Brief Report

Work-related risk factors for lateral epicondylitis

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Important Note:

- *The purpose of this brief report is to summarise the best evidence for the relationship between lateral epicondylitis and workplace physical factors. It has not been systematically developed according to a predefined methodology*

- *It is not intended to replace clinical judgement, or be used as a clinical protocol.*

- *A reasonable attempt has been made to find and review papers relevant to the focus of this report, however it does not claim to be exhaustive*

- *The document has been prepared by the staff of the Research Unit, ACC. The content does not necessarily represent the official view of ACC or represent ACC policy*

- *This report is based upon information supplied up to February 2014.*

Executive Summary

The purpose of this report is to provide a narrative for the findings of the Auckland University of Technology (AUT) review dated 2010 and update these finding with any relevant recently published data after 2011. The evidence described in this report is aimed to facilitate decision making by the ACC Work-Related Gradual Process Diseases and Infections team (WRGPDI) for work-related physical factors and lateral epicondylitis (LE).

Seven primary studies from the AUT review and three systematic reviews were discussed in this report. Studies were first graded by two ACC reviewers using the Scottish Intercollegiate Guidelines Network criteria (SIGN, Appendix 3) in an attempt to ensure the best evidence available was presented. Risk factors were described in the literature as either single (force, repetition, posture, vibration, computer use and work equipment) or combined (force and repetition; force and posture; force, posture and repetition). In most studies, the diagnosis of LE was based on physiological symptoms or signs measured by interview or clinical examinations, but the exact criteria used varied. The methodology of how risk factors were measured also differed. The variability in definitions, methodologies and participant occupations across studies produced variable results that were described as "inconsistent evidence" by the AUT review.

The main finding of this review were that the results showed

- A moderate to strong association between sustained awkward upper limb postures of long duration and LE.
- Vibration use and equipment use had a positive association with the occurrence of LE based on limited evidence
- The combination of high force and high repetition, the combination of forceful activities and awkward or extreme postures, and the combination of high physical strain from high force, posture and repetition might be associated with increased odds of LE.

It is noteworthy that the variability across studies is a caveat within the evidence that should be taken into consideration when using this report to facilitate decision making processes on claims within ACC.

This report provides both quick reference material and more in-depth summaries for the reader. Quick reference material is provided in the form of Summary Tables (Appendix 4) that outline the main results for each physical risk factor. In the subsequent sections (Single Risk Factors and Combined Risk Factors) a more comprehensive outline of the evidence is provided, including specific study results in the form of odds ratios and related statistics (95% confidence intervals and statistical significance). This is followed by a short conclusion and discussion into the limitations within the evidence base. Descriptions of the individual papers used in this report are found in Appendix 2 and evidence tables in Appendix 4.

Recommendations for the WRGDPI unit:

The variation between studies and insufficient/conflicting evidence within the best evidence identified in this and the AUT report for LE means that a multifaceted approach should be taken for an individual claim. This means as well as this evidence other factors such as the Bradford-Hill Criteria, the specifics of the case, and expert opinion should be considered.

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List of Abbreviations

AUT	Auckland University of Technology
CI	Confidence Interval
GP	General Practitioner
LE	Lateral Epicondylitis
ME	Medial Epicondylitis
OR	Odds Ratio
SIGN	Scottish Intercollegiate Guidelines Network
WRGPDI	Work-Related Gradual Process Diseases and Infections team

Definition of LE

Lateral epicondylitis* is defined in the 2009 ACC Distal and Upper Limb Guidelines as follows[1]:

The typical characteristics of epicondylitis (lateral or medial) are: localised pain (which may radiate distally into the forearm), muscular tenderness and functional difficulties with tasks involving gripping. Primary health care providers should establish an early diagnosis of epicondylitis from the synthesis of information derived from the patient history, clinical signs and clinical tests. Appropriate symptoms, clinical signs and tests are:

For lateral epicondylitis: *Pain in the vicinity of the lateral epicondyle, and pain on palpation immediately distal to the lateral epicondyle (within 1-5cm), and either symptomatic pain reproduction on resisted active wrist extension or symptomatic pain reproduction on resisted active extension of the middle finger. Primary health care providers should compare pain responses on the contralateral limb as discomfort may ordinarily be experienced from palpation in this region.*

The prevalence of LE in the general population is estimated to be 1.3%[1] with the prevalence highest in the 40-55 year old age group. For further information regarding the diagnosis, management and prognosis of LE, please refer to the ACC Distal and Upper Limb Guidelines (2009)[1].

Note: Recent literature has stated that this condition should be termed as epicondylosis rather than epicondylitis[2]. The name epicondylitis signifies it is an inflammatory disease, however research into the pathophysiology of the disorder shows that it appears to be a degenerative tendinopathy. Evidence of this is seen from histological examination of the tendon of the main wrist extensor (extensor carpi radialis brevis). This showed after the initial injury there is a change in collagen expression likely due to metabolic changes in the tendon matrix leading to increased vascularisation and disorganised collagen fibre repair. However as the literature included in the AUT report and supporting literature consistently refers to this condition as epicondylitis, to avoid confusion it will be referred to as epicondylitis in this report.

Methodology

The purpose of this report is to provide a narrative to the findings of the AUT review and summarise the best evidence for the relationship between LE and workplace physical factors.

Outline of studies included in this report

Primary studies

Seven primary studies were identified for further discussion. This included: one prospective cohort study[3]; one case-control study[4] and five cross-sectional studies[5-9]. Brief summaries of the primary studies are presented below.

Secondary literature

Three systematic reviews other than the AUT review[10] were included in this report[11-13]. Each of these reviews covered a selection of prospective cohort, case-control and cross-sectional studies that investigated the association of epicondylitis with physical factors (e.g. force, repetition) across different occupations that included: foresters, meatpackers, assembly line workers, blue collar workers and computer-based workers.

Assessment of quality of studies included in report

The studies were assessed for quality and assigned a level of evidence using the Scottish Intercollegiate Guidelines Network (SIGN) criteria (Appendix 3).

The relationship between LE and occupational risk factors was most commonly reported as odds ratios. This provides the reader with quantification that the likelihood that the outcome (in this case LE) will occur if a particular risk factor (e.g. high forces) is present. The descriptors shown in Table 1 below provide a context of how strong and in which direction the OR (association) is - the higher the OR the higher the odds of LE occurring if that particular risk factor is present[14]. A more in-depth description of ORs can be found in Appendix 1.

Table 1 Odds Ratios and relevant descriptor outlining the strength of evidence

Odds Ratio	Descriptor
<1.0	Protective
1.0 – 2.4	Weak
2.5 – 3.9	Moderate
>4.0	Strong

Summary of Findings: Work-related risk factors for LE

The physical work related risk factors for LE were presented as either single or combined physical risk factors in the AUT review and this report. Overall some association was found between the risk factors and LE. There was a large variation between the studies reported and for some risk factors (for example computer use) there was insufficient data.

In the table below a brief descriptions of the main findings are outlined (Table 2). More detailed descriptions of the information seen in the summary tables are provided in the sections following the summary table. This is followed by a discussion of the limitations of the literature included in this report and conclusions. Evidence tables providing details of individual studies are included in Table 4 and 5 (Appendix 4) at the end of this document. It is important to note when reading this report that the evidence comes mainly from cross-sectional and case-control studies which cannot assess causation.

Table 2 Summary of Findings for physical risk factors associated with LE

Risk Factor	Main Findings	Main issues with current evidence	Main occupations* or sectors assessed
Single Risk Factors			
Force	**Increased odds with:** -Using heavy tools for more than 25% of the time -Longer duration of performing forceful exertions at more than 5 times a minute with weights over 4.5kg **Null or no association:** - for exertions using forces less than 1kg	Definitions of loads differed between studies	Carpenters, Farmers, Cleaners, Nurses, Teachers, Office Assistants, Typists Manufacturing, Healthcare
Repetition	**Weak to strong associations in:** - Women performing repetitive arm movements - Odds increased with duration (in years) task had been performed **Null or no association:** -No association seen with repetitive hand or finger movements: - Repetitive tasks at shorter durations (< 9 years)	Variable data between studies leading to a lack of consistency between studies. Insufficient data available.	Manufacturing, Healthcare
Posture	**Moderate to strong associations with:** - Awkward limb postures that include lifting arms in front of body for long durations (more than 75% of the time) and bent and twisted hand postures - Forearm supination of more than 45 degrees for long durations	Variability of data that can be included as posture.	Manufacturing, Healthcare

	- Odds higher in women **Null or non-significant associations with:** - Postures of shorter durations, postures for 'keying' jobs like typing, precision postures		
Vibration	Findings were mixed. Minimal to no relationship found between using hand-held vibrating tools and LE. - Moderate association found in men using vibratory tools for 25 – 50% of the time but not in women, and no association found for using same tools for longer or shorter amounts of time	Wide variation between studies in descriptions of methods and analyses used	Carpenters, Farmers, Cleaners, Nurses, Teachers, Office Assistants, Typists
Computer use	Insufficient evidence of a causal association between computer, keyboard or mouse use with LE	Insufficient evidence looking at LE in relation to computer use	
Work equipment	Odds increased with use of heavier tools. Tools heavier than 1kg had higher odds of LE in men and women than those that weighed between 0.1 to 1kg.	Findings based on one case-control study	Carpenters, Farmers, Cleaners, Nurses, Teachers, Office Assistants, Typists
Combined Risk Factors			
Force and repetition	**Moderate to strong associations when:** - Forceful movement (>1kg) performed for 75 – 100% of time in men only - Increased frequency (strong but variable association at more than five times a minute) **No significant associations with:** -repetitive shoulder movements	Variation in types of analyses led to variable results between studies	Carpenters, Farmers, Cleaners, Nurses, Teachers, Office Assistants, Typists Manufacturing, Healthcare

Force and posture	**Moderate associations with:** **-** Extreme postures (arms raised for > 75% of the time), and with high forces (44.1N or 4.5kg) in both men and women -Forearm supination (>45 degrees) with forceful lifting **No significant postures seen:** - With low forces	Different measures used for postures between studies. Lack in consistency in how force is measured between papers. Lack of high quality papers	Carpenters, Farmers, Cleaners, Nurses, Teachers, Office Assistants, Typists
Force, posture and repetition	All three risk factors combined showed a strong association.	No clear definition how these data were categorised and combined to produce indexes used to quantify risk factors	Carpenters, Farmers, Cleaners, Nurses, Teachers, Office Assistants, Typists

**Occupations were not listed in all studies assessed for this report*

Single risk factors

Evidence for single risk factors in association with LE is discussed in this section. The single risk factors outlined are force, repetition, posture, vibration, computer use and work equipment. Each section provides a brief description of findings from the AUT review followed by further primary and secondary evidence.

Force

The AUT review concluded there is weak to moderate strength of association between LE and force and the evidence was conflicting(10). This was based on two cross-sectional studies(5, 8). These studies and further evidence discussed below in which a systematic review(12), the two cross-sectional studies(5, 8) and one case control study(4) all reported positive associations. Between studies there was wide variability in the definition and measurement of 'force' as well as included participants and settings. Consequently this makes it difficult to combine the results and the findings should be interpreted cautiously.

The systematic review covered a range of case control, cross-sectional and cohort studies that investigated elbow disorders in occupational populations(12). For LE two studies were referenced that investigated force alone which were both case-control studies. The first case-control study provided evidence that LE was associated with handling heavy loads rather than a forceful handgrip(8). A moderate association was reported between LE and handling heavy loads (greater than 20kg) more than 10 times per day for more than twenty years (OR 2.6; 95% CI: 1.3 – 5.1)(8). The same study found weak null associations for smaller loads (greater than 5kg) at two or more times a minute for more than two hours a day for more than 20 years (OR1.8; 95% CI: 0.8 – 4.0). High hand grip forces for longer than an hour a day for over 20 years also had a null association (OR1.4; 95% CI: 0.6 – 3.1).

The second case-control study determined that forceful work in occupations like carpentry, farming and cleaning were associated to LE(4). They defined forceful as using heavy tools for more than 25% of the time, and indexed the weight of the tools as either 100g – 1kg or greater than 1kg. They found a strong association in women between using tools heavier than 1kg and LE (OR 4.6; 95% CI: 2.1 – 10.3) and a moderate association in men (OR 3.5; 95% CI: 1.6 – 7.7). Weak or null associations were found in both genders for tools weighing less than 1kg. This study did not report how many hours or years over which the tools had been used for, making it hard to compare with the first case-control study. Both of these studies show that heavier loads are positively associated with LE. However it should be noted that these studies used different definitions of load.

There is some evidence from a cross-sectional study that forceful lifting and exertion increased the odds of LE in workers in manufacturing and healthcare sites(5). They showed the odds were strongly associated with LE and increased with the frequency of forceful exertion: between one and five times a minute (OR 4.29; 95% CI: 1.55 – 11.88) and more than five times a minute (OR 6.35; 95% CI: 2.2 – 17.9). Forceful exertion (lifting, pulling, pushing, power gripping of more than 44.1N (or 4.5kg) and pinch gripping of more than 8.9N (or 0.9kg) was moderately associated with increasing the odds of LE but this did not increase with the amount of time (3% to 15% compared to more than 15% of the time) the exertion was performed for (for 3 – 15% of the time OR 3.36; 95% CI: 1.3 – 8.84). Overall this study concluded that the odds of LE were increased with greater frequency and duration of the activity[5].

Further investigation of the evidence shows that the mixed results reported by the AUT review are due to the odds of LE being different between the different risk factors attributed to the occupations investigated. For example using heavy tools (more than 1kg) for more than 25% of the time, or longer durations of performing a forceful exertion at more than five times a minute with weights of 4.5kg increased the odds of LE. Weak or null associations were found for exertions with loads less than 1kg. Definitions of loads differed between studies making it difficult to directly compare results. Although there is a trend between increasing load, frequency and duration of force it should be remembered that the results across studies are mixed.

Repetition

The AUT review concluded that there was a mix of weak to moderate positive and null associations for repetition and LE[10]. They stated that the mixed results are likely due to a lack in consistency between studies and because insufficient data were available. The evidence was based on the findings from four studies: three cross-sectional[5, 8, 15] and one case-control study[4].

The systematic review that investigated elbow disorders in occupational populations found positive associations between repetition and LE under specific criteria[12]. It reported that a cross-sectional study in female cooks, nursing assistants nurses, care workers, that repetitive hand-arm movements for more than two hours a day was strongly associated with LE (OR 4.7; 95% CI: 2.2 – 0.7)[7]. This was supported by another cross-sectional study that also showed a positive association between repetitive hand and wrist movements and LE in a working population[8]. They determined that this association was dependent on the number of years the task was performed. A weak association was found for workers employed 9-19 years (OR 2.4; 95% CI: 1.2 – 4.9) and a moderate association for workers employed for more than 20 years (OR 2.8; 95% CI: 1.4 – 5.8)[8]. A case control study from the systematic review provided further evidence that repetitive arm movements in females were associated with LE[4]. This study showed that women who had jobs that involved repetitive arm movements at least 75% of the time (e.g. as a cleaner or farmer) had a moderately positive association with LE (OR 3.7; 95% CI: 1.7 – 8.3). Finally finger or hand movements showed weak association with LE in both men (OR 1.7; 95% CI: 0.9 – 3.3) and women (OR 1.3; 95% CI: 0.7 – 2.5)[4]. These findings show increased odds of LE with long-term (years) and long duration (more than 75% of the time) arm movements in women and that the strength of the association increased with the number of years they performed the repetitive task.

Null associations in the systemic review and other studies were associated with shorter time periods doing repetitive tasks and measurements in men[12]. No significant association was found for when movements were performed for more than two hours per day in workers \ employed from one to eight years. Also no association was found for arm movements in men who had been working for longer than nine years (unlike women in the same study)[8]. This was supported by a further cross-sectional study on upper limb disorders in females that found a low prevalence of LE in the group whose occupation involved assembling, pressing and storage work[15].

Evidence from the AUT review showed a mix of weak to moderately positive and null associations for repetition and LE[10]. This report is in agreement and has found specific contributing factors to the positive and null associations. Weak to strong positive associations for LE were found in women performing repetitive arm movements but not in men. The odds of LE occurring increased with the duration (years) the task had been performed for and LE was not associated with hand or finger movements. Null associations were associated with doing repetitive tasks for a shorter amount of time (less than nine years).

Posture

The AUT review reported evidence of weak to strong associations between posture of the hand and wrist, and moderate association between posture of the shoulder and arm with LE[10]. This was based on two moderate quality studies one cross-sectional[5] and one case control[4]. These studies and other systematic reviews will be described in more detail below.

Two other high quality systematic reviews were found that investigated posture in relation to LE[11-12]. One review covered four studies that recruited people from working populations like waterworks staff, assembly line staff, patients from doctors' practices or people chosen at random from a national population register[12], They found that the odds of LE increased with an increase in the duration of the posture. This was seen where the arms were lifted in front of the body and with twisted or bent hand postures[4]. In jobs where the arms were lifted for more than three-quarters of the time, the odds were higher than for a quarter to one half of the time. These odds were higher in women (three quarters of the time: OR 4.0; 95% CI: 2.0 – 8.3) and not significant in men (OR 1.9; 95% CI: 0.8 – 3.3)[4]. If hands were bent or twisted the odds were higher in women and were increased with increased duration (three quarters of the time for women: OR 7.4; 95% CI 2.9 – 18.7, compared to men: OR 3.2; 95% CI: 1.2 – 7.9). The reviews showed null or non-significant associations of LE with short duration postures, in men, precision postures and postures required for "keying" jobs (e.g. typewriting, computer displays). Although there are differences between how postures were described in the papers contained within these reviews, associations were found between awkward postures of long duration and LE, especially in women.

In manufacturing workers postures that involved forearm supination for long durations were associated with LE[5]. Postures in which the forearm was held in more than 45 degrees supination had increased odds of LE (OR 2.3; 95 CI: 1.1 – 4.5), other sustained postures like wrist flexion or extension and radial or ulnar deviation did not increase odds of LE[5]. Another study in manufacturing workers a prospective cohort study reported an increased likelihood of LE by actions described by participants as 'turning and screwing' or driving screws in repetitively (OR 2.1; 95% CI 1.2 – 3.7)[10]. Although there are differences in methods between the two studies, both outline that LE is prevalent with postures that involve supination and turning or screwing activities within the manufacturing industry.

Evidence for posture suggests that there is a moderate to strong association between sustained awkward upper limb postures of long duration and LE. Evidence was stronger in women and in occupations within the manufacturing industry.

*Vibratio*n

The AUT review reported there was mixed evidence that hand-transmitted vibration was weakly to moderately-associated with LE in two studies[4, 8, 10]. These two studies were also the only studies that were discussed for vibration in a systemic review on LE[12]. Both studies reported positive and null associations between vibration and LE as described below.

Working with vibrating tools was described as a risk factor in one cross-sectional [8] and one case-control study however both studies showed mixed results. In the cross-sectional study working with vibrating tools at least two hours per day was associated with more than twice the likelihood of having definite or possible LE (OR 2.3, 95% CI 1.3 – 4.1)[8]. However when the definition was narrowed down to "definite" there was a null association (OR 0.7, 95% CI 0.2 – 2.1)[8]. In the case-control study non-significant associations were seen in women regardless of how long they worked with vibrating tools, however in men a moderate association was seen if they were used for 25 – 50% of the time (OR 2.9; 95% CI: 1.3 – 6.3)[4]. This suggests that using vibrating tools may have some relation to LE but the results are inconsistent.

Two further cross-sectional studies published after the AUT review also examined the relationship between the use of vibrating tools and LE. No significant association was found when using vibrating hand tools for more than two hours a day[6] or from a population-based study done in the United Kingdom[9].

Evidence for the association shows minimal to no relationship between using hand-held vibrating tools and LE. This is represented widely by null to non-significant associations found across different studies even though different methods and analyses were used between different studies. Mixed findings reported in the AUT review are due to a significant association found in one study that for one criterion (men only who are using vibratory hand tools for 25 – 50% of the time) there was a moderate association. Overall although there is some conflicting data, most results show a minimal relationship between using vibratory tools with LE.

Computer use

The AUT systematic review found insufficient evidence of an association between LE and computer and keyboard use[10]. This was based on a single cross-sectional study that found a non-significant association with "keying" activities that included using a keyboard [8].

This is consistent with a subsequent systematic review that investigated computer work and musculoskeletal disorders of the neck and upper extremity[13]. After reviewing 22 studies they found insufficient evidence of a causal association between computer, keyboard or mouse use and LE. The authors note that the available evidence was insufficient.

Work equipment

The AUT review reported a consistent association between the use of tools of different weights and LE[10], but this was based on the findings from just one case-control study[4]. As the levels increased (use of heavier equipment from 100g – 1kg: Level 1; to more than 1kg: Level 2) so did the likelihood of LE. Level 2 was associated with the highest likelihood of LE in women (OR 4.6; 95% CI: 2.1 – 10.3) and men (OR 3.5; 95% CI: 1.6 – 7.7) compared with not using either tool types. Further description of this work equipment has been discussed under "Force" in this report.

Combined risk factors

Evidence for combined risk factors in association with LE is discussed in this section. Combined risk factors outlined are: force and repetition; force and posture; and force combined with both repetition and posture. Each section provides a brief description of findings from the AUT review followed by further evidence

Force and repetition

The AUT review concluded that tasks involving the combination of force and repetition were moderately to strongly associated with LE[10]. This was based on evidence from three moderate quality studies, two cross-sectional[5, 8] and one case-control study[4].

A further systematic review found conflicting evidence to the AUT review[12]. This review reported two studies that investigated the association between repetition and force with LE. In the case-control study also reported by the AUT review, a moderate association (OR 2.5; 95% CI: 1.3 – 4.9) was found between high force (more than 1kg) and high repetition (75 – 100% of the time)[4]. When separated into men and women this association was significant in men (OR 3.5; 95% CI: 1.3 – 9.1) but not in women. Other combinations of either low force or repetition had no significant relationship with LE[4]. A cross-sectional study not described by the AUT review but outlined in the van Rijn (2009) review included one other cross-sectional study that investigated workers in the fish processing industry[16]. This study found that the combination of high repetition and force (which was not clearly defined) was not significantly associated with LE. Evidence reported from this review suggests that LE is associated with force and repetition only under specific criteria.

More recent primary research shows an increased likelihood of LE with repetitive tasks and force[5-6, 8]. Increased frequency of the forceful exertion was shown to increase odds of LE. When the forceful exertion (pinch grips of 0.9 kg or power grips of 4.5kg) was performed for one to five times a minute there was a strong but variable association (OR 4.3; 95% CI 1.6 – 11.8) that was stronger and even more variable when performed more than five times a minute (OR 6.4; 95% CI 2.3 – 17.9)[5]. Frequency of shoulder movement did not have a significant effect on the odds of LE. In another study interaction between repetitive and forceful activities showed a strong but variable association with LE (OR 5.6; 95% CI 1.9 – 16.5)[8]. Finally the odds of LE increased in people whose work combined hard physical exertion with repeated elbow and wrist movements[6]. This relationship was moderate in men when performing hard physical exertion combined with repetitive flexion and extension of the elbow or wrist (OR 3.5; 95% CI: 1.3 – 9.8), which increased to a strong but more variable association when both elbow and wrist movements were present (OR 5.3; 95% CI: 1.9 – 14.4). Overall further primary research supports the premise that repetitive tasks and force are associated with increased odds of LE however definitions of force and repetition differed between studies and some associations were variable.

Evidence assessed in this report did show moderate to strong associations between LE and combined force and repetition. These associations were found for specific criteria and were variable. Evidence showed that forceful movement was moderately associated with LE when performed for 75 to 100% of the time and was only significant in men[(4)]. More recent studies that looked at the frequency of forceful task per minute found strong but variable associations with LE[(5)]. Overall evidence indicates there is an association between combined force and LE but results are variable due to different definitions and methods used between studies.

Force and posture

The AUT review included two studies that reported moderate to strong associations between force and posture with LE[(10)]. These two studies[(4-5)] used different measures for posture and will be described along with further evidence. The case-control study by Haahr and Anderson (2003) was also reported in a further systematic review as the only paper related to force and posture[(12)].

The results from Haarh and Andersen were variable between genders, posture and the combination of low (100g to 1kg) and extreme force (greater than 1kg)[(4)]. Low force showed no significant association in men or women regardless of whether postures were extreme (lifting arms in front more than 75% of the time) or neutral. However in men extreme posture with low force had a moderate association (OR 3.3; 95% CI: 1.2 – 9.3) and in women high forces and extreme posture had a positive but variable association (OR 6.5; 2.8 – 14.7). All other combinations of forces and postures were not significant.

A further study investigated the effects of forearm posture with LE[(5)]. The likelihood of LE was increased in people whose work combined forearm supination (at more than 45 degrees) at least 5% of the time and forceful lifting (OR 2.98; 95% CI: 1.18 – 7.55)[(5)]. No further information was made available with regards to gender or occupations.

It is difficult to directly compare the findings due to the different definitions of force and posture between studies. Together these studies suggest there is evidence the combination of forceful activities and awkward or extreme postures may be associated with increased odds of LE. However the contributing evidence is in contrast to the AUT review as the evidence is not of high quality and the findings are weakened by a lack of consistency in the way force is measured.

Force, posture and repetition

The AUT review included one case-control study that described the effects of the combination of force, posture and repetition on the odds of LE[(10)]. No further evidence was found for this combination of variables.

The study that combined the three variables showed a strong but variable association of the combination with LE[4]. They classed the combination of force posture and repetition as "physical strain" where high physical strain consisted of high force (forces of more than 4.5kg), long duration awkward posture (arms lifted in front of body for more than 75% of the time), and high repetition (more than 75% of the time)[4]. The case-control study showed positive associations with medium physical strain (OR 2.0; 95% CI 1.1 – 3.7) that increased in odds and variation with high physical strain (OR 4.4; 2.3 – 8.7). When this index was further separated into female and male, the odds increased as well as variability. Medium physical strain showed no significant association in both genders, but high physical strain showed a strong variable association in both women (OR 5.3; 95% CI: 2.0 – 13.7) and men (OR 4.7; 95% CI: 1.6 – 13.4). This evidence suggests that the combination of high physical strain from high force, posture and repetition may be associated with LE.

Although it appears that all three variables together have a strong association with LE, care needs to be taken as the authors of this paper do not clearly define how these data were categorised and combined. For example we do not know if it is an effect of all three physical factors together increasing LE or just an additive effect of adding numbers together. As this study is the only evidence found so far that combines all factors this data is insufficient to be able to make a conclusion.

Limitations of the evidence base

The evidence base regarding the association between various occupational risk factors and the presence of LE was overall of low to moderate quality. The findings for several physical risk factors were generated from only single studies, and where multiple studies were identified there was a lack of consistency in the way occupational risk factors were defined and measured. It is important to acknowledge that a lack of evidence of an association for some occupational risk factors may reflect a lack of high quality studies rather than being evidence of no association. Most of the studies were cross-sectional in design, and possessing limitations that make them open to potential sources of bias as well as being unable to assess the likelihood of a causal relationship between a risk factor and LE. Unfortunately, compared with case-control and cross-sectional studies, comparatively few prospective cohort studies of LE have been undertaken. Given that the occupational studies of LE only include case-control and cross-sectional studies, and can therefore assess association but not causation, any consideration of causation with respect to an individual claim would need to involve wider considerations such as the Bradford Hill Criteria, the specifics of the case, and expert opinion.

Conclusions

The first objective of this report is to summarise the best evidence for the relationship between LE and physical workplace factors. The number of available studies reporting on the association between occupational risk factors and LE is scarce including cross-sectional studies making the overall quality of evidence moderate to low. There is little high quality evidence of a relationship between single risk factors (e.g. force, repetition or posture), and the presence of LE. There is stronger evidence that the presence of a combination of risk factors is associated with increased odds of LE, particularly the combination of forceful and repetitive activities. One important caveat across these studies that is important to note is this evidence comes mainly from cross-sectional and case-control studies which may show a relationship between factors and LE, but cannot assess causation.

Recommendations for the WRGDPI team when considering physical risk factors and LE

Due to variation between studies and conflicting evidence within the best evidence identified in this report and the AUT report for LE, when considering an individual claim, other factors such as the Bradford-Hill Criteria, the specifics of the case, and expert opinion should be considered.

References

1. ACC. Distal Upper Limb: guidelines for management of some common musculoskeletal disorders. 2009. p. 1 - 52.

2. Bishai SK, Plancher KD. The basic science of lateral epicondylosis: update for the future. Techniques in Orthopaedics. 2006;21(4):250-5.

3. Leclerc A, Landre MF, Chastang JF, Niedhammer I, Roquelaure Y, Study Group on Repetitive W. Upper-limb disorders in repetitive work. Scandinavian Journal of Work, Environment & Health. 2001;27(4):268-78.

4. Haahr J, Andersen J. Physical and psychosocial risk factors for lateral epicondylitis: a population based case-referent study. Occupational and environmental medicine. 2003;60(5):322-9.

5. Fan Z, Silverstein B, Bao S, Bonauto D, Howard N, Spielholz P, et al. Quantitative exposure-response relations between physical workload and prevalence of lateral epicondylitis in a working population. American journal of industrial medicine. 2009;52(6):479-90.

6. Herquelot E, Bodin J, Roquelaure Y, Ha C, Leclerc A, Goldberg M, et al. Work-related risk factors for lateral epicondylitis and other cause of elbow pain in the working population. American journal of industrial medicine. 2013;56(4):400-9.

7. Ono Y, Nakamura R, Shimaoka M, Hiruta S, Hattori Y, Ichihara G, et al. Epicondylitis among cooks in nursery schools. Occupational and environmental medicine. 1998;55(3):172-9.

8. Shiri R, Viikari-Juntura E, Varonen H, Heliövaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. American journal of epidemiology. 2006;164(11):1065-74.

9. Walker-Bone K, Palmer K, Reading I, Coggon D, Cooper C. Occupation and epicondylitis: a population-based study. Rheumatology. 2012;51(2):305-10.

10. Boocock M, McNair P, Larmer P, Griffiths R, Tappin D, Trevelyan F, et al. Evidence-based reviews on the epidemiology of work-related gradual process disorders: Carpal Tunnel Syndrome. 2011.

11. Palmer K, Harris E, Coggon D. Compensating occupationally related tenosynovitis and epicondylitis: a literature review. Occupational Medicine. 2007;57(1):67-74.

12. van Rijn R, Huisstede B, Koes B, Burdorf A. Associations between work-related factors and specific disorders at the elbow: a systematic literature review. Rheumatology. 2009:kep013.

13. Wærsted M, Hanvold T, Veiersted K. Computer work and musculoskeletal disorders of the neck and upper extremity: a systematic review. BMC Musculoskeletal Disorders. 2010;11(1):79.

14. Roffey D, Wai E, Bishop P, Kwon B, Dagenais S. Causal assessment of occupational sitting and low back pain: results of a systematic review. Spine. 2010;10(3):252-61.

15. Hansson G, Balogh I, Ohlsson K, Pålsson B, Rylander L, Skerfving S. Impact of physical exposure on neck and upper limb disorders in female workers. Applied ergonomics. 2000;31(3):301-10.

16. Chiang H, Ko Y, Chen S, Yu H, Wu T, Chang P. Prevalence of shoulder and upper-limb disorders among workers in the fish-processing industry. Scandinavian Journal of Work, Environment & Health. 1993:126-31.

17. Garg A, Hegmann K, Wertsch J, Kapellusch J, Thiese M, Bloswick D, et al. The WISTAH hand study: A prospective cohort study of distal upper extremity musculoskeletal disorders. BMC Musculoskeletal Disorders. 2012;13(1):90.

18. Garg A, Kapellusch J, Hegmann K, Wertsch J, Merryweather A, Deckow-Schaefer G, et al. The Strain Index (SI) and Threshold Limit Value (TLV) for Hand Activity Level (HAL): risk of carpal tunnelsyndrome (CTS) in a prospective cohort. Ergonomics. 2012;55(4):396-414.

19. Bland J, Altman D. Statistical notes: The odds ratio. British Medical Journal. 2000;320(7247):1468.

20. Grimes D, Schulz K. Making sense of odds and odds ratios. Obstetrics and Gynecology. 2008;111(2 Pt 1):423-6.

21. Palmer KT, Harris EC, Coggon D. Carpal tunnel syndrome and its relation to occupation: a systematic literature review. Occupational Medicine. 2007;57(1):57-66.

Appendix 1. Project background

Background

ACC Research was commissioned by the Work-Related Gradual Process Diseases and Infections (WRGPDI) team to provide them with a brief report to support day-to-day decision-making as they carry out case assessments. The report uses an evidence-based approach to summarise the evidence regarding the relationship between specific occupational risk factors and LE. The purpose of this report is to provide decision-making support to the WRGPDI team and, in particular, to summarise and explain the current evidence regarding LE and occupational risk factors across multiple studies. Additional information is included in other resources used by the team, including a quick reference decision-support spreadsheet.

AUT Investigation Analysis

In 2009, a group of researchers specialising in occupational health at Auckland University of Technology (AUT) were commissioned by ACC to complete a series of independent systematic reviews of the risk factors associated with 16 gradual process conditions, including LE[10]. The authors searched an extensive set of databases up to October 2010, and all relevant cross-sectional, case-control and cohort studies meeting inclusion criteria were appraised for quality. Studies which did not meet a pre-determined quality assessment score were excluded from further analysis, the remaining studies were summarised in evidence tables (Appendix 4, Table 4 at the end of this document) and summary data was extracted. Due in part to the methodology utilised in these reviews, and the presentation and length of the final reports, ACC Research was requested to complete a brief narrative report describing the findings of the primary studies included in the AUT report, and any additional studies which had been published subsequently.

Horizon Scanning for future upper limb disorder research

A large multi-centre prospective cohort study of distal upper-extremity musculoskeletal disorders also known as the WISTAH hand study started in 2012[17]. Two purposes of this study are to quantify the risks of upper limb disorders, including LE and address weaknesses seen in prior research studies. Steps have been taken in this study to obtain high quality data; this includes using prospective methods, data collection from diverse populations, nerve conduction studies in all subjects, baseline measurements and monthly follow-ups.

For this study over 1,000 workers from 17 different employment settings have been recruited. The settings include: (i) poultry processing, (ii) manufacturing and assembly of animal laboratory testing equipment, (iii) small engine manufacturing and assembly, (iv) small electric motor manufacturing and assembly, (v) commercial lighting assembly and warehousing, (vi) electrical generator manufacturing and assembly, (vii) metal automotive engine parts manufacturing (three facilities), (viii) plastic and rubber automotive engine parts manufacturing and assembly (ix) red meat processing, (x) apparel manufacturing, (xi) office work, (xii) cabinet manufacturing, (xiii) airbag manufacturing, (xiv) light valve assembly, and (xv) small metal parts fabrication. The aim of including this distribution was to include participants with low, medium and high physical demands at work.

Measures

The relationship between LE and occupational risk factors was most commonly reported as odds ratios. This is because of the nature of the research base (cross-sectional or case-control studies which are conducted at a point in time, rather than prospective studies conducted over a prolonged period). An odds ratio reports the likelihood of an outcome being present (e.g. tenosynovitis) when a particular exposure (e.g. forceful work) has been present, compared with the probability of the outcome being present when the exposure has not been present(19). If the odds ratio is 1 then the outcome is equally as likely in the exposed group as the non-exposed group. If the odds ratio is greater than 1, then the outcome occurs more often in the exposed group. If it is less than 1, it occurs more often in the non-exposed group. The higher the odds ratio, the stronger is the association between the exposure and the outcome. The 95% confidence interval (95% CI) measures the precision of the odds ratio – wide confidence intervals indicate a low level of precision. It is important to note that odds ratios report probability based on association at a point in time. Using the odds ratio (OR) as a proxy for Relative Risk (RR) is based on an assumption that any such association arises because of a causal link, and this assumption cannot always be relied on.

The use and interpretation of odds ratios has been debated extensively in the literature, especially when compared with the use of relative risk(19). It is emphasised in the literature that the odds ratio is not a representation of risk, but of probability or odds, and that this can make it more difficult to interpret(20). The use of odds ratios has been criticised for exaggerating the strength of association between an exposure and an outcome when it is applied as a measure of risk. When an outcome is rare (initial risk <10% in both the exposed and non-exposed groups), for instance in the case of rotator cuff syndrome where the prevalence in the normal population is estimated to be 1.3%, the odds ratio is said to be a valid approximation of the true relative risk and the strength of the association can be interpreted accordingly. However, as the prevalence of the outcome increases, the odds ratio moves further away from the true relative risk. Whereas the accepted relative risk cut-off for determining whether an outcome can be attributed to a particular exposure is >2.0(21), the cut-off for odds ratios is not clear and depends on the prevalence of the outcome.

Appendix 2. Outline of methodology of included studies

Fan et al (2009): A cross-sectional study that compared work risk factors in 733 manufacturing workers with LE (n= 38) and without LE who were recruited from 12 sites across the USA. Definite LE was defined as pain at the elbow in the preceding 30 days and pain at the lateral humeral epicondyle region on resisted extension/flexion with the elbow extended. Diagnostic criteria for possible LE (from interview and medical exam) were pain at the elbow in the preceding 30 days and tenderness at the lateral humeral epicondyle. Work related factors were measured by video recording and included forceful exertions (pulling, pushing, lifting, power and pinch gripping), repetitive shoulder movements (times per minute), and percentage of time spent in forearm supination ≥45°, wrist flexion or extension ≥45°, radial deviation <5° or ulnar deviation >20°.

Level of evidence: 2-

Haahr and Andersen (2003): A case-control study that reported physical and psychosocial characteristics in a population of 267 new cases of LE and 388 controls. Cases were identified from all 18-66 year olds enrolled with 104 GP practices in the west of Denmark (out of 146 initially contacted). Case definition of lateral epicondylitis was: pain at the lateral humeral epicondyle, with or without concomitant pain in the adjacent extensor muscles of the forearm, and presence of direct and indirect tenderness at the lateral humeral epicondyle upon resisted extension of the wrist or third finger. Two referents, matched by gender and age, were selected for every case from a public health insurance database. A questionnaire was used to gather information about physical, psychosocial and work-related exposures. Work-related exposures included position held (classified as strenuous/non-strenuous), duration of latest employment, posture of arms and hands, repetitive movements, static load (precision), vibration, and use of tools as a proxy for force (not forceful: up to 1kg; forceful: >1kg).

Level of evidence: 2+

Herquelot et al (2012) A cross-sectional study that utilised a randomly selected sample of workers from a large population-based cohort (n=3710) to examine the relationship between specific physical and psychosocial work factors and lateral epicondylitis. A self-administered questionnaire was used to collect information on physical work-related factors, which included repetitive work, use of vibrating tools, elbow flexion and extension, wrist-bending, posture and various levels of physical exertion plus elbow movements. LE was confirmed by physical examination with 2.4% of men and 2.5% of women in the study being diagnosed with LE (activity-dependent pain directly located around the lateral epicondyle for at least 4 days over the last week and local pain on resisted wrist bending at the examination).

Level of evidence: 2-

Leclerc et al (2001) A prospective cohort study that reported on a cohort of 1420 workers in five occupational sectors involving repetitive work, who completed a questionnaire regarding work activities and were examined by a physician based at their workplace. The sectors included assembly line manufacturing, shoe and clothing manufacturing; food industry (mainly meat); packaging; and supermarket cashiering. A subsample of the original cohort were followed up three years later (n=598) based on the availability of the original workplace physician. Work factors assessed by the questionnaire included working with force, pressing with the hand or elbow, screwing or tightening with force, hitting, pulling, pushing and holding in position. Respondents were asked to indicate whether they did these repetitively, not repetitively or never.

Level of evidence: 2+

Ono et al (1998) A cross-sectional study that compared the prevalence of epicondylitis among 209 nursery school cooks and 366 workers from other social welfare industries (nursing assistants, home care assistants and 'handywomen') in Japan. Work-related risk factors were gathered using a questionnaire and LE was diagnosed via a clinical examination. Work-related risk factors included frequent lifting and handling, static work posture and repetitive shoulder, arm, hand or finger movement – all were self-reported.

Level of evidence: 2-

Shiri et al (2006) A cross-sectional study that utilised data from a national health examination survey in Finland, which collected information regarding LE and work-related risk factors from 4,698 people in the general population aged between 30 and 64 years. Information was gathered through a combination of home interviews, clinical examination and laboratory tests. Diagnostic criteria for definite LE were pain at the elbow during the preceding 30 days and pain at the lateral humeral epicondyle region on resisted extension of the wrist with the elbow extended. Possible LE was defined as pain at the elbow in the preceding 30 days and tenderness on physical examination. Physical work-related risk factors were collected through an interview and included manual handling of loads, high handgrip forces, repetitive movements of the hands or wrists, keying work and work with a vibrating tool.

Level of evidence: 2-

Walker-Bone et al (2011) A cross-sectional study that collected information regarding the physical and psychosocial factors from people aged 25 – 64 years registered at two GP practices (n=6,038). Of these 77% were in paid employment. Factors were collected via questionnaire, with those people who had reported elbow pain in the past week interviewed by a trained research nurse regarding workplace factors (n= 636). This group was diagnosed with LE, ME or non-specific elbow pain using an algorithm. Workplace factors included psychosocial characteristics e.g. distress, and physical factors including repetitive bending/straightening of the elbow, keyboard use, working with arms above shoulder height and exposure to hand-held vibrating tools.

Level of evidence: 2-

Appendix 3.

Table 3 Scottish Intercollegiate Guidelines for Levels of Evidence

1++	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias
1-	Meta-analyses, systematic reviews, or RCTs with a high risk of bias
2++	High quality systematic reviews of case control or cohort or studies High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well-conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2-	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytic studies, e.g. case reports, case series
4	Expert opinion

Appendix 4. Evidence Tables:

Table 4 Evidence tables summarising secondary literature which evaluates the association between physical work characteristics and LE

Reference and Methodology	Inclusion/exclusion criteria	Outcome Measures	Findings
Boocock et al (2010) **Research Question:** To examine the evidence for an association between LE and work tasks/activities **Methodology Described:** Systematic review **Types of study included:** Prospective cohort, case-control, cross-sectional **Literature Search:** 17 electronic databases including	**Included Studies:** N=16 studies **Inclusion criteria:** (i) peer reviewed and published in English, (ii) studies of physical or psychosocial load at work, (iii) self-reported and job title acceptable as measures of work tasks, (iv) non-epidemiologic and lab studies excluded, (v) had to pass initial quality assessment by one of two authors	**Evidence of causation using 2 of the Bradford-Hill criteria:** • Strength of association - based on odds ratios • Consistency of association – based on a pattern-of-evidence assessment of positive, negative and null associations	**Results:** - Repetition: Fan et al (2009), 733 manufacturing workers, no relationship between LE and repetitive shoulder movement. Haahr and Anderson (2003), 209 cases with LE and 274 controls: For women, same mvt of the arms ≥ ¾ of time OR 3.7 (1.7 – 8.3). No relationship for finger repetition. For men no relationship for fingers or arm repetitive mvts. Hansson et al (2000), 155 women, no relationship between LE and repetitive job tasks. Shiri et al (2006), 4698 men and women, repetitive mvt on its own of hand and wrist (e.g. packing, sorting out) not associated with LE (but see interactions with other physical mvt) - Posture: Fan et al (2009), 733 manufacturing workers, ≥ 5% of time in ≥45 degrees forearm supination (dominant side) OR 2.25 (1.13 – 4.5). Not related to ≥ 45 degrees wrist flexion/extension. Not related to ≥ 4% time in wrist radial deviation <5 degrees or ulnar deviation ≥20 degrees (dominant side). Haahr and Anderson (2003), 209 cases with LE and 274 controls: For women, arms lifted in front

PubMed, EMBASE(Ovid), ISI Web of Science, Index NZ, and OSH References Collection Search **(**giving access to the following six databases OSHLINE, NIOSHTIC, NIOSHTIC-2, HSELINE, CISILO and Canadiana). **Date of search:** 1980 - October 2010 **How funded:** Developed as part of a review for Accident Compensation Corporation of NZ			of the body ¼ to ½ time OR 2.0 (NS), ¾ - all the time OR 4.0 (2.0 – 8.3), hands bent or twisted ¼ - ½ time OR 2.8 (1.4 – 5.4), ¾ to all time OR 7.4 (2.9 – 18.7). For men, arms lifted in front of the body ¼ to ½ time OR 2.7 (1.3 – 5.5), ¾ - all the time OR 1.9 (NS), hands bent or twisted ¼ - ½ time OR 1.6 (NS), ¾ to all time OR 3.2 (1.3 – 7.9). - Precision tasks: Descatha (2003), pressing with hand yes/no OR 1.55 (1.12 – 2.15), Haahr and Anderson (2003), 209 cases with LE and 274 controls, for men performing precision tasks or static load ¾ to all the time OR 5.2 (1.5 – 17.9). For women, no relationship between precision tasks/static load and LE. Leclerc (2001), 1420 workers with 598 followed up, turning and screwing OR 2.07 (1.16 – 3.7). - Force: Fan et al (2009), forceful lifting OR 2.65 (1.21 – 5.83). Forceful exertions 3 – 15% of time OR 3.36 (OR 1.28 – 8.84), ≥15% of time OR 3.0 (1.13 – 7.96). Shiri et al (2006), 4698 men and women, high handgrip forces (e.g. squeezing, holding burdens or tools, twisting ≥1 hour per day) on their own not associated with LE (but see interactions with other physical mvt). - Duration: Descatha (2003), no association between years on the job and LE. - Vibration: Shiri et al (2006), 4698 men and women, work with vibratory tools on their own at least 2 hours per day was not associated with definite LE but was associated with possible or definite LE OR

			2.3 (1.3 – 4.1). Haahr and Anderson (2003), 209 cases with LE and 274 controls: for men, work with handheld vibrating tools ¼ - ½ the time OR 2.9 (1.3 – 6.3) but no relationship for ¾ - almost all the time, and no relationship for females between use of vibrating tools and LE. - Computer use: Shiri et al (2006), 4698 men and women, no association between computer use and LE. - Work equipment: Haahr and Anderson (2003), 209 cases with LE and 274 controls: for men and women, working with tools ≥ 1kg and working with tools 100g – 1kg or ≥1kg was associated with a weak (men) to moderate (women) association with LE. Working with both lighter and heavier tools was more strongly associated with LE (OR 4.6 women and OR 3.5 men) **<u>Combined physical factors</u>** **Force and repetition:** - Shiri et al (2006), 4698 men and women, combination of forceful (handgrip ≥ 1 hour per day) and repetitive (mvts of hands/wrists ≥2 hours per day) activities were at 5.6 times (95 percent CI: 1.9, 16.5) higher risk of LE than were those exposed to neither of these activities. The interaction was not statistically significant for the definite cases OR 3.6 ($p<0.069$). - Haahr and Andersen (2003), 209 cases with LE and 274 controls: high force and high repetition

			increased likelihood of LE 2.5 times (95% CI 1.3 – 4.9) - Fan et al (2009), 733 manufacturing workers, forceful exertions (lifting, pulling, pushing, power gripping and pinch gripping) 1-4 times per minute OR 4.29 (95% 1.55 – 11.88), ≥ 5 times per minute OR 6.35 (95% CI 2.25 – 17.93) **Force and posture:** - Haahr and Andersen (2003), 209 cases with LE and 274 controls: high force and extreme posture increased likelihood of LE 3.3 times (95% CI 1.9 – 5.8). - Fan et al (2009), 733 manufacturing workers, ≥5% of time in ≥45 degrees forearm supination and forcefully lifting OR 2.98 (1.18 – 7.55). **Force, posture and repetition** - Haahr and Andersen (2003), 209 cases and 274 controls: physical strain index composed of posture, repetition and force measures. Overall medium and high physical strain was associated with LE (OR 2.0 and 4.4). For women high physical strain only was associated with LE. For men, low and high but not medium. Men: high rep and high force OR 3.5 (1.3 – 9.1); high force and neutral posture OR 3.3 (1.2 – 9.3). Women: extreme posture OR 2.9 (1.4 – 6.0); low rep extreme posture OR 4.4 (1.2 – 15.9); high rep extreme posture OR 2.4 (1.1 – 5.3); high force extreme posture OR 6.5 (2.8 – 14.7).

			Biases/Weaknesses: • Exclusion of studies using quality score prior to synthesis – reasons for exclusion not reported, specific quality assessment of included studies not reported • Only used two of the Bradford Hill criteria to assess strength and consistency of association – unable to assess causal relationship • Assignment of scoring system to papers based on study design and does not take into account study quality **Conclusion:** • Synthesis unclear and did not clearly present the highest quality evidence for each factor • Brief narrative summary
			Level of evidence: 2++ • Search and identification of papers thorough • Final inclusion based on quality score which is not usual practice in systematic reviewing • Use of scoring system to assess consistency of findings seems arbitrary and is based on study design alone

Reference and Methodology	Inclusion/exclusion criteria	Outcome Measures	Findings
Palmer et al (2007) **Research Question:** To assess occupational associations with tenosynovitis and epidcondylitis **Methodology Described:** Systematic review **Types of study included:** Prospective cohort, case-control, cross-sectional **Literature Search:** Medline, EMBASE(Ovid),	**Included Studies:** N=13 studies 9 cross-sectional 2 case-control 2 cohort Quality assessment of included studies completed by two authors	**Odds ratios, risk ratios presented from each study** Statistical associations: Attributable fraction > 50%/ RR>2 in exposed:unexposed popn Deemed satisfactory evidence that the condition is 'more likely than not' attributable to the condition. Studies fell into two groups: those that described association by job title and those that described association by occupational physical activity (n=2)	**Results:** - *Occupations*: foresters v blue collar workers (OR 4.9); pipe fitters, water/gas suppliers >15 yrs v never (OR 3.8); meatcutters (OR 2.4); sausage makers, meatpackers (mixed findings); nursery cooks v social workers (OR 5.1) - *Occupational physical activity* – only 2 studies contributed to these findings: Haahr and Andersen, 2003; Leclerc - *Repetition*: Haahr and Andersen, movement of arm 75 – 100% of time (OR 3.7 - women). - *Vibration:* Haahr and Andersen, hand-held vibrating tool 25 – 50% of time for men (OR 2.9) but not women. No associations for 75 – 100% of time. - *Posture:* Leclerc et al, 'turn and screw' associated with LE (OR 2.07). Haahr and Andersen, for movements 75 – 100% of the time: arms lifted in front of the body (OR 4.0 – women), hands bent or twisted (OR 7.4 – women; OR 3.2 – men), precision movements (OR 5.2 – men) - Authors made reference to stronger evidence for combined physical factors but did not include these analyses in their findings

Date of search: January 2005 How funded: Industrial Injuries Advisory Council (IIAC), UK No conflicts of interest declared			**Biases/Weaknesses:** • Limited number of studies located and included e.g. two studies of occupational activities and LE • Lack of homogeneity in the studies especially in measurement of exposure to risk factors, not possible to pool odds ratios • Methodological quality of some included studies was not high. Lack of prospective cohort studies. **Conclusion:** • Handling loads > 20 kg per day, handling tools >1kg, repetitive arm/hand mvts >2 hrs per day, arms lifted in front of the body, hands bent or twisted and precision mvts during part of the working day are associated with LE. Evidence for force and vibration and LE not as strong as that for ME.
			Level of evidence: 2++ • Selection criteria clearly stated • Two authors completed quality assessment • Objective synthesis limited by a lack of well-conducted studies for some conditions

Reference and Methodology	Inclusion/exclusion criteria	Outcome Measures	Findings
Van Rijn et al (2009) **Research Question:** To examine the occupational risks for MSD of the elbow **Methodology Described:** Systematic review **Types of study included:** Prospective cohort, case-control, cross-sectional **Literature Search:** Medline, EMBASE(Ovid), Cochrane Register of Controlled	**Included Studies:** N=13 studies 9 cross-sectional 2 case-control 2 cohort **Inclusion criteria:** (i) concerned LE, medial epicondylitis, cubital tunnel syndrome or radial tunnel syndrome (ii) peer reviewed and published in English, French, German or Dutch (reports, abstracts and proceedings were not included), (iii) quantitative description of the measures of exposure (iv) association between	**Odds ratios, risk ratios presented from each study** **Statistical associations:** Positive – higher values of risk factor associated with higher occurrence of condition Negative – higher values of risk factor associated with lower occurrence of condition Null – risk estimate not significantly different from 1 (evaluated as no evidence of effect or insufficient evidence 4 exposure risk factors reported: force, repetition, vibration, posture	**Results:** - *Occupations*: female assembly line workers, male meat cutters, female betel pepper leaf cullers – no associations found - *Force*: Shiri et al., loads > 20kg at least 10 times per day for >20 years (OR 2.6). No association with loads >5 kg or high handgrip forces. Haahr and Andersen, handling tools >/= 1kg (OR 2.1 – 3.0). - *Repetition:* Ono et al, repetitive hand-arm mvts OR 4.7. Repetitive mvts >2 hr per day for 9-19 yrs (OR 2.4) and >/= 20 yrs (OR 2.8). Haahr and Andersen, mvt of arm 75 – 100% of time (OR 3.7). - *Vibration*: Haahr and Andersen, hand-held vibrating tool 25 – 50% of time for men (OR 2.9) but not women. No associations for 75 – 100% of time. Shiri et al - no association between LE and vibrating tools > 2 hours per day. - *Posture:* Leclerc et al, 'turn and screw' associated with LE (OR 2.07). Haahr and Andersen, arms lifted in front of the body, hands bent or twist, precision mvts (OR 1.5 – 7.4) - *Combined physical factors:* 1 study (Haahr and Andersen) - *Women*: low rep + extreme posture; high rep + extreme posture; high force + extreme posture (OR

Trials **Date of search:** September 2007 **How funded:** Worksafe, British Columbia No conflicts of interest declared	risk factor and condition expressed quantitatively Quality assessment of included studies completed by two authors		2.4 – 6.5) - *Men*: high rep + high force (OR 3.5); high force + neutral posture (OR 3.3)
			Biases/Weaknesses: • Lack of homogeneity in the studies especially in measurement of exposure to risk factors, not possible to pool odds ratios • Small number of studies for some risk factors e.g force and LE • Methodological quality of some included studies was not high. Lack of prospective cohort studies. **Conclusion:** • Handling loads > 20 kg per day, handling tools >1kg, repetitive arm/hand mvts >2 hrs per day, arms lifted in front of the body, hands bent or twisted and precision mvts during part of the working day are associated with LE. Evidence for force and vibration and LE not as strong as that for ME.
			Level of evidence: 2++ • Selection criteria clearly stated • Two authors completed quality assessment • Objective synthesis limited by a lack of well-conducted studies for some conditions

Reference and Methodology	Inclusion/exclusion criteria	Outcome Measures	Findings
Waerstad et al (2010) BMC Musculoskeletal Disorders 2010, 11:79 **Research Question:** To examine the evidence for an association between computer use and MSD of the neck and upper extremity (except CTS) **Methodology Described:** Systematic review **Types of study included:** Prospective cohort, case-control, cross-sectional **Literature Search:** PubMed, EMBASE(Ovid), ISI Web of Science, CSA Health and Safety Science Abstracts, and	**Included Studies:** N=22 studies published in 26 papers Computer work defined as that involving a visual display unit/terminal and keyboard and/or mouse Does not include small handheld devices **Inclusion criteria:** (i) peer reviewed and published in English (reports, abstracts and proceedings were not included), (ii) data on computer use in a working age population, (iii) included a relevant objective	Relationship between computer use and development of MSD of the neck and upper extremity Evidence of causation using 4 of the Bradford-Hill criteria: Consistency, Temporality, Exposure-effect relationship, Coherence of evidence **Strength of the evidence:** +++ Sufficient evidence of a causal association ++ Moderate evidence (bias and confounding are not a likely explanation of associations (<50%)) + Limited evidence (bias and confounding are not an unlikely explanation of associations (>50%))	**Results:** - NUDATA study, no evidence of association between keyboard or mouse use and LE/ME - Several other studies have also reported no association in keyboard operators v not keyboard operators - Limitations in these studies include a small number of cases and limited statistical power - One recent cross-sectional study identified a higher frequency of LE in extensive computer users - Forearm pain – limited evidence of a causal association between mouse use, but not computer or keyboard use, and forearm pain from one high quality study **Biases/Weaknesses:** • Lack of strong evidence either way – small number of cases identified in most of the studies. **Conclusion:** • insufficient evidence for a causal relationship for computer work per se, keyboard and mouse time

OSH References Collection Search (giving access to the following six databases OSHLINE, NIOSHTIC, NIOSHTIC-2, HSELINE, CISILO and Canadiana). **Date of search:** Feb 2010 **How funded:** Developed as part of a review for Danish National Board of Industrial Injuries to decide whether MSD sustained by computer workers should be added to the government compensation register	examination (e.g. a physical examination, scanning, or x-ray) of musculoskeletal disorders in the neck and upper extremity, (iv) related the exposure to computer work to the findings of the objective examination Quality assessment of included studies completed by two authors	0 Insufficient evidence of a causal association - Evidence suggesting lack of a causal association	• none of the evidence was considered moderate or strong **Level of evidence: 2++** • Selection criteria clearly stated • Two authors completed quality assessment • Broad range of databases searched

Table 5 Evidence tables summarising primary literature which evaluates the association between physical work characteristics and LE

Reference and Methodology	Participants	Intervention	Outcomes
Fan et al (2009) American Journal of Industrial Medicine 52:479–490 **Research Question:** To investigate the relationship between lateral epicondylitis and workplace ergonomic tasks **Methodology Described:** Cross-sectional study	N= 733 manufacturing workers (electronics, automotive parts, windows, cabinets, medical and fitness equipment)in 12 sites across Washington State, USA N= 38 (5.2%) diagnosed with LE 64.5 % participation rate	**Workplace assessments performed to classify jobs into:** • Low/high hand force • Low/medium/high hand repetition Video recordings observed by ergonomists to measure forceful exertions, awkward postures, repetitive movements and duration and frequency of power tool use. **Interviewees were diagnosed with LE:** 1) positive symptoms (pain, aching, stiffness, burning, numbness or tingling in past 7 days and lasted > 1 week or occurred > 3 times in previous 12 months with no history of	**Outcome Measures:** Odds ratios for LE adjusted for age, BMI and gender **Results:** *Forceful exertions* 1 - <5 times/min OR 4.3 (95% CI 1.6 – 11.9) 5+ times per minute OR 6.4 (95% CI 2.3 – 17.9) *Shoulder movements* 10 to<20 times per minute OR 2.0 (95% CI 0.7 - 5.7) 20+ times per minute OR 2.7 (95% CI 1.0 - 7.7) *Forceful lifting* 0 to <2 times per minute OR 2.3 (95% CI 1.0 - 5.6) 2+ times per minute OR 3.1 (95% CI 1.3 - 7.3) *Posture* Forearm supination > 45 degrees > 5% of the time OR 2.3 (95% CI 1.2 – 4.5) Wrist flexion/extension > 45 degrees > 1% of the time, NS,

How funded: Department of Labor & Industries, Washington NIOSH		trauma at the time of symptom onset) at lateral side of elbow or forearm, and 2) pain at lateral epicondyle region on resisted wrist extension or tenderness on palpation of lateral epicondyle.	OR 0.7 Wrist radial deviation <5 degrees or ulnar deviation > 20 degrees, NS, OR 0.7 Forearm supination + forceful lifting Low/Low OR = 1.0 Intermediate: OR = 1.2 (95% CI 0.4 – 3.4) High/High: OR 3.7 (95% CI 1.5 – 9.1)
			Biases/Weaknesses: • Cross-sectional study so can only indicate association not causation – on its own this study presents only limited evidence of a causal relationship at best • Small number of cases • Results applicable to manufacturing and health service sectors – authors suggest cautious application to other sectors • 64.5% participation rate – potential for difference between those who participated and those who didn't **Conclusion:** LE is related to frequent forceful exertions or the combination of forceful lifting and forearm supination.

Reference and Methodology	Participants	Intervention	Outcomes
Haahr and Andersen et al (2003) Occupational and Environmental Medicine, 60, 322-329 **Research Question:** To investigate the relationship between lateral epicondylitis and workplace ergonomic tasks **Methodology Described:** Case-control **How funded:** Research Council of the National Working	N= 267 new cases of LE and 388 controls. Total pool n=360 cases and n=588 controls (74% and 71% participation rates) Cases were identified from all 18-66 year olds enrolled with 104 GP practices in the west of Denmark (out of 146 initially contacted). Two referents, matched by gender and age, were selected for every case from a public health insurance database.	A questionnaire was used to gather information about physical, psychosocial and work-related exposures. Work-related exposures included position held (classified as strenuous/non-strenuous), duration of latest employment, posture of arms and hands, repetitive movements, static load (precision), vibration, and use of tools as a proxy for force (not forceful: up to 1kg; forceful: >1kg). Case definition of lateral epicondylitis was: pain at the lateral humeral epicondyle, with or without concomitant pain in the adjacent extensor muscles of the forearm, and present of direct and indirect tenderness at the lateral humeral epicondyle upon resisted extension of the	**Outcome Measures:** *Odds ratios* Final model presented odds ratios for LE adjusted for age, BMI, gender, social support, job demands and job control A job strain index was constructed combining force, repetition and posture to measure combination of physical factors <u>Combination of force, posture and repetition</u> *High repetition and high force:* OR (women) 1.8 (95% CI 0.7– 5.0) OR (men) 3.5 (95% CI 1.3 – 9.1) *Repetition and extreme posture:* Women – ORs highest for low rep and extreme posture Men – none of the combinations of repetition and posture were significant *High force and extreme posture:* OR (women) 6.5 (95% CI 2.8 – 14.7) OR (men) 2.0 (95% CI 0.9 – 4.5) <u>Physical strain index (combination of force, repetition and posture)</u>

Environment Authority, the Danish Insurance Association, and the Medical Research Unit of Ringkjoebing County		wrist or third finger.	Low: OR 1.4 (95% CI 0.8 – 2.7) Medium: OR 2.0 (95% CI 1.1 – 3.7) High: OR 4.4 (95% CI 2.3 – 8.7)
			Biases/Weaknesses • Final analyses included 209 cases and 274 controls – dropouts not explained • No specific ergonomic assessment for 'strenuous' v 'non strenuous' jobs – based on job title • Tools used as proxy measure of force • Self-reported exposure to physical factors – may be prone to reporting bias • Potential for selection bias as cases were enrolled via GPs and may represent more severe cases **Conclusion:** Lateral epicondylitis was related to force and posture, and to the combinations of force, posture, and repetition. Among women, self-reported low social support at work was related to lateral epicondylitis. Results for precision movements and vibrating tools were not consistent

Reference and	Participants	Intervention	Outcomes

Methodology			
Herquelot (2012) American Journal of Industrial Medicine, 56, 400-409 **Research Question:** To investigate the relationship between lateral epicondylitis and workplace physical and psychosocial factors **Methodology Described:** Cross-sectional study **How funded:** French Institute for Public Health Surveillance No conflicts of interest reported	N=3710 people of working age in Loire region, France 58% men Initial cohort enrolled 2002-2005, participants randomly selected from a cohort undergoing a mandatory annual health examination Workers who reported elbow pain in preceding 12 months were physically examined for LE. Of the whole cohort, 2.4% (n=90) had a confirmed diagnosis of LE	**Self-reported questionnaire regarding workplace physical and psychosocial factors:** Response options: Never/practically never Rarely (<2 hrs per day) Often (2-4 hrs per day) Always (>4 hrs per day) Physical examination by an occupational physician (n=83) employed by each company. **Diagnosis**: activity-dependent pain directly located around the lateral epicondyle for at least 4 days over the last week and local pain on resisted wrist bending at the examination "All OPs were trained to randomly include workers and perform a standardized physical examination"	**Outcome Measures:** Odds ratios for LE and elbow pain Logistic regression incorporating multiple factors **Results:** *Men* Demographic risk factors for LE Age >50 yrs: OR = 11.0 (95% CI 3.3 – 37.0) BMI: not significant Prior MSD: OR 5.80 (95% CI 3.3 – 10.2) Low social support: or 2.0 (95% CI 1.2 – 3.5) Blue collar (manual worker) OR 3.8 (95% CI 1.8 – 7.9) Occupational risk factors for LE: Repetitive tasks (>4 hrs/day): NS, OR 1.6 (95% CI 0.9 – 2.9) Physical exertion (hard): OR 2.7 (95% CI 1.4 – 5.1) Flexion/extension elbow (>2hr/day): OR 2.4 (95% CI 1.4 – 4.2) Wrist bending (>2 hr/day): OR 2.3 (95% CI 1.3 – 4.0) Use of vibrating tools >2 hr/day: NS, OR 0.95 (95% CI 0.5 – 2.0)

			Combination of physical factors: 2 Elbow mvts = wrist bending AND flexion/extension elbow 1 elbow mvt = wrist OR elbow Hard physical exertion + no elbow mvts: NS OR 0.6 (95% CI 0.1 – 2.9) Hard physical exertion + 1 elbow mvt: OR 3.5 (95% CI 1.3 – 9.8) Hard physical exertion + 2 elbow mvts: OR 5.3 (95% ci 1.9 – 14.4) *Women*: Demographic risk factors for LE Age >50 yrs: OR = 8.7 (95% CI 1.9 – 38.8) BMI: not significant Prior MSD: OR 8.5 (95% CI 4.4 – 16.6) Low social support: NS, OR 1.0 (95% CI 0.5 – 1.9) Occupational risk factors for LE: Repetitive tasks (>4 hrs/day): OR 2.5 (95% CI 1.3 – 4.7) Physical exertion (hard): OR 2.9 (95% CI 1.5 – 5.9) Flexion/extension elbow (>2hr/day): OR 2.7 (95% CI 1.4 – 5.0) Wrist bending (>2 hr/day): OR 2.0 (95% CI 1.0 – 3.8)

			Use of vibrating tools >2 hr/day: NS, OR 2.1 (95% CI 0.6 – 7.0) **Combination of physical factors**: 2 Elbow mvts = wrist bending AND flexion/extension elbow 1 elbow mvt = wrist OR elbow Hard physical exertion + no elbow mvts: NS OR 0.8 (95% CI 0.3 – 2.7) Hard physical exertion + 1 elbow mvt: NS, OR 2.1 (95% CI 0.8 – 5.9) Hard physical exertion + 2 elbow mvts: NS, OR 2.5 (95% CI 0.9 – 6.9)
			Biases/Weaknesses: • Self-reported exposure to workplace factors – potential for over/under-representation of exposure • Unclear how workers were 'randomly selected' from the whole cohort • 83 occupational physicians so potential for diagnostic criteria to have been applied inconsistently • Cross-sectional study so can only indicate association not causation – on its own this study presents only limited evidence of a causal relationship at best

			Conclusion: The authors concluded that there is an important relationship between the combination of hard physical exertion and repetitive elbow flexion/extension or wrist bending and lateral epicondylitis

Reference and Methodology	Participants	Intervention	Outcomes
Leclerc et al (2001) Scandinavian Journal of Work, Environment and Health, 27, 268-278 **Research Question:** To investigate the relationship between lateral epicondylitis and workplace ergonomic tasks **Methodology Described:**	N= of 598 workers in five occupational sectors involving repetitive work. Participants were part of an original cohort of 1420 workers. Participants followed up after 3 years Sectors included assembly line manufacturing, shoe and clothing manufacturing; food industry (mainly meat); packaging; and supermarket cashiering.	**Self-reported questionnaire regarding work activities:** • working with force, pressing with the hand or elbow, screwing or tightening with force, hitting, pulling, pushing and holding in position. Respondents were asked to indicate whether they did these repetitively, not repetitively or never. LE defined as epicondylar pain or epicondylar	**Outcome Measures:** Odds ratios for LE adjusted for age and gender Of the 9 physical work factors examined, only driving screws repetitively was significantly associated with LE. Turn and screw: OR 2.07 (95% CI 1.16 – 3.70)

Prospective cohort **How funded:** INSERM (National Institute on Health and Medical Research), France		tenderness and pain on resisted extension of the wrist Examined by a physician based at their workplace.	
			Biases/Weaknesses • self-reported questionnaire used to collect physical work factors – potential for reporting bias, authors felt there may have been some limitations to the questionnaire • >50% loss to follow-up from initial cohort **Conclusion:** LE is related to repetitively driving screws or the action of turning and screwing.

Reference and Methodology	Participants	Intervention	Outcomes
Ono et al (1998) Occupational and Environmental Medicine, 55, 172-179	N= 209 nursery school cooks and 366 workers from other social welfare industries (nursing assistants, home care assistants and	Work-related risk factors were gathered using a questionnaire and LE was diagnosed via a clinical	**Outcome Measures:** Being a cook was associated with LE: OR 4.7 (95% CI 2.2 – 9.7)

Research Question: To compare the relationship between lateral epicondylitis and workplace ergonomic tasks in cooks vs controls **Methodology Described:** Cross-sectional **How funded:** Not reported	'handywomen') in Japan.	examination. Work-related risk factors included frequent lifting and handling, static work posture and repetitive shoulder, arm, hand or finger movement – all were self-reported. LE diagnosed by clinical examination: pain on palpation of the lateral epicondyle and pain on resisted wrist extension	Work-related risk factors: Static work posture OR 7.9 (95% CI 4.9 – 12.8) Frequent repetitive work with shoulders, arms, fingers, hands: OR 6.6 (95% CI 4.1 – 10.8) Frequent lifting: NS, OR 0.6 (95% CI 0.4 – 0.9)
			Biases/Weaknesses: • Cross-sectional study so can only indicate association not causation – on its own this study presents only limited evidence of a causal relationship at best • Self-report questionnaire to collect data on physical work factors • Small number of physical factors examined and not in combination • Small number of cases **Conclusion:** LE is related to frequent forceful exertions or the

			combination of forceful lifting and forearm supination.

Reference and Methodology	Participants	Intervention	Outcomes
Shiri et al (2006) American Journal Of Epidemiology, 164, 1065-1074 **Research Question:** To investigate the relationship between lateral epicondylitis and workplace ergonomic tasks **Methodology Described:** Cross-sectional **How funded:** Finnish Institute of Occupational	N= 4,698 people in Finland participating in a national health survey Eligible participants = 5,871 80% participation rate Aged 30 and 64 years.	Information was gathered through a combination of home interview, clinical examination and laboratory tests. Physical work-related risk factors were collected through an interview and included manual handling of loads, high handgrip forces, repetitive movements of the hands or wrists, keying work and work with a vibrating tool. Diagnostic criteria for definite LE were pain at the elbow during the preceding 30 days and pain at the lateral humeral epicondyle region on resisted extension of the wrist with the elbow extended. Possible LE was defined as pain at the elbow in the preceding 30 days and	**Outcome Measures:** Odds ratios for LE adjusted for age and gender, reported for 3 durations of work: 1-8 years 9-19 years >/= 20 years **<u>Work-related physical factors</u>** Handling loads >20kg >/= 10 times/day – only significant for durations of 20 years or more: OR 2.6 (95% CI 1.3 – 5.1) Repetitive movements of the hand or wrist >/= 2 hours per day: 9-19 years OR 2.4 (95% CI 1.2 – 4.9) 20 years + OR 2.8 (95% CI 1.4 – 5.8) High handgrip forces – not significant Handling loads >5kg >/= 2 times per minute >/= 2 hours per day – not significant

Health National Public Health Institute		tenderness on physical examination.	Keying – not significant Vibrating tools – not significant Combination of forceful and repetitive activities: OR 3.6 (95% CI 0.9 – 14.6)
			Biases/Weaknesses: • Cross-sectional study so can only indicate association not causation – on its own this study presents only limited evidence of a causal relationship at best • Home interview may have improved reporting of work-related factors – no ergonomic analysis • Large nationwide health survey and participation rate was 80% – adds power to the analyses • Authors reported those who did not participate were potentially less healthy and more likely to be exposed to forceful activities. **Conclusion:** • LE is related to the combination of forceful and repetitive activities. On their own, forceful activities were not significantly associated with LE.

Reference and Methodology	Participants	Intervention	Outcomes
Walker-Bone et al (2011) Rheumatology; 51:305_310 **Research Question:** To investigate the relationship between lateral epicondylitis and workplace ergonomic tasks **Methodology Described:** Cross-sectional study **How funded:** HSE grant plus Arthritis Research	N=9696 people aged 25 – 64 years Registered at one of two GP practices Not suffering from recent illness or bereavement Response = 6038 (62%) Mean age = 45.6 years (range 24.6 – 66.3) 55% females 95% caucasion 77% paid employment	Baseline questionnaire regarding workplace physical and psychosocial factors sent out Of responders, those reporting elbow pain in the last week were invited to an interview (n= 636; 11%) with a trained research nurse – detailed information about symptomatology N= 412 (65%) attended Interview was 8 weeks later and 58% of these respondents had persistent elbow pain. Interviewees were diagnosed with LE, ME or non-specific elbow pain according to an algorithm:	**Outcome Measures:** Odds ratios for LE/ME/non-specific elbow pain adjusted for age and gender **<u>Lateral epicondylitis</u>** Demographic risk factors for LE: Psychological distress OR 4.5 (95% CI 2.1 – 9.5) Blue collar (manual worker) OR 3.8 (95% CI 1.8 – 7.9) Not associated: BMI, smoking, diabetes Occupational risk factors for LE (adjusted for age, gender, psych distress, manual worker) Self-reported bending/straightening elbow >1hr/day OR 2.5 (95% CI 1.2 – 5.5) Keyboard use, working with arms above shoulder height, exposure to hand-transmitted vibration not associated) **<u>Medial epicondylitis</u>** Demographic risk factors for LE: Psychological distress OR 4.9 (95% CI 2.0 – 12.4) Not associated: blue collar (manual) worker, BMI, smoking, diabetes Occupational risk factors for LE (adjusted for age, gender, psych distress) Self-reported bending/straightening elbow >1hr/day

Campaign No conflicts of interest reported		N=45 LE (21 men and 24 women) Point prevalence 0.8% and 0.7% N=34 ME (10 men and 24 women) 45 – 54 years was age band with highest prevalence for LE/ME	OR 5.1 (95% CI 1.8 – 14.3) Keyboard use, working with arms above shoulder height, exposure to hand-transmitted vibration not associated)
			Biases/Weaknesses • Response rate reflective of a postal questionnaire but may have been a source of bias • Self-reported exposure to workplace factors – potential for over/under-representation of exposure • Lower confidence interval range was close to 1 for LE • Cross-sectional study so can only indicate association not causation – on its own this study presents only limited evidence of a causal relationship at best **Conclusion:** The authors concluded that there is an important relationship between repetitive elbow

			bending/straightening and medial and lateral epicondylitis