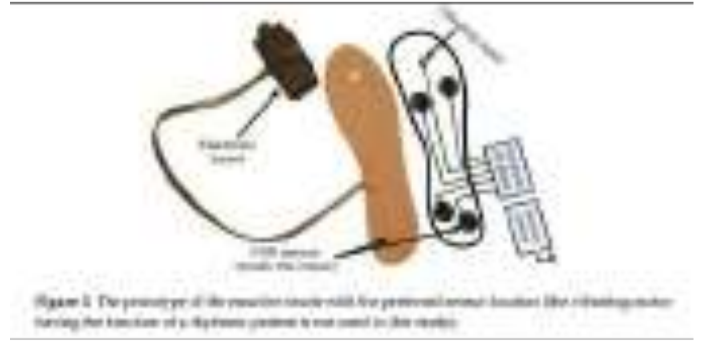
DHHS (NIOSH) Publication Number 94-110
Revised September 2021

Wang et al. The accuracy of a 2D video-based lifting monitor. Ergonomics. 2019 Aug;62(8):1043-1054

An algorithm for automatically calculating the revised NIOSH lifting equation using a single video camera was evaluated in comparison to laboratory 3D motion capture. The results indicate that this method has suitable accuracy for practical use and may be, particularly, useful when multiple lifts are evaluated

Barkallah E, Freulard J, Otis MJ, Ngomo S, Ayena JC, Desrosiers C. Wearable Devices for Classification of Inadequate Posture at Work Using Neural Networks. Sensors (Basel). 2017 Sep 1;17(9)

- ENACTIVE INSOLE Sensori di forza inseriti nella suola delle scarpe: spostamento del centro di pressione (COP)
- SMART HELMET : IMU accelerometro + giroscopio + magnetometro



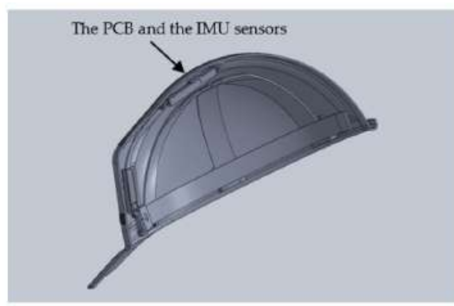


Figure 2. The instrumented safety helmet prototype.

Barkallah E, Freulard J, Otis MJ, Ngomo S, Ayena JC, Desrosiers C. Wearable Devices for Classification of Inadequate Posture at Work Using Neural Networks. Sensors (Basel). 2017 Sep 1;17(9)

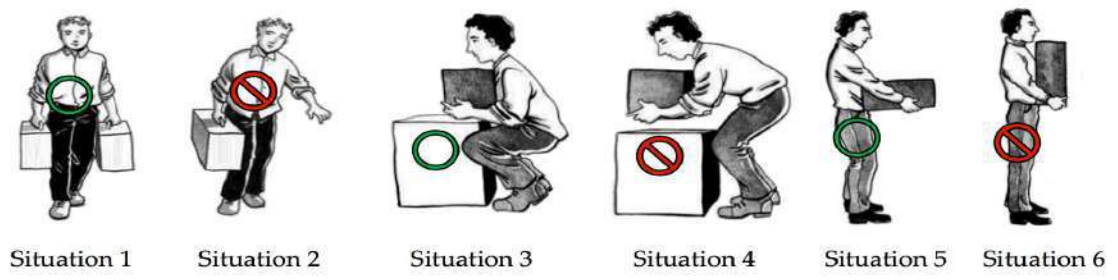


Figure 9. Six situations for evaluating adequate and inadequate posture for handling tasks, this figure is adapted from [53] with permission from Caroline Merola and the publisher.

- Automated assessment tool for posture analysis using specific features and artificial neural networks (ANN)
- Detect inadequate postures of individuals in a work environment.

Tu sum up!

Valori guida

Dati antropometrici e funzionali

Descrivere le caratteristiche del corpo umano (genere, età …)

Dimensioni

Ampiezza di Movimento

Forza

Resistenza

Dati sperimentali

Dati sull'uomo

Misure sul campo (P intramuscolare, attività muscolare, parametri fisiologici / metabolici)

Misure su cadavere (Fc discali)

Dati su animali

Modelli biomeccanici

Dati epidemiologici

Ricerca «hazard»

Monitoraggio

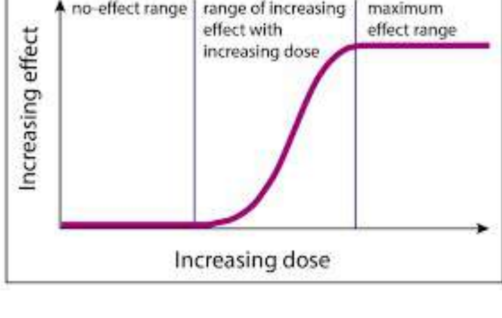
Relazione dose risposta e definizione valori di azione e valori limite

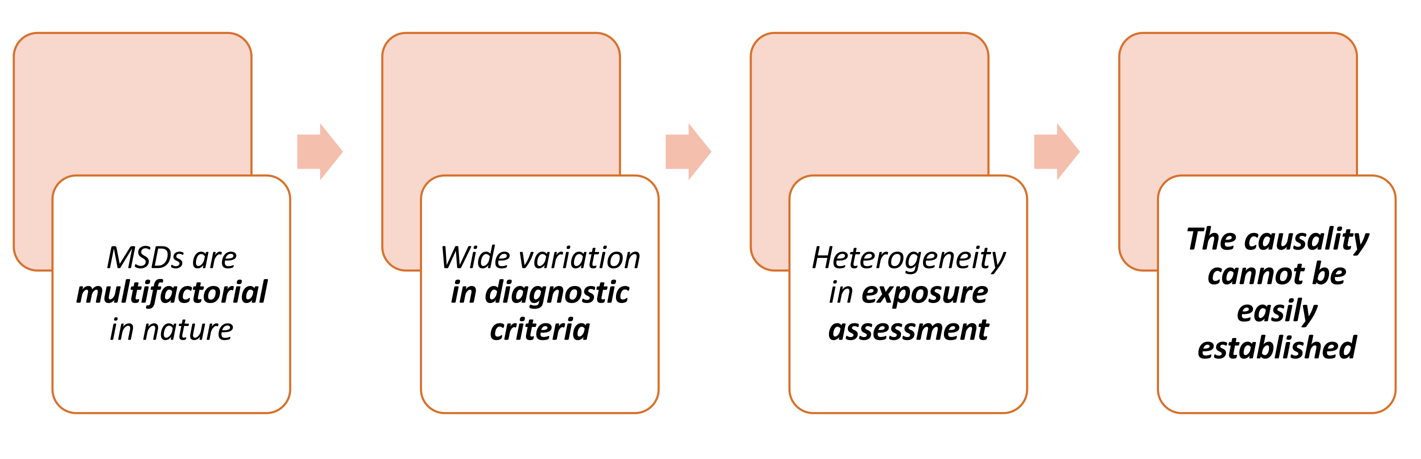
Validazione

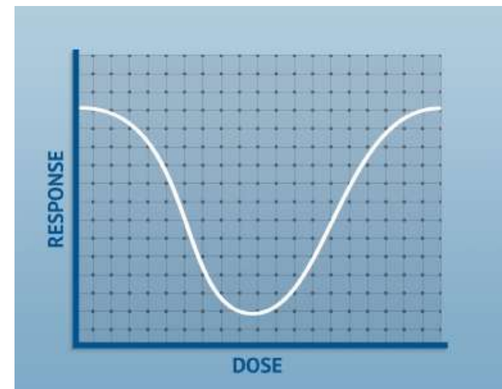
Efficacia interventi

Metodi di misura esposizione a fattori biomeccanici

Metodi ancora prevalentemente osservazionali
Criticità e Limiti







Exposure assessment

Administrative data

Job category (i.e. blue/white collar)

Job title

Job Exposure Matrix

JEM

Links job titles with indices of exposure to one or more factor

Questionnaire

Self-administered

Interview

Observation

Task observation

- Checklist
- Video analysis

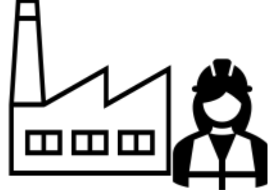
(Wearable) Sensor-based measures

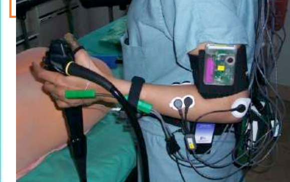
Surface EMG

IMUs

Force (pressure) sensors

Goniometers





International Journal of
Environmental Research and Public Health

Systematic Review

Reliability Analysis of Observation-Based Exposure Assessment Tools for the Upper Extremities: A Systematic Review

Preston Riley Graben *, Mark C. Schall, Jr. *, Sean Gallagher, Richard Sesek and Yadrianna Acosta-Sojo

Condividi

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Abstract: (1) Background: The objectives of this systematic review were to (i) summarize the results of studies evaluating the reliability of observational ergonomics exposure assessment tools addressing exposure to physical risk factors associated with upper extremity musculoskeletal disorders (MSDs), and (ii) identify best practices for assessing the reliability of new observational exposure assessment tools. (2) Methods: A broad search was conducted in March 2020 of four academic databases: PubMed, Science Direct, Ergonomic Abstracts, and Web of Science. Articles were systematically excluded by removing redundant articles, examining titles and abstracts, assessing relevance to physical ergonomics and the upper extremities, and article type. (3) Results: Eleven articles were included in the review. The results indicated no singular best practice; instead, there were multiple methodological approaches researchers chose to use. Some of the significant variations in methodologies include the selection of reliability coefficients, rater and participant selection, and direct vs. digital observation. (4) Conclusion: The findings serve as a resource summarizing the reliability of existing observational risk assessment tools and identify common methods for assessing the reliability of new observational risk assessment tools. Limitations of this review include the number of databases searched, the removal of truncation symbols, and the selection of keywords used for the initial search.

Citation: Graben, P.R.; Schall, M.C., Jr.; Gallagher, S.; Sesek, R.; Acosta-Sojo, Y. Reliability Analysis of Observation-Based Exposure Assessment Tools for the Upper Extremities: A Systematic

Graben et al. 2022. Reliability Analysis of Observation-Based Exposure Assessment Tools for the Upper Extremities: A Systematic Review

- Few articles have investigated the reliability of observation-based ergonomics exposure assessment tools for the upper extremities.
- OCRA, HAL, and the Strain Index were the most heavily researched tools. Many ergonomic risk assessment tools (i.e. REBA and RULA) may have acceptable reliability in certain situations;
- The Strain Index was one of the most repeatedly high-performing assessment tools for reliability.
- The results of this review indicated **no singular best practice** when performing rater- reliability studies. Instead, there were multiple methodological approaches researchers chose to use.
- Some variations in methodologies include the selection of reliability coefficients, rater and participant selection, and direct vs. digital observation.
- The dissonance between the two methods (video-based analysis vs. field studies) may suggest that the best method would be **to initially use video-based observations for pilot experiments, with the plan to follow up with a more robust field study to provide further statistical evidence regarding the reliability of a tool.**

International Journal of
Environmental Research and Public Health

Article

Reliability and Validity of Six Selected Observational Methods for Risk Assessment of Hand Intensive and Repetitive Work

Teresia Nyman [1,2,*], Ida-Märta Rhén [3,4,5], Peter J. Johansson [1,2], Kristina Eliasson [1,2], Katarina Kjellberg [4,5], Per Lindberg [6], Xuelong Fan [5] and Mikael Forsman [3,4,5]

- To evaluate **six risk assessment methods**, concerning **inter- and intra-observer reliability and concurrent validity,** using the same methodological design and statistical parameters in the analyses.
- Twelve experienced ergonomists were recruited to perform risk assessments of ten video-recorded work tasks twice, and consensus assessments for the concurrent validity were carried out by three experts (at baseline and 3 months later).

Nyman et al., 2023

Table 1. Descriptions of the ten different video-recorded work tasks in the study.

Work Task	Task Activity	Hours [1] per Workday	Handled Goods (kg)	Environment, Physical Factors	Discomfort (CR-10)	Work Demands and Control [2]
1	Unpacking groceries to shelves in a supermarket store	just above 4	2	Good	3	Partly autonomy
2	Putting nets around roasts at a slaughterhouse	just above 4	2.5–4.5	Cold, wet, noisy	4	Group autonomy
3	Throwing small boxes into containers (post sorting)	just above 2	3	Cold during winter, warm during summer, noisy, difficulty concentrating	3–4	Controlled
4	Putting bundles of letters into boxes (post sorting)	approx. 6	2	Cold during winter, warm during summer, noisy, difficulty concentrating	3–4	Controlled
5	Deboning meat at a slaughterhouse	approx. 7	3–4	Cold, wet, noisy, sharp knives	3–4	Group autonomy
6	Assembling engines	just under 3	2	Good	2.5	Controlled
7	Cutting hair	just above 4	1	Good	3	Autonomy
8	Cleaning lavatories	approx. 5	1	Good	2	Partly autonomy
9	Supermarket cashier work	approx. 7	1–5	Good	3	Controlled
10	Cleaning stairs	just under 4	1	Usually good, sometimes cold	3	Partly autonomy

[1] Pre-set task duration. [2] Autonomy: The worker controls the work himself/herself as if self-employed. Partly autonomy: The worker controls the work task but is limited in time and by obligations of other work tasks included in the work. Group autonomy: a group of employees control and divide work tasks within the group. Controlled: The work task is completely time-controlled by work instructions and space-controlled by the physical design of the workplace.

Nyman et al., 2023

Table 2. Description of body regions where posture and movements/repetitions were assessed from the video and rated by the ergonomists, for each of the six methods.

	Posture					Movement/Repetition				
	Back	**Neck**	**Shoulder/Arm**	**Elbow**	**Wrist/Hand**	**Back**	**Neck**	**Shoulder/Arm**	**Elbow**	**Wrist/Hand**
ART	X	X	X		X			X		X
HARM		X	X		X		X	X	X	X
OCRA			X	X	X			X	X	X
QEC	X	X	X		X	X		X		X
SI					X					X
SWEA	X	X	X		X			X		X

Nyman et al., 2023

Table 3. Number of ergonomists that completed the risk assessments in the first session and in the second session (in brackets), number of items rated in each method, total number of performed item ratings and total number of risk level assessments, and the distribution, in percent, of risk levels in the assessments in the different risk levels stipulated in each of the methods, from "1" = lowest risk to "5" highest risk. The risk level distribution for the expert group is shown in bold print.

Method	Number of Ergonomists	Items Rated	Performed Ratings	Risk level Assessments	Distribution, in Percent, of Risk Levels [1] from Low (1) to High (5)				
					1	2	3	4	5
ART left arm	11 (9)	12	1320 (1080)	110 (90)	17 (17) **20**	44 (39) **50**	39 (44) **30**	-	-
ART right arm	11 (9)	12	1320 (1080)	110 (90)	8 (12) **10**	35 (32) **40**	56 (56) **50**	-	-
HARM	12 (8)	27	3240 (2160)	120 (80)	27 (25) **20**	48 (54) **70**	26 (21) **10**	-	-
OCRA	11 (10)	12	1320 (1200)	110 (100)	26 (28) **20**	15 (15) **20**	16 (19) **30**	33 (27) **20**	9 (11) **10**
QEC total	12 (10)	7	840 (700)	120 (100)	2 (2) **10**	15 (11) **0**	57 (59) **50**	27 (28) **40**	-
QEC Neck	12 (10)	2	240 (200)	120 (100)	0 (0) **0**	13 (14) **10**	54 (50) **60**	33 (36) **30**	-
QEC Shoulder	12 (10)	5	600 (500)	120 (100)	2 (2) **10**	38 (39) **20**	60 (59) **70**	0 (0) 0	-
QEC Wrist	12 (10)	5	600 (500)	120 (100)	0 (0) **0**	33 (35) **30**	68 (65) **70**	0 (0) 0	-
QEC Back	12 (10)	6	720 (600)	120 (100)	17 (14) **10**	38 (39) **30**	41 (44) **60**	5 (3) 0	-
Method	**Number of Ergonomists**	**Items Rated**	**Performed Ratings**	**Risk level Assessments**	**Distribution, in Percent, of Risk Levels [1] from Low (1) to High (5)**				
SI highest score	12 (10)	6	720 (600)	120 (100)	3 (6) **20**	15 (6) **0**	83 (88) **80**	-	-
SWEA Overall Repetition	12 (8)	1	120 (80)	120 (80)	8 (11) **10**	42 (41) **30**	51 (48) **60**	-	-
SWEA Overall Postures and movements	12 (8)	1	120 (80)	120 (80)	20 (15) **20**	73 (70) **80**	8 (15) **0**	-	-
SWEA Neck posture [2]	10 (6)	1	100 (60)	100 (60)	31 (13) -	55 (60) -	14 (27) -	-	-
SWEA Shoulder/arm Posture [2]	10 (6)	1	100 (60)	100 (60)	26 (23) -	69 (72) -	5 (5) -	-	-
SWEA Back posture [2]	10 (6)	1	100 (60)	100 (60)	22 (10) -	64 (82) -	14 (8) -	-	-

[1] ART, HARM, SI, SWEA (three levels, 1–3); QEC (four levels 1–4); OCRA (five levels, 1–5). [2] No ratings were performed by the expert group.

23/06/2023 - Prof Roberta Bonfiglioli

Nyman et al., 2023

- ***Inter-Observer Reliability*** - The results show that for all methods (overall risk levels) the inter-observer percentage agreement ranged between 39 to 83, showing the highest agreement for SI and the lowest agreement for OCRA. The same for concurrent validity
- ***Intra-Observer Reliability*** - As expected, a somewhat higher reliability was found within observers (intra-observer reliability) compared to between observers (inter-observer reliability), with an overall percentage agreement ranging between 45% in OCRA to 79% in ART.
- All methods' total-risk linearly weighted kappa values (when all tasks were set to the same duration) were lower than 0.5 (0.15–0.45).
- Moreover, the concurrent validity values were in the same range with regards to total-risk linearly weighted kappa (0.31–0.54). Although these values are often considered as being fair to substantial, they mean agreements lower than 50% when the expected agreement by chance has been compensated for.
- **Hence, the risk of misclassification is substantial**

Nyman et al., 2023

- Since observation without the use of any specific method have a **lower and non-acceptable reliability** it is recommended to **use one or more systematic observational-based risk assessment methods.**
- Another approach would be to **combine an observational method with validated methods of direct measurements** where the items of the lowest reliability in the observational method of choice are replaced by using technical methods, especially so when an intervention is to be evaluated.
- This study indicates that when experienced ergonomists use observational risk assessment methods, the reliability is low. As seen in other studies, assessments **of hand/wrist postures** were especially difficult to rate.
- In light of these results, complementing observational risk assessments with technical methods may be needed, especially when evaluating the effects of ergonomics interventions.

bioengineering

Article

A Twenty-Year Retrospective Analysis of Risk Assessment of Biomechanical Overload of the Upper Limbs in Multiple Occupational Settings: Comparison of Different Ergonomic Methods

Emma Sala [1,*], Lorenzo Cipriani [2], Andrea Bisioli [2], Emilio Paraggio [2], Cesare Tomasi [2], Pietro Apostoli [2] and Giuseppe De Palma [1,2]

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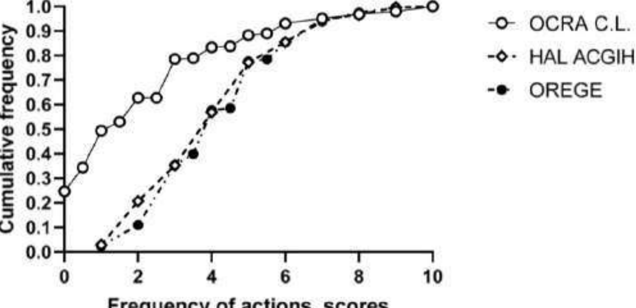
Abstract: Background: Several methods with which to assess the risk of biomechanical overload of the upper limb are described in the literature. Methods: We retrospectively analysed the results of the risk assessment of the biomechanical overload of the upper limb in multiple settings by comparing the application of the Washington State Standard, the threshold limit values (TLV) proposed by the American Conference of Governmental Industrial Hygienists (ACGIH), based on hand-activity levels (HAL) and normalised peak force (PF), the Occupational Repetitive Actions (OCRA) check-list, the Rapid Upper-Limb Assessment (RULA), and the Strain Index and Outil de Repérage et d'Evaluation des Gestes of INRS (Institut National de Recherche et de Sécurité). Results: Overall, 771 workstations were analysed for a total of 2509 risk assessments. The absence of risk demonstrated for the Washington CZCL, used as the screening method, was in good agreement with the other methods, with the sole exception of the OCRA CL, which showed at-risk conditions in a higher percentage of workstations. Differences in the assessment of the frequency of actions were observed among the methods, while their assessments of strength appeared to be more uniform. However, the greatest discrepancies were observed in the assessment of posture. Conclusions: The use of multiple assessment methods ensures a more adequate analysis of biomechanical risk, allowing researchers to investigate the factors and segments in which different methods show different specificities.

Keywords: upper limb; biomechanical overload; risk assessment

check for updates

Citation: Sala, E.; Cipriani, L.; Bisioli, A.; Paraggio, E.; Tomasi, C.; Apostoli, P.; De Palma, G. A Twenty-Year Retrospective Analysis of Risk Assessment of Biomechanical Overload of the Upper Limbs in Multiple Occupational Settings: Comparison of Different Ergonomic Methods. *Bioengineering* **2023**, *10*, 580. https://doi.org/10.3390/bioengineering10050580

Academic Editors: Fabian Holzgreve, Daniela Ohlendorf and Christian



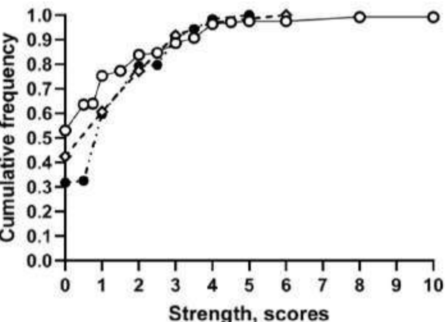


Figure 1. Upper graph shows that although the evaluations conducted by the HAL ACGIH and OREGE methods were structured on 0–10 analogy scales, as with the OCRA CL, they overlapped, but were different from those of the OCRA CL. In particular, the OCRA CL undervalued the frequency of actions compared to the other two. As can also be observed graphically, the assessments were mostly discordant in terms of the risk scores for intermediate frequencies, whereas the assessments were very similar, almost overlapping, in terms of the extreme scores, especially at higher values.

The greatest discrepancies were observed between the assessments of posture, (differed in terms of the duration of incongruous-posture maintenance necessary to configure risk, the level of association with other risk factors (e.g., strength), the range of motion, and the areas analysed).

MS health outcomes

Pain (Symptoms, Questionnaire, Patient Reported Outcome Measures)

- Low back pain
- Low back pain and sciatica
- Shoulder pain

Loss of function (Physical examination)

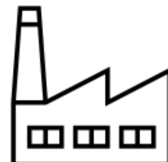
- Lumbar motion
- Lower leg muscle strenght
- Shoulder joint ROM

Tissue damage (Imaging)

- Lumbar degenerative disc disease
- Lumbar disc herniation
- Supraspinatus tendonitis

Disability (FCE)

*Functional Capacity Evaluation (FCE)



Reduced work ability

Sick leave

«SUBJECTIVE» CRITERIA

MS health outcomes - **Musculoskeletal system:** Tendons / Muscles / Joints / Nerves

Body area		Symptoms		Symptoms Physical examination Disability (PROMS)	Symptoms Physical examination / Disability Instrumental test (TC; MRI; US, EMG)
Spine	Neck	Back and neck pain or discomfort	Neck or Cervical pain	Trapezius myalgia Abnormal C spine curvature (flat) Reduced ROM Cervical radiculopathy	Cervical disc disease/ degeneration Cervical disc herniation <u>Cervical osteoarthritis</u>
	Dorsal spine		Dorsal pain or discomfort	Abnormal spine curvature: dorsal scoliosis	Dorsal scoliosis (severity) Dorsal disc disease
	Lower back	Low back pain	Low back pain	Abnormal Lumbar spine curvature (flat) Reduced ROM LS radiculopathy	Lumbar disc degeneration Lumbar disc herniation Radicular compression <u>Osteoarthritis</u>
Upper limb	Shoulder	Upper arm pain or discomfort	Shoulder pain	Shoulder tendonitis	Rotator cuff syndrome Shoulder bursitis <u>Osteoarthritis</u>
	Elbow	Forearm pain or discomfort	Elbow pain	Lateral or medial epycondilitis	Lateral or medial epycondilitis Ulnar nerve entrapment
	Hand-wrist		Hand-wrist pain, tingling Hand weakness	Hand-wrist tendonitis Hand loss of strength	Carpal tunnel syndrome Guyon syndrome Osteoarthritis
Lower limb	Hip	Lower limb pain or discomfort	Hip pain	Tendonitis Reduced hip ROM	Hip soft tissue disorders Hip Osteoarthritis
	Knee		Knee pain	Instability, Swelling of the Knee Reduced knee ROM	Bursitis, tears in the ligaments, Osteoarthritis of the joint
	Foot-ankle		Foot-ankle pain	Instability, Swelling of the ankle	Tendonitis Tarsal tunnel syndrome Osteoarthritis

«OBJECTIVE» CRITERIA

Text Box 2. Revised IASP Definition of Pain (2020)

Pain

An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage.

Notes

- Pain is always a personal experience that is influenced to varying degrees by biological, psychological, and social factors.
- Pain and nociception are different phenomena. Pain cannot be inferred solely from activity in sensory neurons.
- Through their life experiences, individuals learn the concept of pain.
- A person's report of an experience as pain should be respected.*
- Although pain usually serves an adaptive role, it may have adverse effects on function and social and psychological well-being.
- Verbal description is only one of several behaviors to express pain; inability to communicate does not negate the possibility that a human or a non-human animal experiences pain.

Etymology:

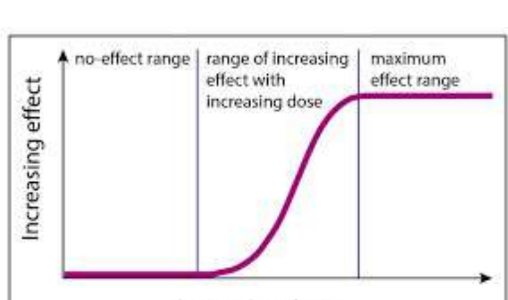
Middle English, from Anglo-French peine (pain, suffering), from Latin poena (penalty, punishment), in turn from Greek poinē (payment, penalty, recompense).

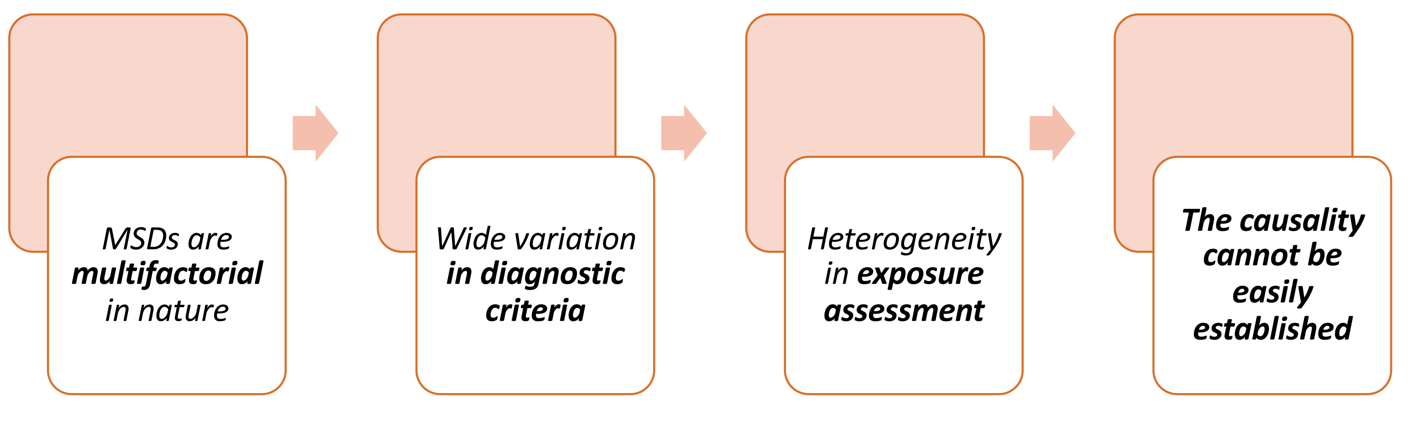
* The Declaration of Montréal, a document developed during the First International Pain Summit on September 3, 2010, states that "Access to pain management is a fundamental human right."

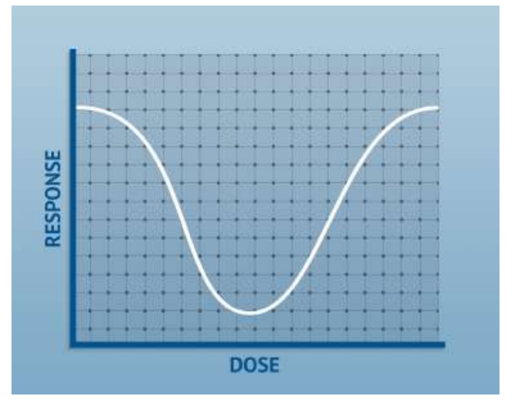
https://www.iasp-pain.org/resources/terminology/

Raja, Srinivasa N.a et al. **The revised International Association for the Study of Pain definition of pain:** concepts, challenges, and compromises. **PAIN: September 2020** - Volume 161 - Issue 9 - p 1976-1982

*A more holistic approach to risk assessment, **combining physical and psychosocial risks,** both of which put workers at risk of developing MSDs, is advocated (EU-OSHA)*





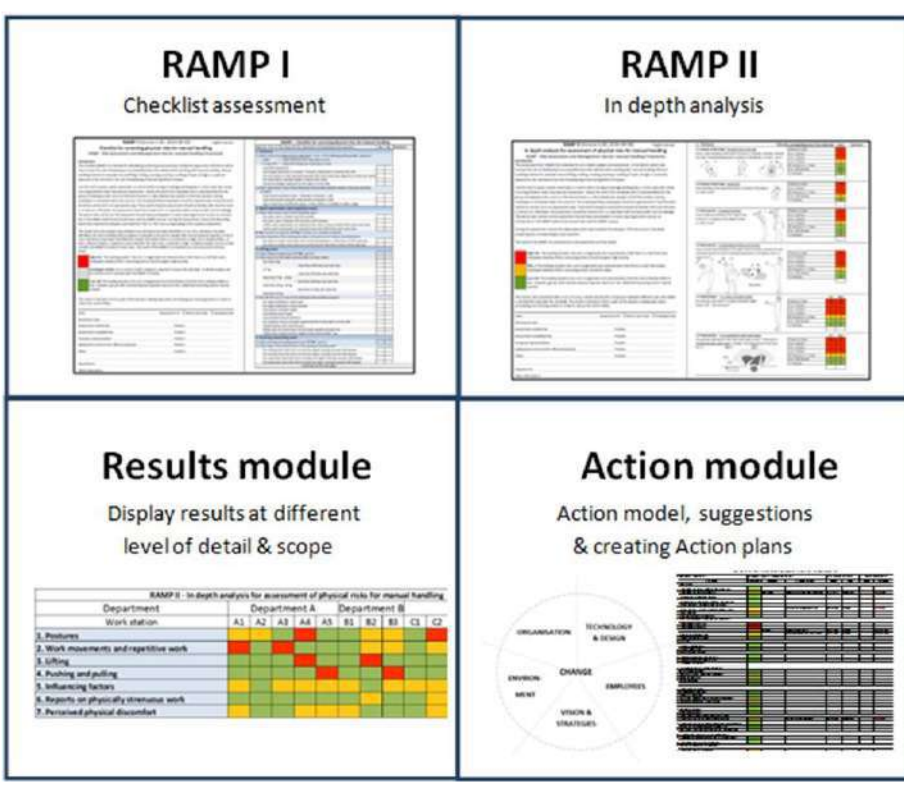


- New methods / models are continuously proposed ….

Risk Assessment and Management tool for manual handling Proactively – RAMP tool

The RAMP tool includes four parts supporting risk management of a wide range of WMSD risk factors related to industrial manual handling operations (MHOs):

1. the RAMP I screening tool (Lind, Forsman, and Rose 2017) and
2. the RAMP II assessment tool that facilitate screenings and assessments of MSD risk factors (This tool can be used to assess a job, work task, or a work station during an average work day.)
3. the 'Results module' designed to aggregate and visualise assessments performed by RAMP I and RAMP II from single workstations to an entire department or production site;
4. and the 'Action module' designed to support the design and follow-up of risk-reducing measures.



https://www.ramp.proj.kth.se/

ERGONOMICS
https://doi.org/10.1080/00140139.2019.1710576

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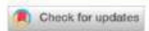

Development and evaluation of RAMP II - a practitioner's tool for assessing musculoskeletal disorder risk factors in industrial manual handling

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ABSTRACT

RAMP II is an observation-based tool developed for assessing a wide range of musculoskeletal disorder risk factors related to industrial manual handling. RAMP II, which is part of the RAMP tool, is based on research studies and expert judgments. The assessment relies mainly on direct or video observations of the work being assessed, but additionally on measured push/pull forces and weights of handled objects, and on perceived workload and discomfort. Over 80 practitioners participated in the development of the tool. According to the evaluations, 73% of the assessment items evaluated had acceptable reliability, and the majority of the potential end-users reported that RAMP II is usable for assessing risks and as a decision base. It is concluded that this study provides support that RAMP II is usable for risk assessment of musculoskeletal disorder risk factors in industrial manual handling.

Practitioner summary: RAMP II is an observation-based assessment tool for screening and assessing major musculoskeletal exposures in industrial manual handling jobs. Over 80 practitioners participated in the development of the tool. This study provides support that RAMP II is usable for risk assessment of musculoskeletal disorder risk factors in industrial manual handling.

ARTICLE HISTORY
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KEYWORDS
The RAMP tool; risk assessment; screening; observation; musculoskeletal disorders

KTH Teknik och hälsa

k. The loading situation has such a magnitude and characteristics that many
es are at an increased risk of developing musculoskeletal disorders. Improvement measures should be given high priority.

Risk. The loading situation is of such a magnitude and characteristic that certain employees are at an increased risk of developing musculoskeletal disorders. Improvement measures should be taken.

Low risk. The loading situation is of such a magnitude and characteristic that most employees are at a low risk of developing musculoskeletal disorders. However, individuals with reduced physical capacity may be at risk. Individually tailored improvement measures may be needed.

Figure 2. The color-code scale used in RAMP II for communicating the risk and priority levels.

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BMC Musculoskeletal Disorders

RESEARCH Open Access

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Saeid Yazdanirad, Gholamhossein Pourtaghi, Mehdi Raei and Mohammad Ghasemi*

MOREBA method

Table 1 The guidance of scoring the factors

Factor		Scoring	Factor	Scoring
Posture group A		Assessing the most worst and frequent positions related to neck, trunk, and legs during work time and calculating score A using the table of REBA method.	Static activity	- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)
Posture group B		Assessing the most worst and frequent positions related to upper arm, lower arm, and wrist during work time and calculating score B using the table of REBA method.	Repetitive activity	- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)
Coupling status		- Very good (0) - Good (1) - Acceptable (2) - Poor (3) - Very poor (4)	Rapid and sudden movement	- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)
Contact stress		- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)	Throwing motion (such as hitting with a hammer or hand)	- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)
Load	Maximum load weight	- Less than 5 kg (0) - 5 to 10 kg (1) - 10 to 15 kg (2) - 15 to 20 kg (3) - More than 20 kg (4)	Hand-arm vibration	- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)
	Load-carrying time	- Never (0) - Less than 2 h (1) - 2 to 4 h (2) - 4 to 6 h (3) - More than 6 h (4)	Whole-body vibration	- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)
Force	Maximum force value	- Less than 1 kg (0) - 1 to 2 kg (1) - 2 to 4 kg (2) - 4 to 6 kg (3) - More than 6 kg (4)	Air temperature	- Neutral (0) - Slightly warm or cool (1) - Warm or cool (2) - Hot or cold (3) - Very hot or very cold (4)
	Work time	- Less than 2 h (0) - 2 to 4 h (1) - 4 to 6 h (2) - 4 to 8 h (3) - More than 8 h (4)	Work – rest cycle (rest duration per two hours)	- Without rest (4) - 15 min (3) - 30 min (2) - 45 min (1) - 60 min and more (0)

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$$
\begin{aligned}
MOREBAscore = [&(0.734 \times P_A) + (0.714 \times P_B) + (0.582 \times C) \\
&+ (0.272 \times CS) + (0.658 \times L) + (0.638 \times F) \\
&+ (0.585 \times SA) + (0.586 \times RA) + (0.525 \times RM) \\
&+ (0.588 \times TM) + (0.349 \times HAV) + (0.257 \times WBV) \\
&+ (0.346 \times T) + (0.481 \times WRC)]
\end{aligned}
$$

The results showed that the strain produced by the physical risk factors with the total effect coefficient of 0.783 could significantly affect the musculoskeletal symptoms.

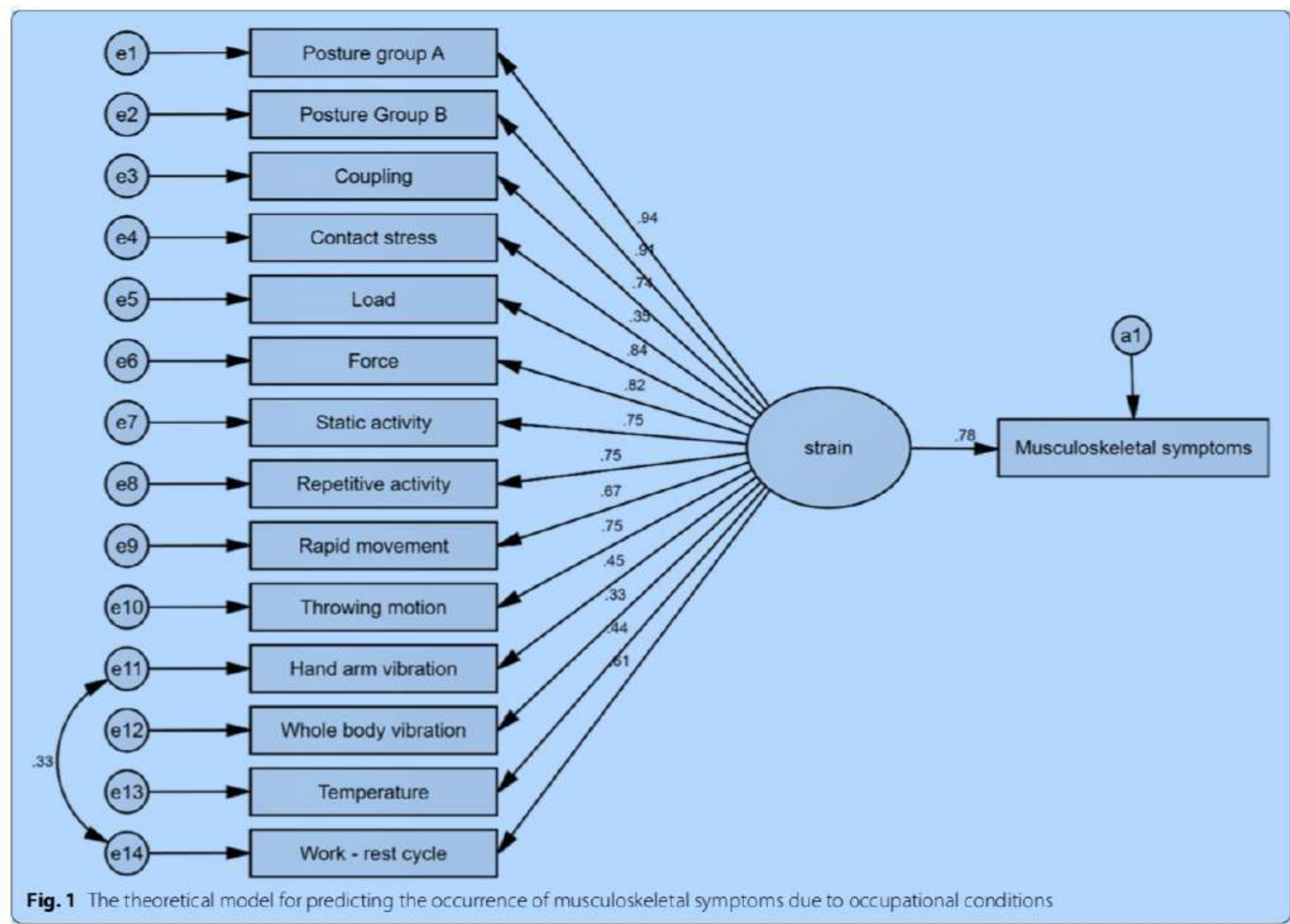

Fig. 1 The theoretical model for predicting the occurrence of musculoskeletal symptoms due to occupational conditions

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Table 6 The risk levels and equivalent MOREBA scores

Risk level	Equivalent score
Low	Less than 12.37
Moderate	12.37 to 16.50
High	16.51 to 24.35
Very high	More than 24.35

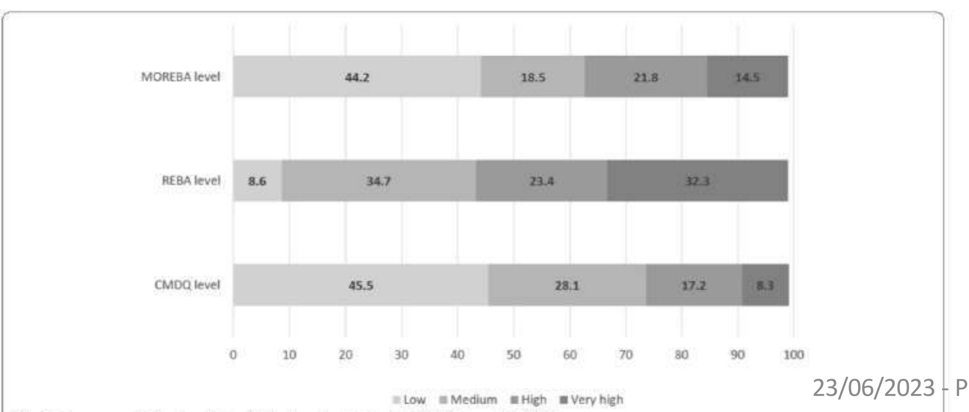


Fig. 5 Frequency distribution of the risk levels estimated by CMDQ, REBA, and MOREBA

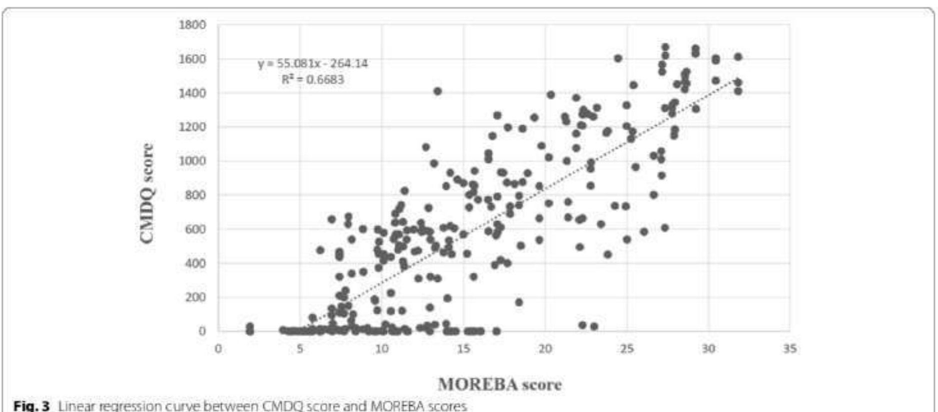


Fig. 3 Linear regression curve between CMDQ score and MOREBA scores

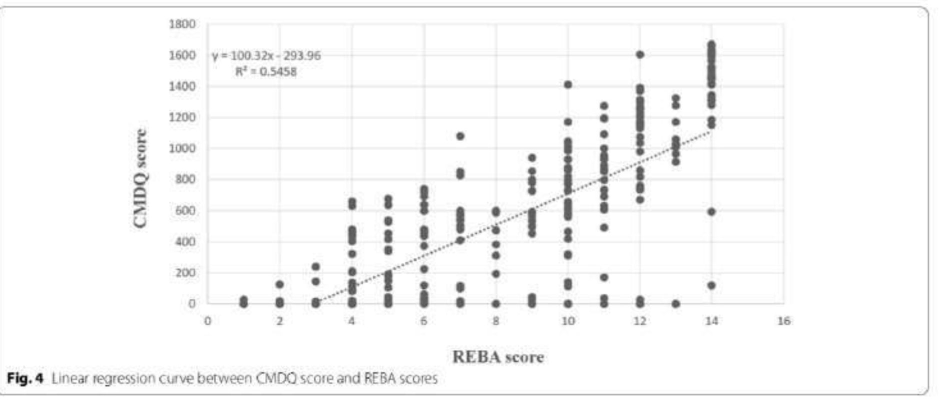


Fig. 4 Linear regression curve between CMDQ score and REBA scores

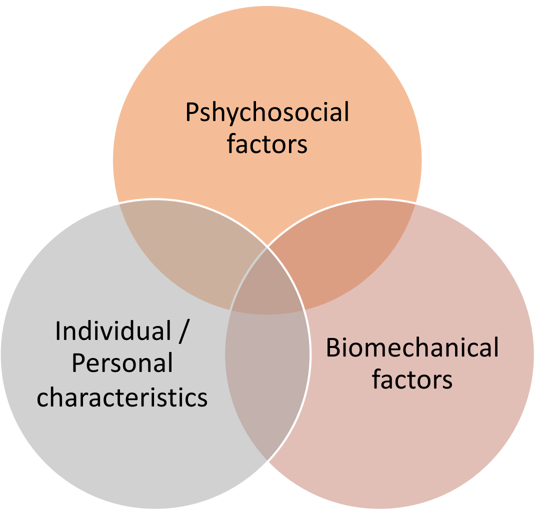
Based on the results, the MOREBA and REBA methods could justify 67 and 55% of the variations of musculoskeletal symptoms, respectively.

Numeri, aree, colori ....

- Il significato da attribuire al risultato della valutazione e l'utilizzo che ne deriva dipendono da numerosi fattori che possono influenzare e caratterizzare la riproducibilità e la validità della misura effettuata
- Da ultimo, ma non per importanza, va considerato il contesto di applicazione

Objective (goal): Design job task – layout
Prevention at group level

- To set priorities
- To assess interventions
- Benchmarking

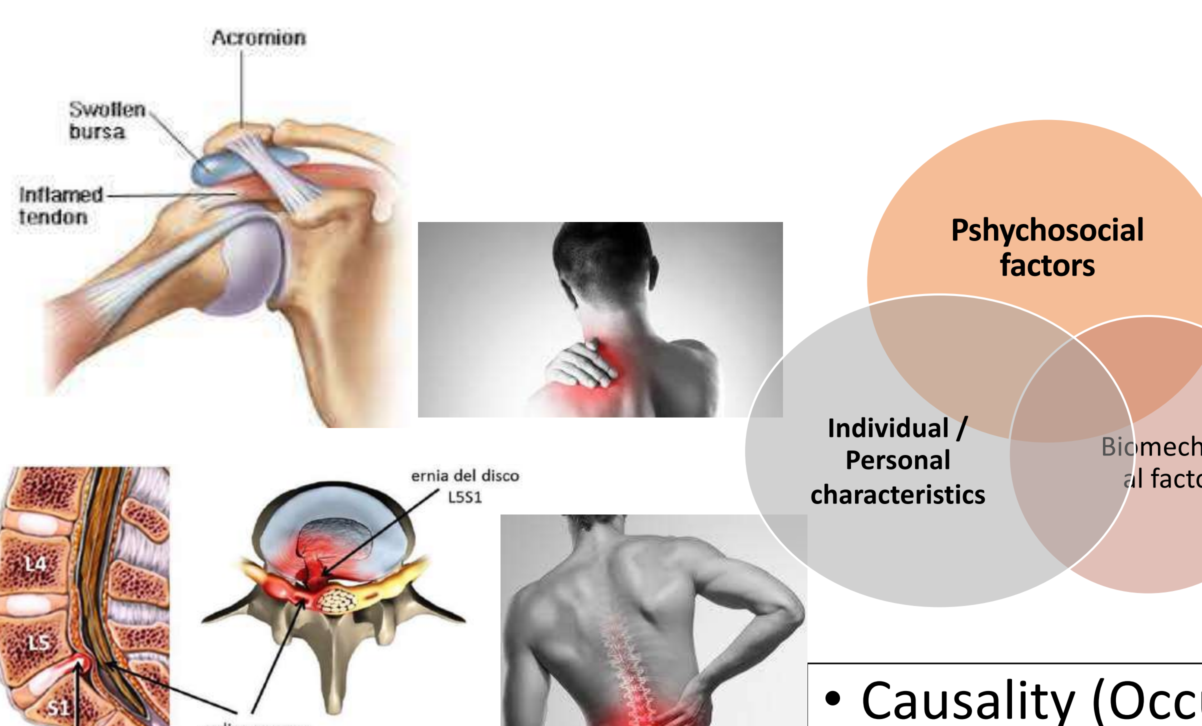


- Select one/more methods
- Scores (Lifting Index, TLV/AL ACGIH, SI, OCRA Index)
- Action levels (RULA, REBA, OCRA Checklist)

Remember: scores are based on adult working population data

Objective (goal):
Prevention / Assessment at individual level

- Return to work (sub)-acute conditions
- Chronic conditions - Disability accommodations



(unless specified) methods and related scores ARE NOT

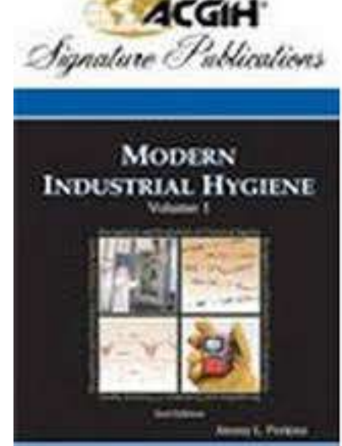
- based on (intended for) disabled people
- designed to be applied for causality, especially if not validated for the disease

- Causality (Occupational disease)

- Approccio ***multi-step*** (raccomandato)
- **Integrazione di diversi strumenti di valutazione** (multifattorialità)
- **«Nuove tecnologie»:** verosimilmente potranno correggere i limiti legati alla ripetibilità e permettere in ambito epidemiologico la misura dell'esposizione anche in campioni ampi di popolazione in studio (oggi valutata mediante criteri anamnestici, questionari)
- **La comprensione dell'insieme di dati sperimentali, dei risultati della valutazione e soprattutto di potenzialità e limiti dei metodi e dei modelli utilizzati**, costituisce utile guida per la progettazione e l'adattamento della mansione (in particolare in caso di lavoratori con disabilità)
- Particolare cautela va adottata nell'utilizzo degli indici di esposizione in relazione al **processo di validazione** cui sono stati sottoposti **per specifiche patologie** (soprattutto nella valutazione del nesso di causalità)

OELs are not magical numbers, absolute values of safety, which can be applied without thought….. The user shoud read the "Documentation" and not rely solely on the number …

JL Perkins. Industrial Hygiene, Chapter 10 OELs and TLVs



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