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Concerns regarding the publication "Powered-hand tools and vibration-related disorders in US-railway maintenance-of-way workers"

Greg G. WEAMES[1]*, George B. PAGE[2], Matthew S. THIESE[3] and Kurt T. HEGMANN[3]

[1]Page Engineering, Inc., Canada
[2]Page Engineering, Inc., United States
[3]University of Utah Health Ringgold standard institution, United States

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We have reviewed with interest and comment on "Powered-Hand Tools and Vibration-Related Disorders in US-Railway Maintenance-of-Way Workers" by Eckardt Johanning *et al.*[1], with partial support from the Association of American Railroads. The authors of this paper conclude that, "the comprehensive health survey suggests that MoW workers have a high risk of typical hand-transmitted vibration-related disorders". We present concerns regarding this conclusion as it: (1) failed to include and discuss published objective exposure data specific to this occupational group which markedly conflict with their subjective data, (2) presented exposure durations that are not possible (3) included few of the workers (~8% effective response rate), with additional documentation suggesting striking non-representativeness and selection bias compared with the target population, (4) relies on subjective recall of hand-arm vibration (HAV) exposure, and (5) relies on the subjective self-reported recall of discomfort (not health outcomes).

Johanning *et al.*[1] have not incorporated the relevant, quantified exposure research data of others. For example, Weames *et al.* (2017a)[2] and Weames *et al.* (2017b)[3] have published objective data from full-shift measurements to report average daily power tool use for Maintenance-of-Way (MOW) section maintainers (average objective exposure data based on 14 full-shift data collection days in 10 States and spanning 2003–2011) and MOW track welders (average based on 7 full-shift data collection days in 4 States and spanning 2004–2013). Such objective exposure data are essential for proper scientific analyses of hand/arm vibration (HAV) exposures compared with subjective data[4].

To help the readership understand these important issues some facts about MOW work may help. MOW employees maintain railroad track and its various structures. Section maintainers work in "gangs" of 3–4 employees and effect localized track repairs. Track welders work in gangs of 2 employees and are trained to restore worn steel that typically takes place at switch points and frogs (a track appliance that is part of a switch that allows trains to roll from one track to another) as well as weld pieces of rail together. Section maintainers operate out of a basic track maintenance forces (BTMF) work vehicle while track welders generally use an industrialized-looking delivery truck. Both types of vehicles can operate either on roadways or on railroad tracks. These two types of MOW jobs use a variety of specialized tools (including power tools) and are reasonably common MOW jobs across the U.S. railroad industry. MOW work almost always requires track occupancy permission from railroad dispatchers to ensure safe access to railroad track, void of any other train traffic. It is naturally common for MOW employees to spend appreciable por-

*To whom correspondence should be addressed.
E-mail address: gweames@pageengineering.net

tions of their day waiting for track occupancy permission.

For both the section maintainer and track welder, approximately 20% of the work shift on average, involved occupational exposure for the hands, including using hand tools, power tools and handling parts and equipment[3, 4]. The approximately remaining 80% of the work shift on average is the combined occupational durations of beginning/end of shift activities (paperwork, meetings, booking in/out), job briefings, travel to/from worksites, waiting for authorized access to the track, time when the MOW employee's hands are idle and using the hands for donning/doffing PPE[3, 4]. When in use, the different power tools used by these MOW employees typically include variations of the hydraulic spiker, hydraulic spike puller, hydraulic tamper, impact wrench, rail saw, rail grinder, and chipping hammer.

The section maintainer's use of power tools (all various power tools combined) was directly measured and resulted in a daily average of 1.4% and 1.5%, of the duration of the shift, for the left and right hands, respectively[3]. The track welder's use of power tools was also directly measured and resulted in a daily average of 4.7%, for either hand, over the duration of the shift[4]. The results further demonstrated that the cumulative duration of HAV exposure was generally experienced intermittently, and that this exposure was not experienced within a single exposure duration[3, 4]. We know of no quality epidemiological data that suggest that this minimal daily and intermittent HAV exposure is a hazard for MSDs.

Objectively measured occupational exposures have been shown to be superior to questionnaire data as self-reporting of exposures is quite inaccurate compared to the actual exposure[5–11]. These articles also have shown that self-reported exposure data are consistently biased towards overestimation of exposure resulting in errors, often many times greater than actual exposures. As an example, self-reported daily durations for HAV exposures were 9 times greater than the actual exposure[12].

As part of their results, Johanning *et al.*[1] state that, "Tools where a majority of participants (>50%) indicated that they "Always" or "Often" use it daily at work, are listed in capital letters", for their published Table 3 and Table 4, where 9 power tools met the criteria of >50% of the survey participants. Based on the survey questions used by Johanning *et al.*[1], it appears reasonable to assume that "always" and "often" for the questions of power tool use were understood by participants as durations of 8–10 hours and 4–6 hours, respectively. These results regarding the amount of daily HAV exposure are impossible. There is not time available in the work shift to experience 4–10 hours of HAV exposure, according to objectively measured results of section maintainer and track welder job activities[3, 4]. According to the reported results of Johanning *et al.*[1], it was very likely some survey respondents identified that they used more than one power tool "always" and/or "often" daily. This combination of survey responses would have resulted in the sum of the reported power tool use exposure to exceed the duration of the shift, and possibly exceed the duration of an entire day. Thus, the reported Johanning *et al.*[1] power tool use results, based on self-reported estimates, are orders of magnitude inaccurate compared to the actual, objectively measured exposure. We obtained IRB approval and then requested access to de-identified raw data to verify the very likely supposititious results of Johanning *et al.*[1], but were denied access.

We could not find quantification of daily duration of power tool use definitions in Johanning *et al.*[1], Landsbergis *et al.*[13] or any of the supplemental digital content, for the terms "always", "often", "sometimes", "rarely", or "never". However, there was context provided to the survey respondents via the question of "how many hours during your workday" do "hand tool vibrations bother me", with the options of "always (8–10 hours)", "often (4–6 hours)", "sometimes (1–2 hours)", "seldom (less than 1 hour)", and "never (0 hours)"[1, 13]. The power tool use, objectively measured and reported in Weames *et al.*[3, 4] would be categorized as at the low end of "rarely", according to Johanning *et al.*[1], or at the very low end of "occasional", according to the U.S. Department of Labor[14].

Regarding participation rate, Johanning *et al.*[1] reported a survey response rate of 12%, which is an unusually low rate and thus especially prone to selection bias[15–18]. Respondents to the survey were instructed to return the survey with any degree of completion[1, 13]. Careful review of the published data documented that the response rate for any one question was less than reported at ~8%[1, 13]. The response rate could not have adequately controlled for selection bias. Johanning *et al.* reported that a subset of non-responders was used to validate that the respondents were representative of the MOW population. However, the subset instead showed striking differences thus documenting a high probability that a markedly non-representative sample responded to the survey[1, 13].

The Johanning *et al.*[1] survey question and response details on power tool use did not appear to be the same as any question in a previously administered survey[19–23]. Johanning *et al.* (2020) asserts that they relied on the VIBRISKS Protocol for Epidemiological Studies of Hand-Transmitted Vibration[24]. The VIBRISKS publication supports that

health case definitions, medically affirmed diagnostic data and observed, and objectively determined exposure durations are scientifically important[24]. None of these VIBRISKS elements were incorporated by the authors[1].

Johanning *et al.*[1] state that "a focus of this study is the diagnoses of carpal tunnel syndrome (CTS) and HAV related disorder". The authors' approach to investigate this focus was to simply ask the target population if they recall being told if they have such a condition[1, 13]. A validated and/or consensus case definition of CTS was not apparently used in Johanning *et al.*[1], as no such diagnostic information or documentation was collected[25, 26].

Determining HAV exposure requires not only duration of exposure, but also its magnitude. The authors have not provided measurements of the vibration of any of the power tools in use by MOW employees, as listed in Johanning *et al*[1]. The authors chose to present other sources of information about power tool vibration emissions, such as from manufacturers' tool publications[1]. It appears many of the tools' information is inconsistent with tools used by MOW employees in the U.S. Vibration-dampening devices, mounts, handle extensions, guides, support apparatus unique to railroad MOW work, and unique ground conditions that modify power tool emissions (e.g., using a "jackhammer" to tamp ballast and not break apart concrete), were not mentioned by Johanning *et al.*[1] and do not appear to have been considered[22].

The conclusion in Johanning *et al.*[1] that, "MoW workers have a high risk of typical hand-transmitted vibration-related disorders" appears to be based on speculation. We agree with the authors that HAV exposure research helps to understand the level of thresholds for increased risk. We commend the BMWED's efforts to study the health and safety of their membership. However, we find that Johanning *et al.*[1] have presented a HAV exposure assessment of MOW employees that relies on inaccurate self-reporting of HAV exposure durations, an extremely low survey response rate, an extremely biased response sample, speculative representation of tool emission and design, and is thus quite misleading to the readership.

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