The role of occupational and personal risk factors in the occurrence of the hand-arm vibration syndrome

Massimo Bovenzi

Department of Medical Sciences

University of Trieste

Hand-Arm Vibration Syndrome

- Vascular component
- Sensorineural component
- Musculoskeletal component

HAND-ARM VIBRATION SYNDROME

- Vibration-induced white finger (secondary form of Raynaud's phenomenon)
- Diffuse-multifocal neuropathy with predominant sensory impairment
- Nerve trunk entrapment syndromes in the upper limbs
- Changes in the bones and joints of the upper limbs
- Upper limb muscle and tendon disorders

Consorzio per l'accreditamento
e aggiornamento in Medicina del Lavoro

Società Italiana di Medicina del Lavoro
ed Igiene Industriale

Fondazione Salvatore Maugeri
Clinica del Lavoro e della Riabilitazione
I.R.C.C.S.

Centro Studi

LINEE GUIDA

per la prevenzione dei disturbi e delle patologie da esposizione a vibrazioni meccaniche negli ambienti di lavoro

M. Bovenzi *(coordinatore)*
G. Angotzi, P. Apostoli, C. Negro, W. Versini

Vol. 5
PRIMA REVISIONE

MINISTERO DI AGRICOLTURA, INDUSTRIA E COMMERCIO

UFFICIO DEL LAVORO

Bollettino dell'Ispettorato del Lavoro

V.e II - N. 1 - Gennaio 1911.

ROMA
OFFICINA POLIGRAFICA ITALIANA
—
1911

VI.

INCHIESTE E RAPPORTI

Il lavoro con i martelli pneumatici.

(Seconda Relazione del prof. Giovanni Loriga *a S. E. il Ministro di Agric. e Comm.).*

In seguito ai risultati del mio studio sul modo con cui si compie la lavorazione delle pietre e dei marmi con i martelli pneumatici nei cantieri di Roma e sulle condizioni sanitarie degli operai che vi sono addetti (1) piacque alla E. V. di affidarmi l'incarico di estendere le mie indagini a tutte le altre forme di applicazione dei suddetti martelli al lavoro manuale.

Sono grato alla E. V. dell'incarico onorevolissimo, il quale mi ha dato occasione di fare osservazioni non prive di importanza sopra un argomento nuovo di Patologia ed Igiene del lavoro, di cui esiste soltanto qualche vago cenno nella letteratura medica italiana e straniera, mentre era indispensabile ed urgente di acquistarne una conoscenza più profonda e più precisa, e ciò non solo perchè l'applicazione dell'aria compressa per trasformare in piccole macchine a motore gli usuali utensili si estende ogni giorno di più in un grande numero di industrie, ma anche perchè era doveroso ricercare le ragioni delle lagnanze o delle acquiescenze dei singoli gruppi di operai verso le nuove forme di lavoro e trarne ammaestramenti per la tutela della salute dei lavoratori.

Nel rendere conto dei risultati del nuovo studio mi sembra logico prendere separatamente in esame il lavoro delle pietre e dei marmi e quello dei metalli, corrispondentemente ai due gruppi di materiali adoperati, per arrivare ad intendere meglio i caratteri specifici o l'influenza sull'organismo di ciascuna forma di lavoro, quali risultano dalle loro eventuali analogie o differenze.

Lavorazione delle pietre e dei marmi. — Allo scopo di completare e controllare le osservazioni già fatte nei cantieri romani ho visitato otto fra i principali cantieri per la lavorazione dei marmi in Carrara, due laboratori di marmi e di pietre dure per uso artistico in Milano ed il cantiere istituito in Mazzano (Brescia) dalla Ditta Caffuri e Massardi per la lavorazione del *botticino*, che è la stessa pietra impiegata per la costruzione del monumento a V. Emanuele in Roma.

(1) Tale studio viene ripubblicato in allegato alla presente relazione.

Bando ricerche BRiC 2022

Progetto: *No Risks – nuovi modelli per ridurre il rischio derivante dall'esposizione dei lavoratori a vibrazioni*

WP1

Il ruolo dei fattori di rischio personali, non-occupazionali, nell'occorrenza della sindrome da vibrazioni mano-braccio: analisi aggregata di studi epidemiologici italiani con disegno trasversale e longitudinale

Pooled cross-sectional study

- The study populations included **1272 HTV exposed male workers** and **579 unexposed control men** who were investigated in a series of cross-sectional studies conducted in geographic areas of the Central and North-Eastern Italy during the autumn/winter seasons in the calendar period 1990-2010.
- The **HTV exposed workers** were employed in various industrial sectors: forestry (n=524), construction (n=221), shipbuiding (n=192), engineering (n=206), iron and steel (n=129).
- The **control men** were manual workers (n=429) or inspectors/supervisors (n=150) not exposed to HTV and recruited in the same enterprises or companies of the HTV exposed workers.

Pooled cohort study

- Two prospective cohort studies included **377 HTV exposed workers** (343 forestry operators and 34 stone workers) and **138 control men** employed at the same companies (129 maintenance operators, 5 inspectors, 4 supervisors).

- They were investigated at the cross-sectional survey and over either 1 or 5 yr-interval follow-up investigations carried out in the autumn-winter seasons of the calendar period 1990-2007.

Risks of Occupational Vibration Exposures

VIBRISKS

EC FP5 project no. QLK4-2002-02650
Quality of Life and Management of Living Resources Programme
January 2003 to December 2006

Background

Millions of European workers are exposed to mechanical vibration transmitted to their hands from powered tools or transmitted to their whole body from the seats of industrial vehicles. Disorders of the upper limbs caused by hand-transmitted vibration are among the most compensated industrial diseases in several European states and exposure to whole-body vibrati is associated with disorders of the spinal system.

The currently standardised methods of assessing the severity of vibration exposures are not based primarily on epidemiological evidence or on an understanding of the relevant mechanisms of injury. They are not sufficient to predict the risks of injury or define optimum means of preventing injury.

http://www.vibrisks.soton.ac.uk/

Risks of Occupational Vibration Exposures

VIBRISKS

Epidemiological Protocols and Questionnaires

The first activities of the VIBRISKS project were the definition of draft diagnostic protocols for epidemiological studies of hand-transmitted and whole-body vibration. These were initially based on procedures developed by the earlier Vibration Injury Network project (FP4, European Commission). They were further developed throughout the VIBRISKS project and now provide important tools to assist the design and conduct of epidemiological studies and workplace assessments of exposures to hand-transmitted vibration. The documents provide a unique combination of useful information for future research as well as a guide to the studies conducted by VIBRISKS.

Hand-transmitted vibration

The diagnostic protocol for hand-transmitted vibration provides not only the definition of tests for diagnosing the hand-arm vibration syndrome, it also provides colour charts to improve patient reports of finger blanching, criteria for the diagnosis of carpal tunnel syndrome in persons exposed to hand-transmitted vibration, clinical tests for the diagnosis of upper limb disorders, criteria for the clinical diagnosis of neck and upper limb musculoskeletal disorders, guidance on differences between reported and observed exposure durations, alternative measures of vibration dose, uniform means of summarising vibration exposures and their effects, and newly improved self-administered and clinically administered questionnaires for cross-sectional and follow-up studies. For the purposes of the multi-national surveys in VIBRISKS, each of the questionnaires has been translated into both Italian and Swedish.

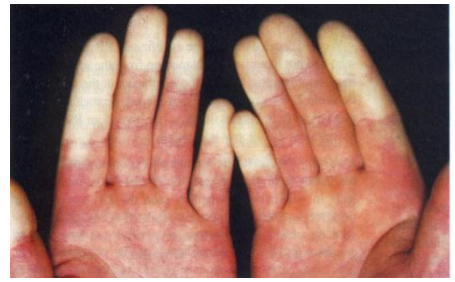
1130 kB Protocol for epidemiological studies of hand-transmitted vibration, Annex 1 to VIBRISKS Final Technical Report, February 2007.
M J Griffin (UoS) and M Bovenzi (UTRS)

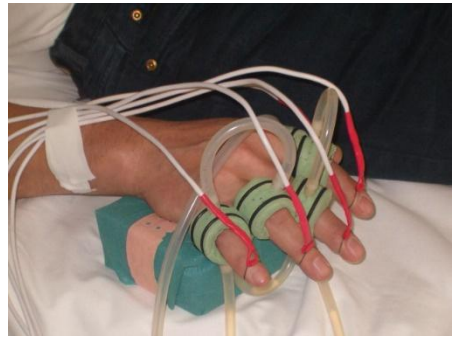
193 kB Self administered questionnaire: Italian translation, Italian translation of Appendix 8a to Annex 1, April 2004.
M Bovenzi (UTRS)

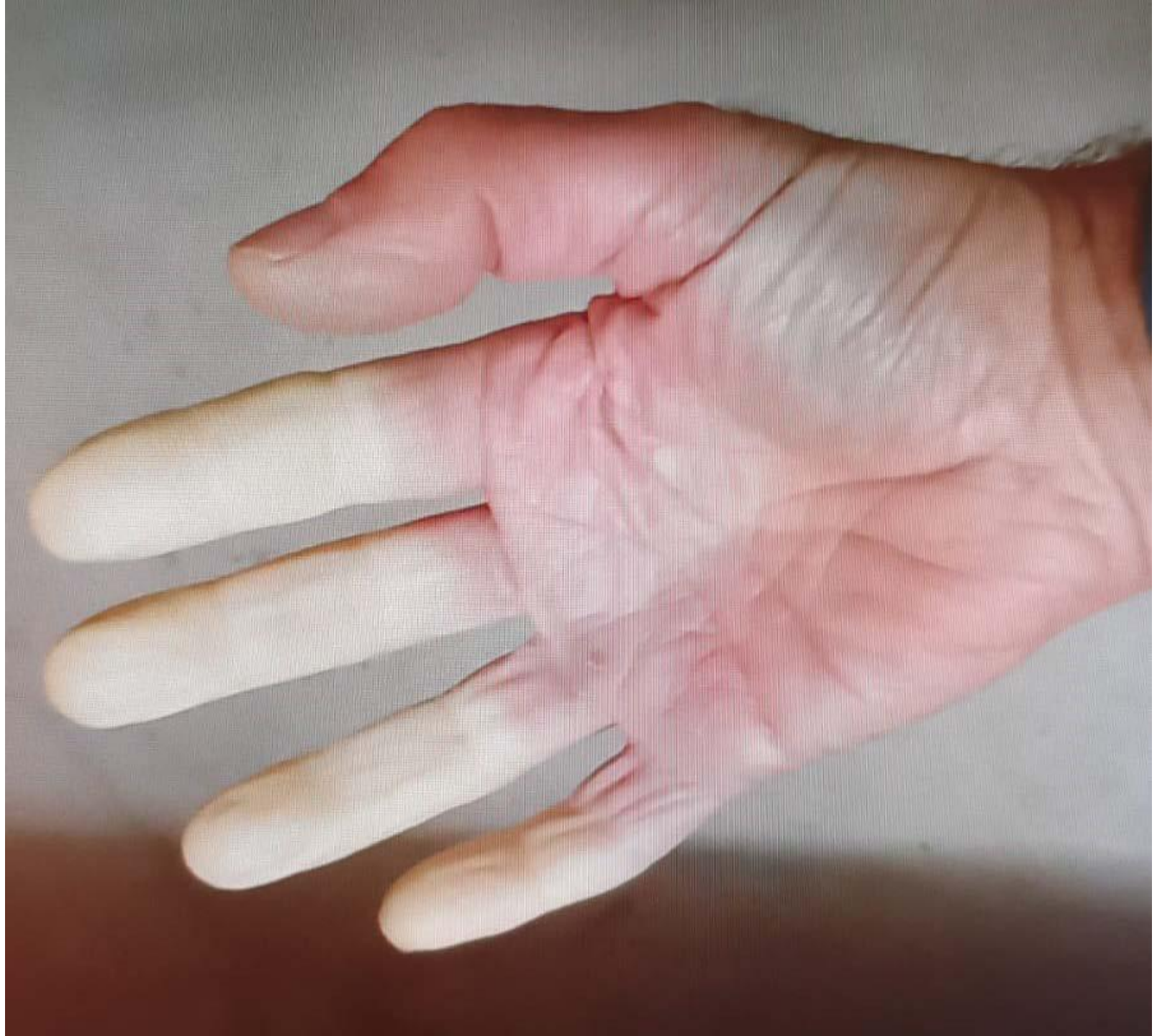
220 kB Clinically administered questionnaire: Italian translation, Italian translation of Appendix 8b to Annex 1, April 2004.
M Bovenzi (UTRS)

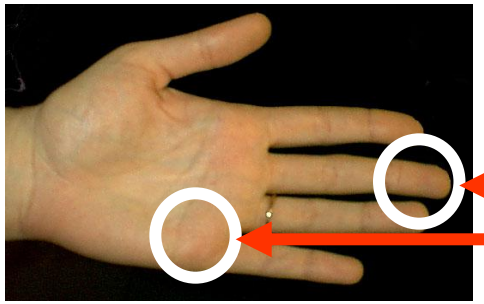
Symptoms and signs of HTV induced vascular disorders

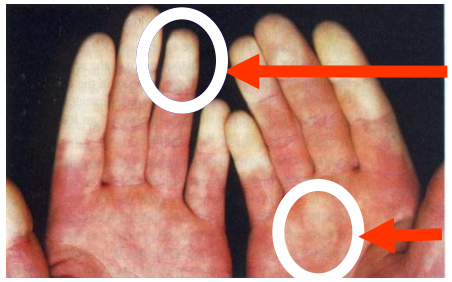
- Medical interview according to the criteria of the Stockholm Workshop ’94.
- Administration of colour charts.
- Abnormal findings at a cold test with measurement of finger systolic blood pressure at 10° C

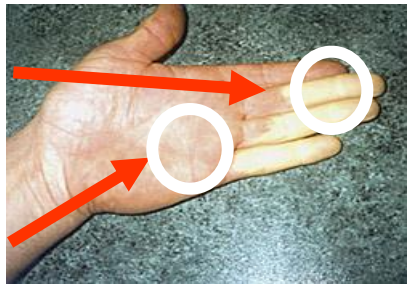


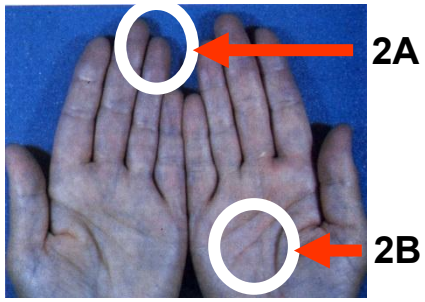


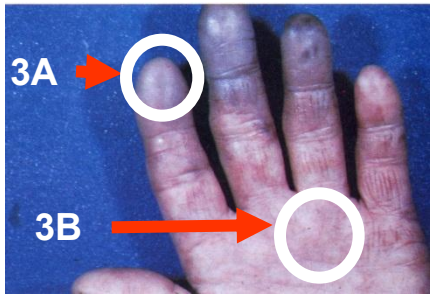


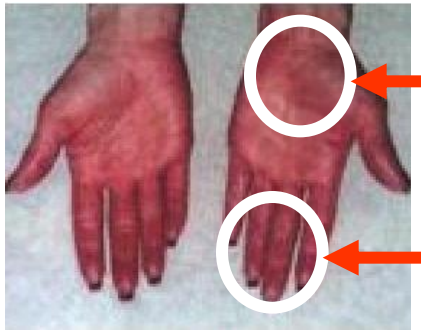

0 A
0 B


1A
1B




2A
2B


3A
3B


4 B
4 A

Symptoms and signs of HTV induced neurosensory disorders

- Medical interview according to the criteria of the Stockholm Workshop ’94.
- *Persistent* finger numbness.
- Impaired perception thresholds for touch, heat, cold and vibration sensations.
- Impaired manipulative dexterity.

Consensus criteria for the classification of CTS symptoms/signs in epidemiologic studies

(*Am J Public Health* 1998; 88:1447-1451)

- Classic/probable symptoms (numbness, tingling, burning or pain in at least two of digits 1, 2, or 3)
- Nocturnal symptoms
- Positive physical examination (Tinel's test or Phalen's test)

Dupuytren's contracture

(*Am J Ind Med* 1996; 29:521-532)

Nodules and cords in the palmar aponeurosis eventually resulting in irreversible flexion contracture of one or more fingers of the hand.

Personal risk factors

EU VIBRISKs Questionnaire
(*http://www.vibrisks.soton.ac.uk*)

- Age (y)
- BMI (kg/m^2)
- Smoking habit (pack-yrs)
- Drinking habit (alcohol units/d)
- Regular intake of medicines
- Traumas/surgery of the neck-upper limbs
- Disorders of the cervical spine
- Metabolic disorders
- Cardiovascular diseases

Vibration measurement and exposure

- Vibration measurements were made in three orthogonal directions (*x*-, *y*-, *z*-axes) according to the procedure in ISO 5349-1.
- Acceleration magnitudes were weighted according to ISO frequency weighting (w_{hi}) and daily HTV exposure was expressed in terms of ***A*(8)** according to ISO 5349-1 and the EU Directive on vibration.

$$a_{hvi} = \sqrt{a_{hwxi}^2 + a_{hwyi}^2 + a_{hwzi}^2} \qquad (ms^{-2}\ r.m.s.)$$

$$A(8) = \sqrt{\sum_{i=1}^{n} a_{hvi}^2 \frac{T_i}{T_0}} \qquad (ms^{-2}\ r.m.s.)$$

Ergonomic risk factors for CTS

- EU VIBRISKS questionnaire: five questions concerning twisting, forceful or repetitive movements, uncomfortable hand positions/grips, and heavy demands on precision scored on a 4-point response scale (*http://www.vibrisks.soton.ac.uk*).
- The score of hand/forearm physical load was categorised into quartiles corresponding to four grades of increasing physical load from mild to hard load grade (*SJWEH* 2015; 41:247-258).

Data analysis

Pooled cross-sectional study

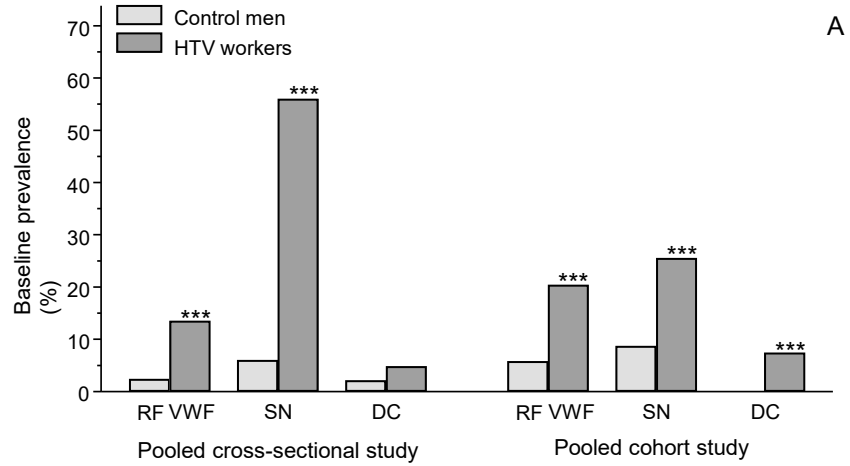
- Prevalence data
- Multivariable linear and logistic regression analyses
- Likelihood ratio test
- Goodness-of-fit statistic (H-L method)

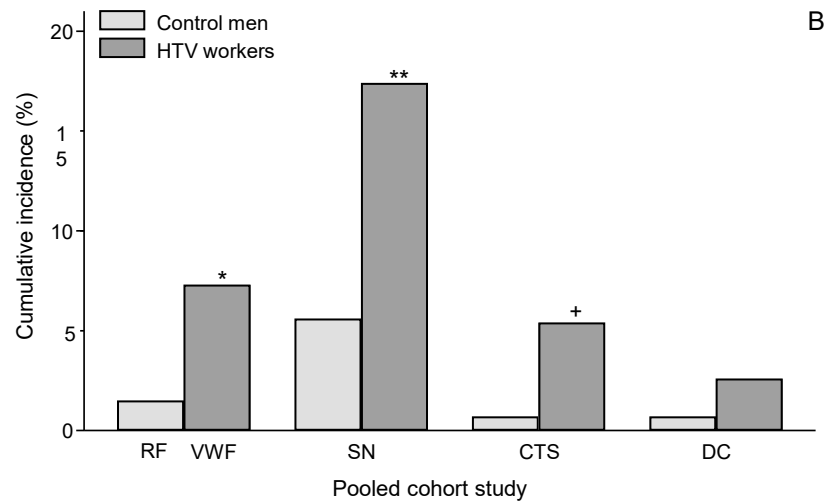
Pooled cohort study

- Prevalence and incidence data
- GEE method
- Identity and logit link functions
- Autoregressive correlation structure
- Time-dependent covariates

Individual characteristics in the pooled cross-sectional and cohort studies

Factors median (q) n (%)	Cross-sectional study		Cohort study	
	Controls (n=579)	HTV workers (n=1272)	Controls (n=138)	HTV workers (n=377)
Age (y)	**42 (34-50)**	**46 (39-52)[c]**	**38.8 (34.1-45.9)**	**43.1 (35.2 – 49.8)[b]**
BMI (kg/m^2)	**25.3 (23.1-27.7)**	**26.1(23.8-28.4)[c]**	**24.5 (23.0-27.2)**	**25.9(23.8 – 27.7)[c]**
Smoking	266 (45.9)	710 (55.8)	**49 (35.5)**	**256 (67.9)[c]**
Drinking	444 (76.7)	943 (74.1)	104 (75.4)	282 (74.8)
Regular intake of medicines	85 (14.6)	228 (17.9)	24 (17.4)	50 (13.3)
Trauma/surgery neck-upper limb	**239 (41.3)**	**631 (49.6)[c]**	58 (42.0)	157 (41.6)
Disorders of the cervical spine	28 (4.9)	83 (6.5)	**6 (4.4)**	**38 (10.1)[a]**
Metabolic disorders	**12 (2.1)**	**55 (4.3)[c]**	**4 (2.9)**	**36 (9.6)[a]**
Cardiovascular disorders	**64 (11.1)**	**197 (15.5)[a]**	14 (10.1)	55 (14.6)
***A*(8) (ms^{-2} r.m.s.)**	-	2.98 (1.90 – 4.41)	-	3.72 (2.80 – 4.98)


A
Control men
HTV workers
Baseline prevalence (%)
70
60
50
40
30
20
10
0
***
***
***
***
***
RF VWF SN DC
RF VWF SN DC
Pooled cross-sectional study
Pooled cohort study


B
Control men
HTV workers
Cumulative incidence (%)
20
1
5
10
5
0
**
*
+
RF VWF SN CTS DC
Pooled cohort study

Relations of vascular disorders to HTV exposure and personal risk factors

Factors	Cross-sectional study		Cohort study	
	Total sample (n=1851)	**HTV workers (n=1272)**	**Total sample (obs=1665)**	**HTV workers (obs=1172)**
Age (×10 y)	**1.72 (1.27-2.30)**	**2.20 (1.48-3.27)**	**1.83 (1.45-2.31)**	**2.16 (1.66-2.81)**
BMI (kg/m^2)	**0.89 (0.83-0.97)**	**0.88 (0.84-0.93)**	0.95 (0.89-1.01)	0.97 (0.90-1.04)
Smoking (current-exsmoker)	1.53 (0.92-2.55)	1.74 (0.95-3.20)	1.21 (0.72-2.05)	1.09 (0.62-1.92)
Drinking (≥ 3 alcohol units/d)	1.65 (0.76-3.57)	1.26 (0.83-1.92)	1.41 (0.90-2.19)	1.25 (0.83-1.88)
Regular intake of medicines	0.83 (0.35-1.97)	0.53 (0.18-1.53)	1.06 (0.68-1.64)	1.09 (0.65-1.82)
Trauma/surgery neck-upper limb	0.61 (0.37-1.10)	0.54 (0.30-1.35)	0.93 (0.62-1.39)	0.82 (0.58-1.17)
Disorders of the cervical spine	1.51 (0.66-3.44)	1.59 (0.65-3.91)	1.14 (0.64-2.04)	1.25 (0.64-2.42)
Metabolic disorders	**3.16 (1.10-9.10)**	**3.35 (1.09-10.3)**	**2.14 (1.12-4.11)**	**2.46 (1.15-5.25)**
Cardiovascular disorders	1.90 (0.82-4.38)	1.41 (0.53-3.76)	1.10 (0.67-1.81)	0.90 (0.52-1.56)
Exposure to HTV (yes vs no)	**2.87 (1.56-5.30)**	–	**4.20 (1.93-9.11)**	–
***A*(8) (ms^{-2} r.m.s.)**	–	**1.19 (1.10-1.29)**	–	**1.22 (1.13-1.32)**

Relations of cold-induced vascular dysfunction to HTV exp. and personal risk factors

Factors	Cross-sectional study		Cohort study	
	%FSBP$_{10°}$		%FSBP$_{10°}$	
	Total sample (n=1504)	**HTV workers (n=1070)**	**Total sample (obs=1665)**	**HTV workers (obs=1172)**
Age (×10 y)	0.05 (-1.97; 2.07)	-0.53 (-2.90; 1.83)	-0.88 (-2.14; 0.39)	**-2.29 (-3.86; -0.72)**
BMI (kg/m^2)	**0.54 (0.005; 1.07)**	0.47 (-0.15; 1.09)	**0.67 (0.31; 1.03)**	**0.74 (0.29; 1.18)**
Smoking (current-exsmoker)	1.27 (-2.75; 5.28)	1.86 (-3.03; 6.76)	0.54 (-1.70; 2.78)	1.08 (-1.74; 3.91)
Drinking	-0.84 (-4.87; 3.18)	0.51 (-4.52; 5.55)	-1.42 (-3.91; 1.07)	1.33 (-1.83; 4.49)
Raynaud's phenomenon	**-18.1 (-26.4;-9.85)**	**-15.6 (-24.5; -6.75)**	**-19.3 (-22.3; -16.3)**	**-15.8 (-19.3; -12.2)**
Regular intake of medicines	2.46 (-4.07; 8.99)	4.11 (-4.78; 13.0)	0.84 (-2.21; 3.88)	3.29 (-0.52; 7.11)
Trauma/surgery neck-upper limb	-0.05 (-3.76; 3.67)	0.97 (-3.82; 5.76)	-0.14 (-2.27; 1.99)	0.25 (-2.46; 2.95)
Disorders of the cervical spine	-1.20 (-9.76; 7.36)	2.44 (-6.46; 11.3)	1.78 (-2.41; 5.98)	4.32 (-0.58; 9.23)
Metabolic disorders	-7.43 (-20.3; 5.46)	-2.13 (-17.0; 12.7)	-0.13 (-4.74; 4.47)	1.29 (-4.00; 6.58)
Cardiovascular disorders	-1.77 (-9.16; 5.61)	-0.54 (-9.96; 8.88)	-2.65 (-6.34; 1.04)	-3.41 (-7.86; 1.05)
Exposure to HTV (yes vs no)	**-6.03 (-9.62; -2.44)**	–	**-6.30 (-8.76; -3.85)**	–
***A*(8) (ms^{-2} r.m.s.)**	–	**-1.61 (-2.54; -0.68)**	–	**-2.14 (-2.59; -1.69)**

Relations of neurosensory disorders to HTV exposure and personal risk factors

Factors	Cross-sectional study		Cohort study	
	Total sample (n=1851)	**HTV workers (n=1272)**	**Total sample (obs=1665)**	**HTV workers (obs=1172)**
Age (×10 y)	**1.53 (1.20-1.96)**	**1.67 (1.28-2.18)**	**1.93 (1.50-2.47)**	**2.06 (1.66-2.56)**
BMI (kg/m^2)	1.02 (0.97-1.07)	1.02 (0.96-1.07)	1.00 (0.95-1.05)	1.00 (0.95-1.06)
Smoking (current-exsmoker)	1.28 (0.85-1.92)	1.10 (0.70-1.74)	1.31 (0.87-1.99)	1.19 (0.76-1.86)
Drinking (≥ 3 alcohol units/d)	1.84 (0.99-3.43)	1.87 (0.94-3.73)	1.08 (0.83-1.42)	1.11 (0.83-1.48)
Regular intake of medicines	1.12 (0.56-2.23)	1.13 (0.55-2.35)	0.91 (0.63-1.30)	0.87 (0.63-1.20)
Trauma/surgery neck-upper limb	**2.32 (1.56-3.45)**	**1.90 (1.21-2.97)**	**1.35 (1.03-1.76)**	1.35 (0.95-1.92)
Disorders of the cervical spine	**3.56 (2.17-6.10)**	**4.22 (1.93-9.23)**	0.99 (0.68-1.45)	1.26 (0.69-2.30)
Metabolic disorders	1.61 (0.61-4.22)	2.13 (0.72-6.32)	0.94 (0.54-1.63)	1.12 (0.56-2.22)
Cardiovascular disorders	1.57 (0.77-3.20)	1.44 (0.67-3.06)	1.23 (0.64-2.35)	1.01 (0.64-1.59)
Exposure to HTV (yes vs no)	**3.64 (2.17-6.10)**	–	**2.70 (1.50-4.87)**	–
***A*(8) (ms^{-2} r.m.s.)**	–	**1.09 (1.01-1.17)**	–	**1.13 (1.05-1.21)**

Relations of suspected CTS to HTV exposure and personal risk factors

Factors	Cohort study	
	Total sample (n=515; obs=1665)	HTV workers (n=377; obs=1172)
Age (×10 y)	**1.63 (1.17 – 2.77)**	**1.61 (1.15 – 2.27)**
BMI (kg/m^2)	1.06 (0.99 – 1.15)	1.08 (0.99 – 1.17)
Smoking (current-exsmoker)	1.11 (0.64 – 1.95)	0.98 (0.54 – 1.74)
Drinking (≥ 3 alcohol units/d)	**2.97 (1.26 – 6.99)**	**3.41 (1.37 – 8.44)**
Regular intake of medicines	1.67 (0.87 – 3.22)	1.87 (0.94 – 3.72)
Trauma/surgery neck-upper limb	**1.89 (1.09 – 3.26)**	**1.90 (1.08 – 3.35)**
Disorders of the cervical spine	1.70 (0.70 – 4.15)	2.04 (0.81 – 5.13)
Metabolic disorders	1.39 (0.38 – 5.08)	1.49 (0.38 – 5.81)
Cardiovascular disorders	0.66 (0.28 – 1.54)	0.45 (0.18 – 1.16)
Exposure to HTV (yes vs no) **$A(8)$ (ms^{-2} r.m.s.)**	**14.9 (4.12 – 54.3)** –	– **1.12 (1.05 – 1.19)**

Relations of Dupuytren's contracture to HTV exposure and personal risk factors

Factors	Cross-sectional study		Cohort study	
	Total sample (n=803)	**HTV workers (n=515)**	**Total sample (obs=1665)**	**HTV workers (obs=1172)**
Age (×10 y)	**1.95 (1.17-3.25)**	**1.84 (1.05-3.24)**	**1.95 (1.28-2.99)**	**1.47 (0.97-2.22)**
BMI (kg/m^2)	0.99 (0.87-1.15)	0.93 (0.81-1.08)	0.97 (0.86-1.08)	1.00 (0.89-1.11)
Smoking (current-exsmoker)	0.69 (0.29-1.65)	0.52 (0.21-1.29)	0.70 (0.31-1.57)	0.66 (0.30-1.46)
Drinking (≥ 3 alcohol units/d)	**3.49 (1.04-11.7)**	2.24 (0.59-8.56)	**2.65 (1.02-6.04)**	**2.72 (1.18-6.28)**
Regular intake of medicines	0.59 (0.16-2.19)	0.71 (0.16-3.06)	0.28 (0.07-1.16)	0.27 (0.09-1.20)
Trauma/surgery neck-upper limb	1.19 (0.52-2.71)	1.03 (0.41-2.58)	0.84 (0.25-2.71)	0.87 (0.42-1.81)
Disorders of the cervical spine	2.20 (0.70-6.92)	1.92 (0.43-8.45)	0.87 (0.32-2.38)	0.73 (0.21-2.61)
Metabolic disorders	3.77 (0.76-18.7)	**6.31 (1.34-29.7)**	**4.99 (1.88-13.3)**	**5.05 (1.89-13.5)**
Cardiovascular disorders	1.53 (0.49-4.80)	1.98 (0.50-7.93)	1.67 (0.63-4.40)	1.85 (0.74-4.62)
Exposure to HTV (yes vs no)	2.00 (0.70-5.68)	–	**23.9 (3.05-188)**	–
***A*(8) (ms^{-2} r.m.s.)**	–	0.97 (0.81-1.17)	–	0.96 (0.82-1.13)

C1 – Disorders of the upper limbs and HTV exposure

- Occupational exposure to HTV treated as either a qualitative (binary) or a quantitative (daily *A*(8)) variable is a primary factor in the etiopathogenesis of the vascular and neurosensory disorders occurring in the upper limbs of workers operating vibratory tools or machines.

- The findings of the two pooled studies are in accord with those of systematic reviews and meta-analyses which have reported a more than 2-fold risk for CTS and DC associated with prolonged use of power machinery.

C2 – Vascular disorders of the HAVS and personal risk factors

- In the two pooled studies, vascular symptoms of white finger were associated with metabolic disorders and showed an increasing trend of occurrence with the increase of age.
- In the study populations there was evidence for an inverse relationship between digital vasospastic symptoms and BMI.
- No significant associations were observed between vascular symptoms and drinking or smoking habits in both pooled studies.

C3 – Neurosensory disorders of the HAVS and personal risk factors

- In the two pooled studies, the occurrence of SN disorders were related to age and two comorbidities: traumas or surgery to the neck or upper limbs and disorders of the cervical spine.
- Three non-occupational factors were significantly related to CTS in the pooled cohort study: age, alcohol consumption, and traumatic events (accidental or surgical).
- The role of overweight and obesity on the risk of developing CTS is controversial: in the pooled cohort study the risk of CTS increased by 6% to 8% for each one-unit of increase in BMI (kg/m^2).

C4 – Dupuytren's contracture of the HAVS and personal risk factors

- In addition to HTV exposure, age, alcohol consumption ≥3 units/day, and metabolic disorders were significantly associated with the occurrence of DC in the pooled studies.
- Metabolic disorders was a strong predictor of DC risk, and among DC cases there were patients affected with dyslipidemia, gout, type 2 diabetes mellitus, and obesity either isolated or combined in a diagnosis of metabolic syndrome.
- Likewise CTS, there is a general consensus that the etiology of DC is of multifactorial origin with varying contributions of occupational and individual risk factors.

Summary of the associations between the components of the HAVS and occupational and personal risk factors

Factors	Pooled cross-sectional study			Pooled cohort study			
	Vascular	Neurosensory	DC	Vascular	Neurosensory	CTS	DC
Age	+++	+++	++/+	+++	+++	++	++
BMI	+++/++	-	-	++	-	-	-
Smoking	-	-	-	-	-	-	-
Drinking	-	-	+	-	-	++/+	+
Regular intake of medicines	-	-	-	-	-	-	-
Trauma/surgery of neck-upper limbs	-	+++/++	-	-	+	+	
Disorders of the cervical spine	-	+++	-	-	-	-	-
Metabolic disorders	+	-	+/-	++/+	-	-	+++
Cardiovacsular disorders	-	-	-	-	-	-	-
HTV exposure	+++	+++/+	-	+++	+++/++	+++/++	++/-

+++ P<0.001; ++ 0.001<P<0.01; + 0.01<P<0.05; - NS

C5 – General considerations (1)

- The findings of the pooled analysis of epidemiological studies with individual-level data showed that exposure to HTV is a major occupational risk factor for the onset and development of disorders in the upper limbs of professional users of vibratory tools.

- Ageing and personal risk factors connected to lifestyles and comorbidities were found to concur with HTV exposure to the development of upper limb disorders.

C6 – General considerations (2)

- Data modelling did not show significant interactions between HTV exposure and individual characteristics suggesting that occupational and personal risks factors may play independent roles in the occurrence of upper limb disorders.

- The lack of statistical significance for interactions between variables does not exclude possible underlying biological synergy between risk factors which can cooperate to the occurrence of upper limb disorders in the exposed workers.

C7 – General considerations (3)

- The presence of non-occupational risk factors should not be considered a sufficient justification for rebutting the presumption of work relatedness for the disorders in the upper limbs of HTV exposed workers providing that the symptoms and signs of the disorders arise after the first exposure to HTV.

C8 – General considerations (4)

- These findings may be helpful for occupational physicians who have the responsibility to manage and to update protocols for the health surveillance of vibration exposed workers.

- Targeted preventative measures at the workplace and programs for health promotion should be implemented to protect vulnerable workers, with particular considerations for the elderly workers and those affected with comorbidities which can make them more susceptible to the adverse effects of HTV.

International Archives of Occupational and Environmental Health (2025) 98:757–774
https://doi.org/10.1007/s00420-025-02169-0

ORIGINAL ARTICLE

The role of personal risk factors in the occurrence of the hand-arm vibration syndrome: a pooled analysis of individual data from Italian cross-sectional and cohort studies

Massimo Bovenzi[1] · Federico Ronchese[1] · Francesca Larese Filon[1] · Enrico Marchetti[2] · Angelo Tirabasso[2] · Carlotta Massotti[3] · Marco Tarabini[3]

Received: 26 May 2025 / Accepted: 21 August 2025 / Published online: 9 September 2025

Grazie per l'attenzione