

**van Rijn RM, Huisstede BM, et al. Associations between work-related factors and specific disorders of the shoulder - a systematic review of the literature. Scand J Work Environ Health 2010;36(3): 189-201.**

Design: Systematic review of observational studies

Purpose of study: To provide a quantitative assessment of the associations between work-related physical/psychosocial exposures and disorders of the shoulder such as subacromial impingement, biceps tendinitis, rotator cuff tears, and suprascapular nerve compression

Literature search and assessment:

- MEDLINE, EMBASE, and the Cochrane Register of Controlled Trials were searched up to and including November 2009
- Articles had to include all of these criteria for inclusion
  - o Report the occurrence of tendinitis, of the biceps tendon, rotator cuff tears, shoulder impingement syndrome (SIS), and suprascapular nerve compression in occupational populations
  - o Exclude musculoskeletal complaints arising from trauma or from any organic disease
  - o Present a quantitative description of measures of exposure
  - o Be published in English, German, French, or Dutch
- Quality assessment was considered for 5 topics with 16 items; a score of 11/16 or greater was considered a “high quality” study:
  - o Study population
    - Study groups (exposed and unexposed) clearly defined
    - Participation  $\geq 70\%$
    - Number of cases  $\geq 50$
  - o Assessment of exposure
    - Exposure clearly defined
    - Assessment method described
    - Exposure assessed by an independent person and not on self-report
  - o Assessment of outcome (specific disorder)
    - Outcome clearly defined
    - Assessment method of outcome suitable
    - Outcome measured without knowledge of exposure status
  - o Study design

- Prospective design or a retrospective cohort
  - Inclusion and exclusion criteria defined
  - Followup period at least one year
  - Demographic information given on completers and withdrawals
- Analysis and data presentation
  - Risk estimate calculations are presented: relative risks or odds ratios
  - Confounders were described
  - Confounders were controlled for by methods which were described
- Statistical associations were classified three ways
  - “Positive” associations meant that the occurrence of a shoulder disorder was statistically associated with higher values of the risk factor
  - “Negative” associations meant that a higher value of the risk factor was statistically associated with a lower occurrence of a shoulder disorder
  - “Null” associations meant that the risk estimate was not statistically different from unity
    - These were further differentiated between those suggesting an absence of a risk effect and those which are inconclusive due to a lack of information

#### Results:

- Search of literature resulted in 1739 potentially relevant studies with 17 selected for inclusion in the systematic review
  - 1066 articles excluded based on the title, 477 based on abstract, 180 excluded based on lack of description of shoulder disorders in occupational population or other lack of information
- Only 3 studies fulfilled both criteria of prospective design and at least one year followup, but 8 studies were scored with 11 points or more as “high quality”
- Five types of exposure were emphasized: force, repetitiveness, hand-arm vibration, posture, and combined exposure measurement
- For force and SIS, three high-quality studies were included, each with a different definition of force; two were positive and one was null
  - Force defined as more than 10% of maximal voluntary contraction was positively associated with SIS with odds ratio of 4.1 for high force versus the reference level of no high force
  - Force defined as lifting more than 20 kg more than 10 times per day was positively associated with SIS; for duration of 4-13 years, the odds ratio was 3.0, and for 14-23 years the odds ratio was 2.8
  - Force defined as frequent lifting  $\geq 5$  kg,  $> 2$  times per minute, for  $> 2$  hours per day, was not statistically associated with SIS

- For repetitiveness, two high quality studies found statistical associations between different measures of repetition and SIS
  - o Compared to workers who do no repetitive work, workers whose work entails up to 14 cycles/minute had an odds ratio of 2.93 and workers with 15-36 cycles/min had an odds ratio of 3.29
  - o Workers with repetition defined by repetitive motion of the hand/wrist for  $\geq 2$  hours/day had a statistical association with SIS, but only if they had more than 14 years of work
    - For 14-23 years of work, the odds ratio for SIS was 2.4; for more than 23 years, the odds ratio was 2.6
- For hand-arm vibration, two high quality studies reported associations with SIS in workers using a vibrating tool  $\geq 2$  hours/day or for a mean vibration dose above a certain level
- For posture, 5 articles, three with high quality scores, reported statistical associations between postural load and SIS
  - o One of the high quality studies used hand above shoulder level for  $\geq 1$  hour/day and found odds ratios of 3.2, 4.5, and 2.3 for increasing numbers of years of exposure
  - o The other two high-quality studies used upper-arm elevation  $> 90^\circ$  and reported significant odds ratios for lifetime upper-arm elevation and for elevation in terms of percentage of working hours (odds ratio was 4.7 for 6-9% of working hours in elevation  $> 90^\circ$  compared to 0-3% of working hours)
- For combined exposure measurement, two high-quality studies reported statistical associations with SIS
  - o One study reported an odds ratio of 4.82 for high force plus high frequency
  - o The other study reported an association in women with an odds ratio of 6.68 for upper arm flexion  $> 45^\circ$  for  $\geq 5\%$  of the time, but no significant association in men
- High psychosocial job demands were reported in one study to be associated with SIS, and high job security was negatively associated with SIS
- No articles were found reporting associations of work factors with rotator cuff tears and subscapular nerve compression; only two described the occurrence of biceps tendinitis across occupations

Authors' conclusions:

- Subacromial impingement syndrome is associated with several work factors, including force requirements more than 10% of maximal voluntary contraction, lifting  $\geq 20$  kg  $\geq 10$  times per day, high hand force more than 1 hour per day, repetitive movements of the shoulder  $\geq 2$  hours per day, using a vibrating tool  $\geq 2$

- hours per day, upper-arm elevation  $>90^\circ$ , working with hand above shoulder level  $\geq 1$  hour per day, upper-arm flexion  $45^\circ$ , and other factors
- There is heterogeneity in the definition of SIS among studies, and the results cannot be combined across studies
- There is even greater heterogeneity in assessment of exposure among studies; no two studies defined the exposures in the same way; the same phenomenon occurred when the authors attempted to synthesize the evidence of work factors and carpal tunnel syndrome
- There is a lack of cohort studies needed to establish causality, since a clear temporal relation cannot be inferred from cross-sectional studies

Comments:

- Most of the analytical problems are noted by the authors; there is a wide array of definitions of exposure, and no two studies use the same definition
- Some associations of work factors with shoulder impingement syndrome appear to be supported by virtue of having been found in a variety of settings and populations; this consistency is one of the considerations for causation endorsed by Bradford Hill; another Bradford Hill consideration is the dose-response relation found for repetitive cycles per minute in the study which reported this information
- The preponderance of cross-sectional studies does, as the authors note, place limitations on inferences of a causal nature
- Svendsen 2004 had some strengths and weaknesses, and illustrates some of the difficulties involved in analyzing causality of musculoskeletal disorders in the workplace
  - o Although exposure was directly measured in only a small percentage ( $n=72$ ) of the 1866 workers in the study, it was measured with more precision than is usually obtainable through self-report
    - Arm elevation was ascertained through four consecutive working days using an inclinometer connected to a data logger in the worker's belt; the percentage of time in which the arm was elevated with respect to gravity was likely to be accurate
    - Subjects were excluded from the inclinometer analysis if they had shoulder complaints which interfered with their performance at work this may not represent the working patterns of subjects who had shoulder pain with disability, who could have had different patterns of arm elevation due to their pain
  - o Shoulder disorders were ascertained by an examiner who was carefully kept unaware of the job classification of the examinees; again, outcome is established by something other than self-report

- The study population is difficult to generalize from, and was defined with criteria which are difficult to grasp
  - The participants were classified as having supraspinatus tendinitis, shoulder pain with disability, and shoulder pain without disability
  - “Shoulder pain with disability” was defined as having a Constant score <=80
  - It appears that the study would have included participants who work in spite of having disabling pain; this should have been clarified by the authors
  - The numbers of workers with tendinitis (n=48), pain with disability (n=138), and pain without disability (n=240) can be calculated from Table 5 for the dominant shoulder, but is difficult to coordinate with the Venn diagrams in Figure 3
- As often is the case with cross-sectional studies, the healthy worker survivor effect limits the ability of the investigators to analyze incident cases
  - That is, workers who adapt and are able to endure in the workplace remain in the study population, while many workers who experience significant work-related pain drop out of the workforce and are not represented in the analysis
- Despite the difficulties with the text and tables, the study did provide evidence that when the upper arm is elevated above 90° for more than 6% of working hours, the odds of supraspinatus tendinitis increase 4.7-fold, and the odds of shoulder pain with disability increase 3.5-fold
- Frost 2002 also had exposure and outcome assessments by trained observers (ergonomists for exposure, physicians for outcome) in a cross-sectional study from 19 different work sites
  - Shoulder repetitive movements, assessed from videotapes from three camera angles of at least 10-15 minutes, defined repetition in three categories: no repetitive work (n=813), 1-14 shoulder movements per minute (n=1057), or 15-36 movements per minute (n=976)
  - Shoulder tendinitis was diagnosed by on site physical examinations by physicians using a defined protocol, diagnosed as present when a minimum pain and activity impairment scale was combined with pain at resisted abduction and impingement pain (exacerbation with internal rotation of the elevated arm in the plane of the scapula), and/or palpation tenderness of the greater tuberosity
  - The odds ratio for tendinitis, compared with no repetition, was 2.93 for tasks with 1-14 repetitions per minute, and 3.29 for tasks with 15-36 repetitions per minute

- High force (more than 10% of maximal voluntary contraction) had an odds ratio of 4.21 for shoulder tendinitis
- Combination high frequency and high force had an odds ratio of 4.82 for shoulder tendinitis

Assessment: Adequate for some evidence that shoulder impingement syndrome is associated with several physical work factors, including heavy lifting, repetitive tasks involving the shoulder, working above shoulder level, and frequent force requiring more than 10% of maximal voluntary contraction. Arm elevation over 90° for 6-9% of working hours may increase the risk of supraspinatus tendinopathy more than fourfold and the risk of disabling shoulder pain 3.5 fold. Frequent force may increase the risk of shoulder tendinitis fourfold.

#### References:

- Frost P, Bonde JPE, et al. Risk of Shoulder Tendinitis in Relation to Shoulder Loads in Monotonous Repetitive Work. *Am J Ind Med* 2002;41:11-18.
- Svendsen SW, Bonde JP, et al. Work related shoulder disorders: quantitative exposure-response relations with reference to arm posture. *Occup Environ Med* 2004;61:844–853.