Physical & Work Psychosocial Factors Associated with Carpal Tunnel Syndrome: A Pooled Prospective Study.

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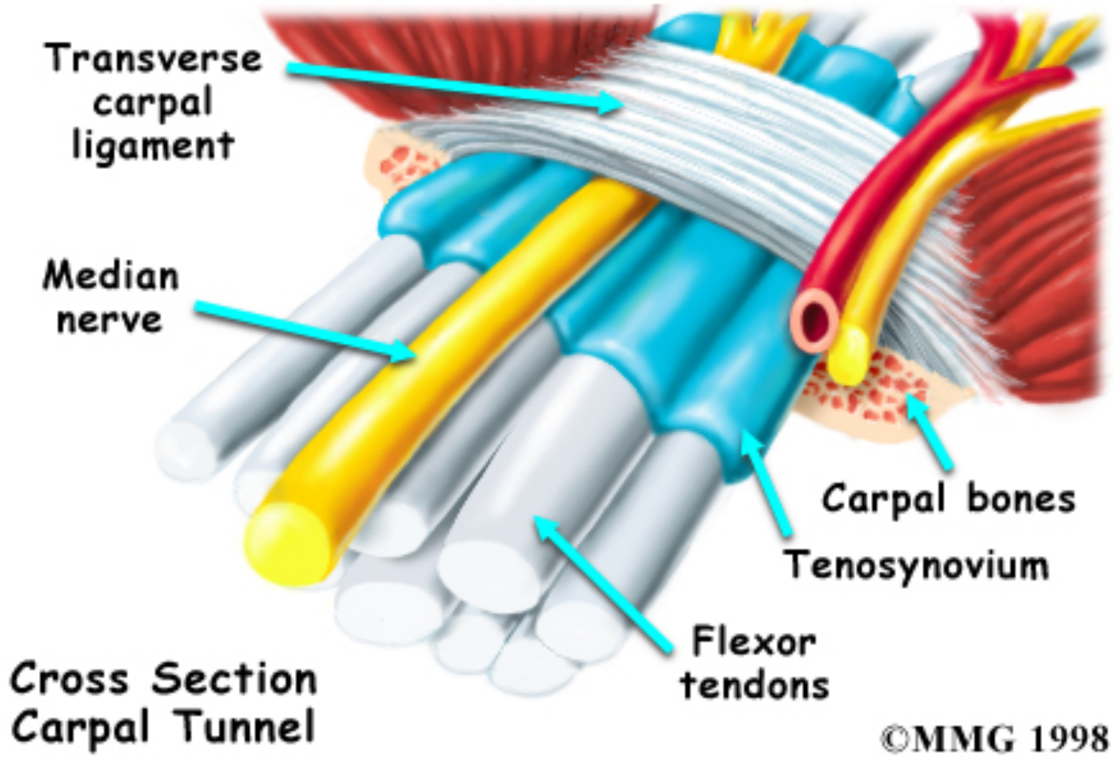
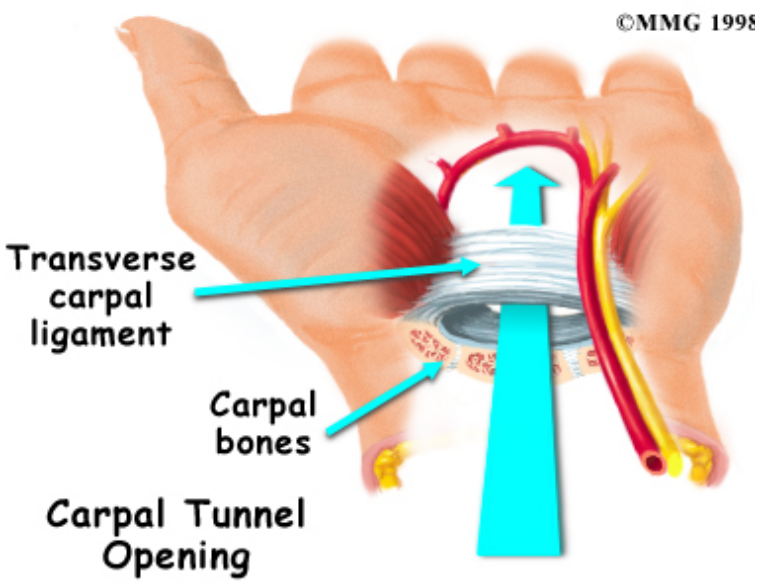
Background

- Incidence rates range from 0.23 to 11 per 100 person-years
  (Roquelaure et al, 2008)





Background

- CTS direct medical costs exceed $2 billion each year (Stapleton, 2006)
- Non-medical costs substantially higher (Foley et al, 2007)
- Median lost time from work is 27 days (Foley et al, 2007)
- 18% report leaving job within 18 months (Faucett et al, 2000)
- Few large prospective studies
  - rigorous case criteria
  - detailed individual exposure assessment
  - adequate power to control for confounding
- Exposure-response relationships not known

Background

Data from 6 prospective studies with similar designs were combined to estimate the relationships between incident CTS and

- Biomechanical risk factors
- Work psychosocial risk factors

Background

CTS case criteria includes a prolonged median nerve latency AND symptoms consistent with the median nerve

YET

Electrophysiologic measures alone has advantages:

- Free of subjective bias
- More specific to median mononeuropathy than symptoms
- Can be analyzed continuously (increased power)

Objective

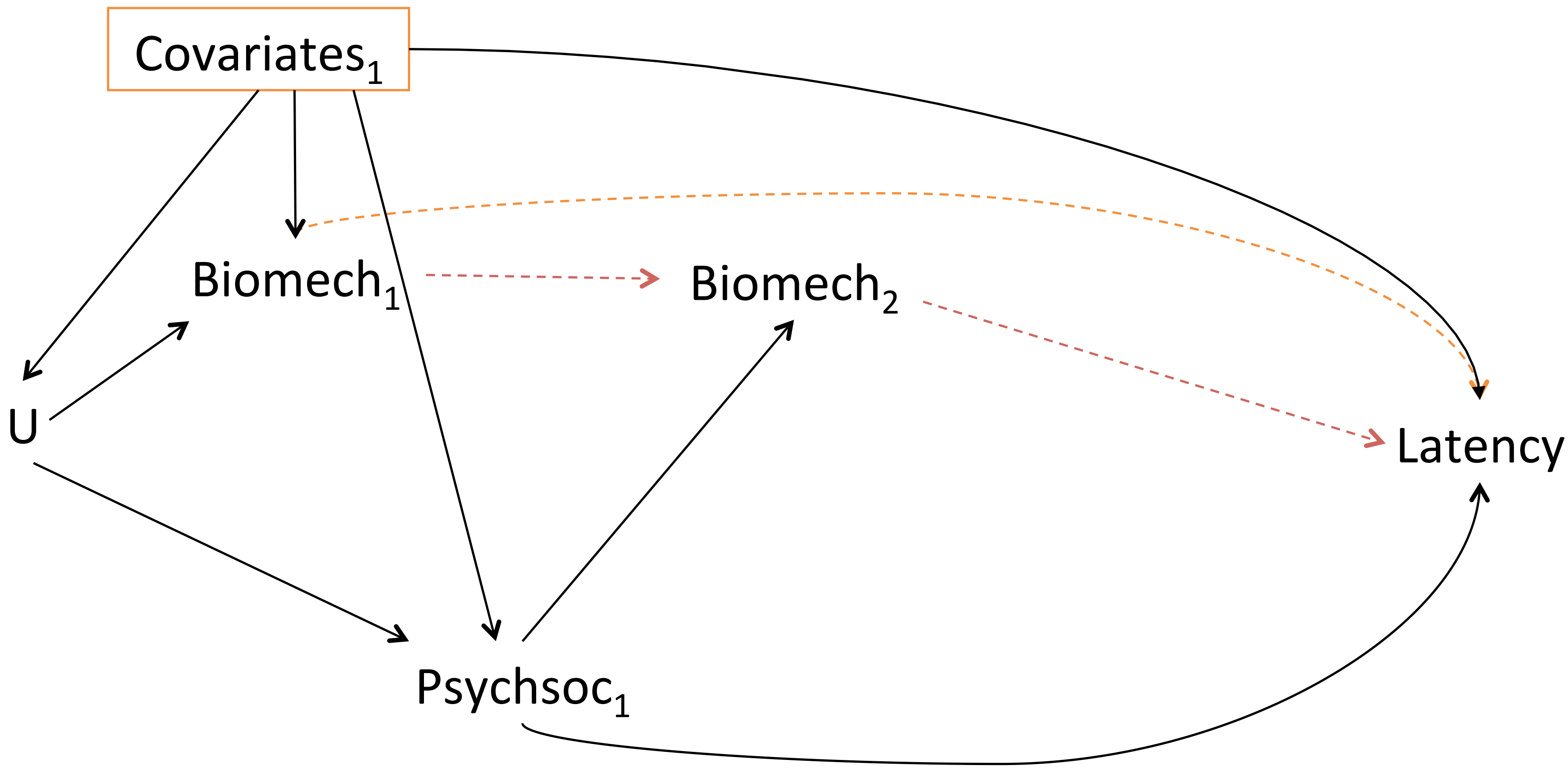
To estimate the relationships between biomechanical risk actors and median nerve sensory and motor latencies ccounting for:

- covariance of measures
- individual differences in latencies at baseline
- Individual differences in exposure-response slopes

Study Population

- Employed full-time in manufacturing, production, service, or construction industries
- Accessible for individual level exposure measurements

Assess the exposure-response relationship between biomechanical factors and median nerve latency



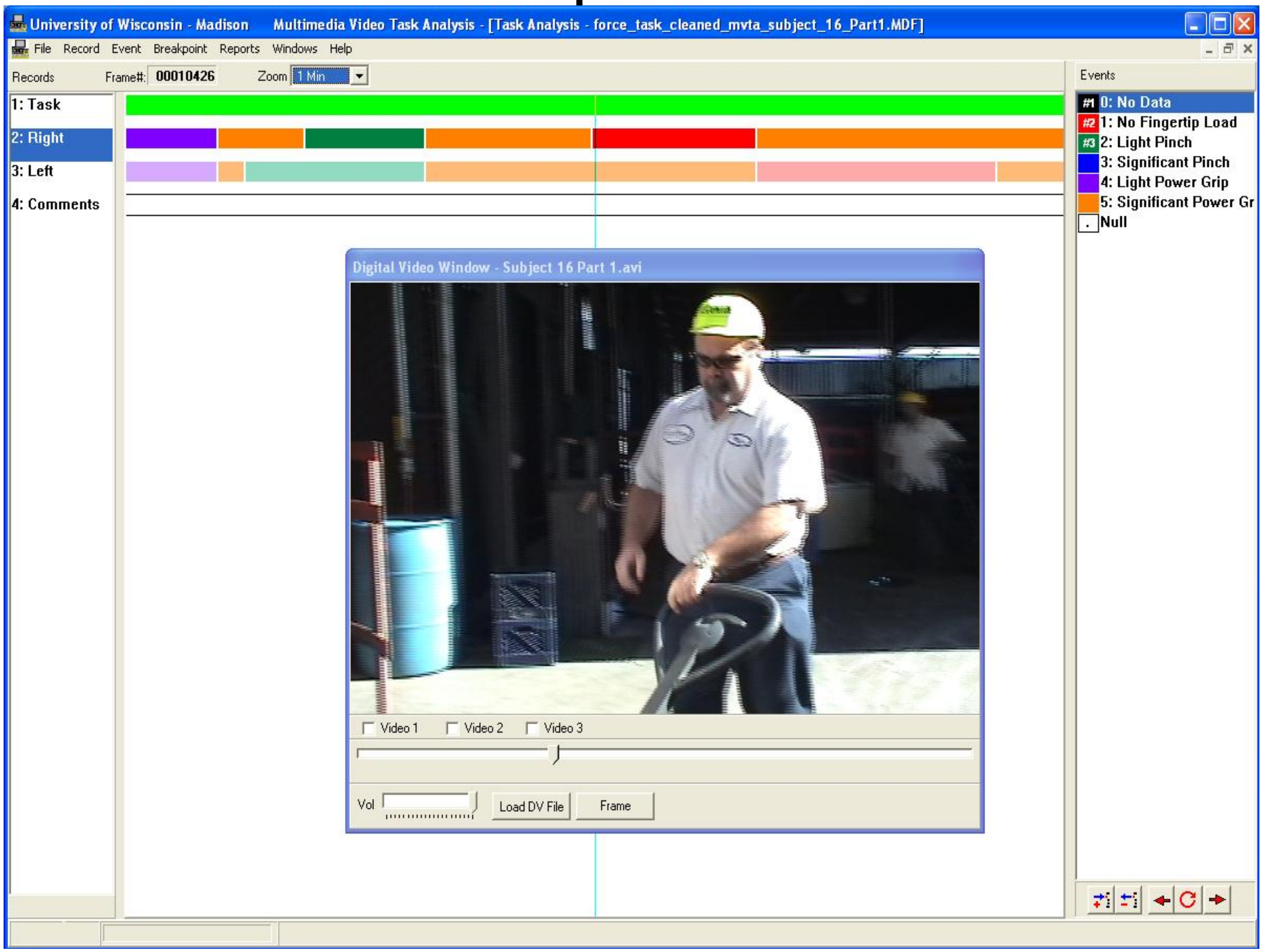
Directed Acyclic Graph to show the hypothesized relationship between biomechanical factors and median nerve latency (sensory & motor)

Biomechanical Exposure

	Exposure Measurement	Method
% TIME & FORCE	% time Forceful Hand Exertions	Video Analysis
REPETITION & FORCE	Forceful (Hand Exertion) Repetition Rate	Video Analysis
ACGIH TLV for HAL	Composite Score Using Peak Force (Borg CR-10 scale) & % time spent in forceful exertion	Analyst & Video Analysis

[Forceful = ≥9N pinch force or ≥45N of power grip]

Biomechanical Exposure



Video colle
at 30 frame
second

Frame by F
Analysis

[Forceful = ≥9N pinch force or ≥45N of power grip]

$$X_{TWA} = \Sigma\ [(X_1 * p_1) + (X_2 * p_2) + \ldots.\ (X_{12} * p_{12})]$$

Statistical Analysis

Mixed model using random intercept and random effects with robust confidence intervals

$_{j} = \beta_0 + \beta_{0i} + (\beta_1 + \beta_{1i})\ X_{ij} + \beta_2 X_i + \beta_3 X_i\ + \beta_4 X_i\ + \beta_4 X_i\ + \beta_6 X_{ij}\ +\ e_{ij}$

Y_{ij}: Median Nerve Latency for individual i at time point j

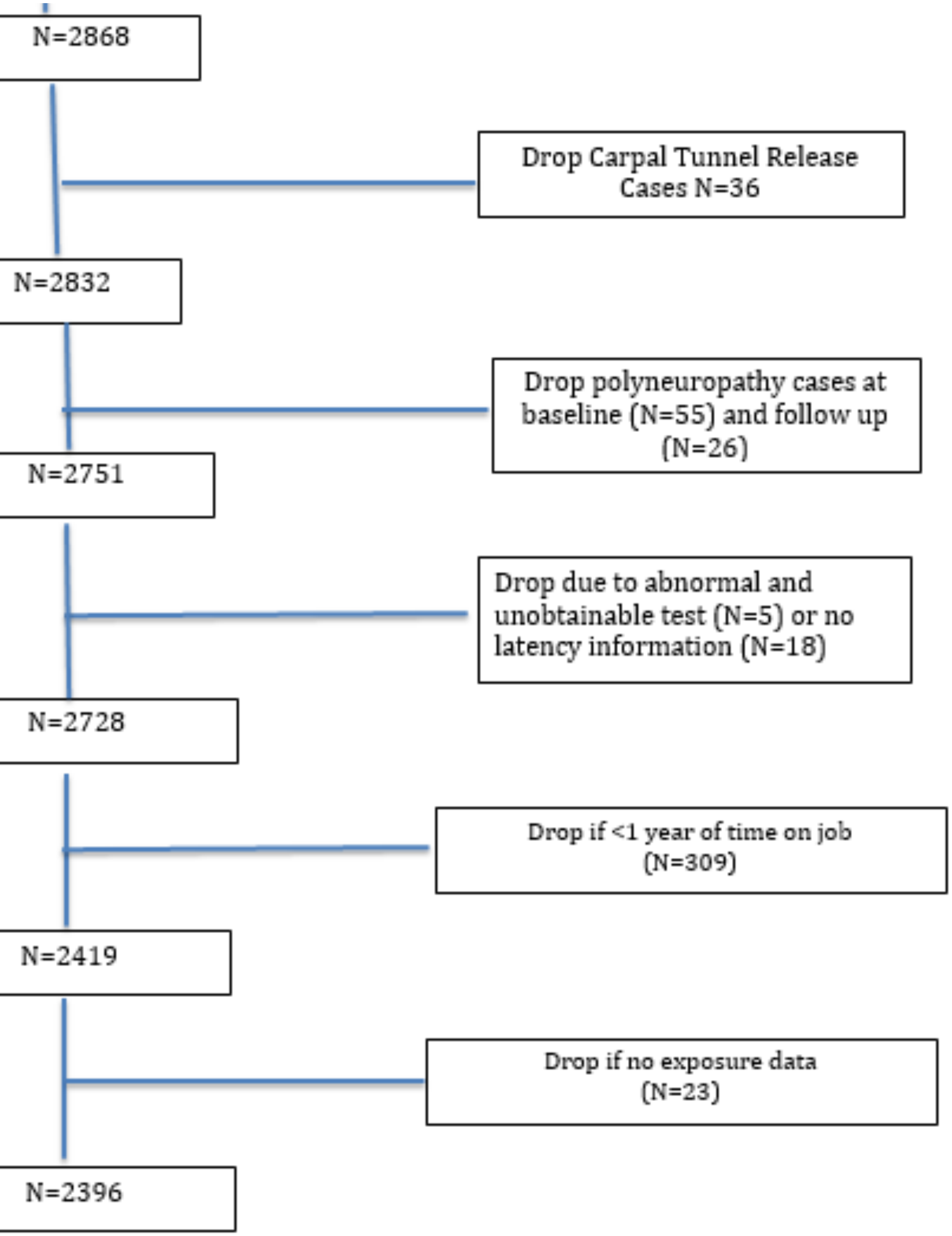
β_{0i}: random intercept

$(\beta_1 + \beta_{1i})\ X_{ij}$ Random effect of slope by individual for biomechanical exposure

Adjusted for age (β_2), gender(β_3), BMI(β_4), study site(β_5), & days between measures (β_6)

- xtmixed tnms age gndr bmi days xtlvn_twa || rid: xtlvn_twa, stddev cov(un) cluster(rid) ro

Incident Analysis (dominant hand)



Demographic Characteristics

	Pooled cohort (n = 2396)
Male	47 %
Caucasian race	47 %
Medical Condition	12%
Obese (BMI≥30)	35 %
Smoking	25%
< High School Diploma	21%
Mean Age	40.8 years
Mean time in current job	6.1 years

Exposure & Outcome Summary at Baseline

OMECHANICAL MEASURES	N	Mean	S.D.	Median	IQR
orceful Repetition Rate	2289	9.4	13.5	4.3	1.1 - 10.4
% Duration Forceful Exertions	2289	22.6	20.3	17.3	5.6 - 35.3
ACGIH TLV for HAL	2238	0.70	0.61	0.57	0.29 - 0.86
TENCY MEASURES					
Median Sensory Latency	2326	3.578	0.625	3.448	3.15 - 3.85
Median Motor Latency	2367	3.929	0.926	3.800	3.40 - 4.22
ensory Med-Ulnar Difference	2257	0.467	0.532	0.288	0.12 - 0.60

ory Latency								
	N	Coef.	Std Error	95% CI (Lower)	95% CI (Upper)	P value	AIC	BIC
	2337	0.015	0.001	0.013	0.017	0.000	4879.92	4945.60
		-0.068	0.022	-0.111	-0.025	0.002		
		0.021	0.002	0.017	0.026	0.000		
al Exposures								
etition Rate	2312	0.004	0.001	0.002	0.006	0.000	4824.84	4909.31
ndom effects parameters								
σβ1i		0.006	0.004	0.001	0.023			
σβ0i		0.474	0.018	0.439	0.511			
corr(β0i, β1i)		0.197	0.519	-0.696	0.851			
orceful Exertions	2312	0.002	0.001	0.001	0.003	0.000	4820.54	4905.00
ndom effects parameters								
σβ1i		0.005	0.002	0.002	0.012			
σβ0i		0.477	0.021	0.438	0.521			
corr(β0i, β1i)		-0.033	0.241	-0.467	0.414			
AL (PF/1-%time FE)	2248	0.104	0.019	0.067	0.140	0.000	4639.04	4723.18
ndom effects parameters								
σβ1i		0.168	0.090	0.059	0.482			
σβ0i		0.466	0.021	0.426	0.510			
corr(β0i, β1i)		0.129	0.271	-0.389	0.585			

*adjusted for age, gender, BMI, Study Site & days between measures

tor Latency								
	N	Coef.	Std Error	95% CI (Lower)	95% CI (Upper)	P value	AIC	BIC
	2375	0.016	0.001	0.014	0.019	0.000	8366.53	8432.34
		-0.139	0.030	-0.199	-0.079	0.000		
		0.031	0.004	0.023	0.038	0.000		
cial Exposures								
petition Rate	2348	0.004	0.001	0.002	0.007	0.002	8129.31	8213.95
random effects parameters								
sd(xrepf_~a)		0.011	0.004	0.005	0.024			
sd(_cons)		0.784	0.068	0.662	0.929			
corr(xrepf_~a,_cons)		-0.553	0.227	-0.852	0.018			
Forceful Exertions	2312	0.002	0.001	0.000	0.003	0.014	8085.01	8169.66
random effects parameters								
sd(xdurf_~a)		0.009	0.003	0.005	0.017			
sd(_cons)		0.826	0.075	0.691	0.986			
corr(xdurf_~a,_cons)		-0.593	0.161	-0.824	-0.194			
osite (PF/1-%time FE)	2248	0.035	0.018	0.001	0.070	0.046	7930.57	8014.89
random effects parameters								
sd(xdurf_~a)		0.227	0.121	0.080	0.648			
sd(_cons)		0.846	0.083	0.698	1.026			
corr(xdurf_~a,_cons)		-0.857	0.099	-0.965	-0.501			

*adjusted for age, gender, BMI, Study Site & days between measures

Conclusion

On average, increases in forceful repetition rate and the composite ACGIH TLV for HAL (force and repetition) both indicate an increase in he median sensory nerve conduction velocity, yet the increase is highly variable by individual

Conclusion

Accounting for covariance of measures for each exposure improved the model resulting in better inference (AIC and BIC values lower in each model shown versus standard regression models)

Range of the slopes within 2 standard deviations of the mean slope varied significantly

- Indicates a random effect by individual (ie., change in slope is influenced by individuals response to a given exposure)
- mixed effect models that include random intercept and random effect of slope between biomechanical exposure and change in latency by individual is a more robust model than using standard linear regression, OLS approach

Limitations

- Unbalanced data set
- Healthy worker Survivor Effect Bias
  - Left truncation – not a new hire cohort, individuals with symptoms consistent with nerve latency changes likely left the cohort before enrollment
  - Right Truncation- indications of survivor bias
    - Latencies improving over time
    - Attenuation of exposure-response curves for force and repetition on CTS showed attenuation at high exposures
- Used a normative model, perhaps there is a different model that would fit the data better, particularly for forceful repetition rate

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