Coenen P, Kingma I, et al. Cumulative Low Back Load at Work as a Risk Factor of Low Back Pain: A Prospective Cohort Study. J Occup Rehabil 2013;23:11-18.

Design: Prospective cohort study.

Population/sample size/setting:

- 1086 workers (70% male, mean age 35.6) with both white-collar and blue-collar jobs from 34 companies participating in a large national health study in the Netherlands
    - The Dutch study had the acronym SMASH, for Study on Musculoskeletal disorders, Absenteeism, Stress, and Health
- SMASH asked participating companies to select workers who had been working for at least 1 year for at least 20 hours per week; any worker meeting these requirements was eligible for inclusion, unless they also held a paid job at another company for a substantial amount of time

Main outcome measures:

- The purpose of SMASH was to examine relationships between multiple work-related factors and the occurrence of musculoskeletal conditions
- Main measure of exposure was the cumulative low back load (CLBL), which was calculated over time based on several factors
    - Physical work load was assessed by video observations and force measurements in the workplace
    - External force exertion at the hands was measured with force transducers or a weighting scale
    - Workers were video-recorded at their workplace during 4 randomly selected times during the work day, with recordings lasting from 5 – 14 minutes
    - 35 university students in the Human Movement Sciences department of the University of Amsterdam used a standard protocol to assess the workload, considering factors such as sagittal flexion, trunk rotation, arm elevation, and external forces, extrapolating the video data to an 8 hour work day
    - A constructed manikin was used to estimate some forces on the body
    - Net movements at the L5-S1 joint were calculated using a general equation of motion, and the calculated forces were integrated over time to produce an estimated area under the curve, which was the CLBL, the principal exposure variable
- The CLBL was divided into quintiles for purposes of a logistic regression model, in order to assess the linearity assumption of the regression model
- Potential confounders were entered into the regression model, using questionnaire data for such factors as leisure activity, age, gender, job demands, supervisor/coworker support, and driving a vehicle
- Low Back Pain (LBP) was self-reported, and was the main outcome measure for the study, and was reported annually for three years of follow-up questionnaires

    - LBP was defined if there was regular or prolonged back pain for most of the prior 12 months
- Initially, 1745 workers were eligible for inclusion in the analysis; however, data for both LBP and for all exposures and confounders could be obtained on only 1086 workers, whose data were analyzed in the regression model
- Of the 1086 workers, 416 reported LBP at baseline and 537 reported LBP during at least one of the 3 annual follow-up questionnaires; the 537 LBP cases at follow-up included workers with LBP at baseline
- Odds ratios (OR) were calculated for each quintile of CLBL, using the lowest quintile of CLBL as the reference category, yielding an OR for each of the other 4 quintiles
- Half of the lowest quintile (109/216) reported LBP during follow-up; about 62% (136/220) of the highest quintile reported LBP during follow-up
    - This yields an OR for LBP of 1.60, not adjusted for confounders; the 95% confidence interval was from 1.10 to 2.35
    - The fully adjusted OR for the highest quintile was 2.02; the 95% CI was from 1.32 to 3.20
    - For the second, third, and fourth quintiles, the OR was not significantly different from the null value of 1.00
- Additional analyses were done on another 3 risk factors: trunk flexion, number of lifts per day, and number of lifts > 25 kg/day; of these factors, only lifting a load of > 25 kg at least 15 times/day had a significant OR for LPB (2.03, 95% CI from 1.23 to 3.36)
    - Percent of time working in a flexed position and the number of lifts per day (weight unspecified) did not significantly predict LBP after adjustment was made for confounders in the logistic model

Authors' conclusions:

- CLBL is a significant predictor of LBP, but is only shown with the highest levels of CLBL
    - For example, this level of CLBL would be attained if a load of 200 newton-meters (148 foot-lb) is lifted 50 or more times in a work week
- Incidental peak loads, such the number of lifting loads > 25 kg in an 8 hour work day, constitute an important risk for LBP
    - This underscores the importance of focusing on peak loads rather than the number of lifts per se
- Although there was considerable attrition (complete data on only 1086 out of 1745 initially eligible workers), the workers excluded for incomplete data were similar with respect to age, gender, working hours per wee, and years of employment
- It is reasonable to include workers with LBP at baseline in the analysis; an extra analysis of only incident LBP showed odds ratios very close (differing by less than 0.1) to the analysis reported in the text and tables
- Although the outcome of LBP was subjective, LBP as a symptom is strongly related to clinically examined LBP

- The dose estimates rely on a biomechanical calculation which contains assumptions about the workers' anthropometrics and segment orientations; however, these sources of error are likely to underestimate the calculated load; the association of CLBL may be even higher if more reliable dose estimates are available
- Prevention programs for LBP should incorporate changes in posture and lifting forces, as well as reduction of exposure to adverse postures

Comments:

- Many features of a high quality cohort study are present: exposure measurements are based on direct observation, many relevant confounders are adjusted for in the analysis, and the logistic regression model checked on the linearity assumption, which is often neglected in other ergonomic studies; the association is also biologically plausible
- The authors state that the high attrition is not likely to bias the results, since the workers excluded from the analysis were similar on age, gender, hours per week, and years worked
    - However, the excluded workers may have differed on some of the CLBL exposure measures, or may have differed on some of the other job variables, and it is not clear whether they had incomplete data because they dropped out of the workplace or for other reasons
    - An e-mail to the corresponding author does provide some information about the 659 workers in Table 1 who were not in the analysis
        - Out of the 659 workers who dropped out after baseline, 463 workers filled out a short questionnaire regarding their reason for not participating anymore, but most did not report a specific reason for dropping out
        - Of the 65 who did report a specific reason for not continuing to participate, 52 had changed to different jobs in the same company and 54 were working for different companies; only 1 had retired and 3 had lost their jobs
- Most prospective cohort studies are done to examine variables associated with incidence of disease, and include only incident cases
    - The authors did state that the odds ratios of the incident cases were very close to that of all the cases, but did not present the data in the text; it is not clear that all of the reported odds ratios were thus analyzed, or if only selected odds ratios were calculated
    - It has been shown in other settings that there are considerable differences between prevalent and incident cohorts from the same population (Buckley 2010), and the authors have not convincingly made the case that this population can combine prevalent and incident cases without consequences
    - For a condition like LBP, which is recurrent and episodic, the distinction between incident and prevalent cases is less critical than for other conditions, and the authors' decision to combine the cases does not materially weaken the study conclusions

- The quoted load of 200 newton-meters is about 148 foot-pounds, corresponding to lifting a 50 pound box 3 feet more than 50 times per work week
- LBP was very common in all CLBL quintiles, and was more common in the lowest quintile than in the second, third, and fourth quintiles
    - This seems to require explanation, and would be clearer if there were a clear separation of incident and prevalent LBP cases
    - It is reasonable to speculate that workers with LBP at baseline are selectively assigned to jobs with lower CLBL demands, but the lack of different reporting of incident and prevalent LBP prevents us from examining this speculation
- Overall, the strengths of the study approximately compensate for the weaknesses, making it adequate for evidence that CLBL is a predictor of LBP at work

Assessment: Adequate for evidence that high levels of cumulative low back pain load, especially those associated with high lifting peak loads, are associated with low back pain in workers

Reference:

Buckley BS, Simpson CR. Considerable differences exist between prevalent and incident myocardial infarction cohorts from the same population. J Clin Epidemiol 2010;63:1351-1357.