Whole-body vibration knowledge survey of U.S. occupational safety and health professionals

Helmut W. Paschold *, Alexander V. Sergeev

School of Public Health Sciences & Professions, College of Human and Health Services, Ohio University, Athens, Ohio 45701, USA

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ABSTRACT

Problem: Whole-body vibration (WBV) is an occupational issue of concern due to adverse health effects or simple discomfort and annoyance. Unlike in Europe, WBV is an emerging topic in the U.S. safety and health (S&H) professional community. We hypothesized that at least one-half of the U.S. occupational S&H professionals knew little or nothing about WBV. Method: We conducted a cross-sectional study (survey) of WBV knowledge among members of the American Society of Safety Engineers. A Likert scale (1-none to 5-expert) was used to determine WBV topic knowledge levels (KL1-5). Results: Analysis of 2,764 responses revealed that 69.5% of the participants self-reported a less than basic WBV understanding. The WBV KL1-5 mean for all participants was 1.94±1.00, corresponding to an awareness of WBV without a depth of understanding. Summary: Many at-risk U.S. workers may not be supported by occupational S&H professionals with adequate WBV knowledge. Impact on Industry: A significant number of U.S. workers may be exposed to unhealthy levels of whole-body vibration. However, the U.S. occupational safety and health community is generally unprepared to anticipate, monitor, and control the whole-body vibration hazard.

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1. Problem

Whole-body vibration (WBV) involves the transmission of mechanical vibration to the entire human body while in any of the three postures of standing, sitting, or reclining, with frequencies of concern ranging from 0.5 to 80 Hz (International Organization for Standardization [ISO], 1997). The most common WBV occupational exposure is while seated and found with the operators of a variety of vehicle categories such as cars, buses, forklifts, tractors, trucks, and heavy machinery either on or off paved roads (Paddan & Griffin, 2002; Schwarze, Notbohm, Dupuis, & Hartung, 1998). Other transportation vehicles with seated WBV exposures include locomotives (Johanning et al., 2006) and aircraft, including helicopters (Griffin, 1990). Depending on intensity levels, WBV: (a) may contribute to potential negative health effects after chronic exposure and may result in back problems, abdominal and digestive problems, cardiovascular, respiratory, metabolic, motor, postural, and visual disorders (Griffin, 1990); (b) may contribute indirectly to incident causation factors; or (c) may simply result in discomfort or annoyance (ISO, 1997).

The greatest concern involving WBV exposure is low back pain (LBP; Bovenzi & Hulshof, 1998; Hoy et al., 2005; Kittusamy & Buchholz, 2004; Schwarze et al., 1998). NIOSH (1997) assigned their highest ranking of “strong evidence” to the association between WBV and LBP. WBV can also adversely affect gastric motility (Ishitake, Miyazake, Noguchi, Ando, & Matoba, 2002), metabolic and respiratory responses (Maikala, King, & Bhamhini, 2006), hearing (Dennis, 1965), and the digestive system, genital or urinary system, and female reproductive organs (ISO, 1997). As of 2002, WBV exposure and associated LBP has been recognized as a qualifying compensable occupational disease in four European countries (Hulshof, Van der Laan, Braam, & Verbeek, 2002).

European development of WBV standards started in 1966 resulting in the publication of ISO 2631 in 1974 and a series of British standards beginning in 1973 (Griffin, 1990). Presently, it appears that the most commonly referenced standard for WBV is ISO 2631-1 (1997) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements. The British Standards Institution BS 6841 of 1987 differs from the ISO in methods and can result in different outcomes, a drawback to operating with multiple standards (Mansfield, 2005). The American National Standards Institute (ANSI) originally published American National Standard S3.18 in 1979 that was almost identical to the ISO2631 (Griffin, 1990) and later released ANSI S3.18-2002 ISO 2631-1:1997, an adaptation of the most recent ISO standard. The WBV exposure limits published by the American Conference of Governmental Industrial Hygienists (ACGIH®) are based upon the ISO standard (ACGIH®, 2001). In the United States these are voluntary standards. The Occupational Safety and Health Administration (OSHA) standards for general industry – Part 1910, maritime – Parts 1915, 1917, and 1918, construction – Part 1926, and agriculture – Part 1928 have no inclusion of the words whole-body vibration (OSHA, 2008). A November 2006 on-line search by a Ohio
University Health Sciences Librarian for ISO WBV standards found only three copies listed in U.S. and Canada university library catalogs.

Following the 2005 enactment of the United Kingdom's Control of Vibration at Work Regulations (CVVR), a survey with a relatively small sample (n = 88) of managers or designers in construction was conducted and reported by Edwards and Holt (2007). Participants were asked about their knowledge of the CVVR, WBV, and WBV risk levels in their workplaces. Six safety and health (S&H) professionals within the population reported a mean index response of 2.33 for their knowledge of WBV on a scale of 0 (know nothing) to 4 (know everything). A summary of the findings according to a sub-division of respondents is shown in Table 1. Edwards and Holt concluded “it was clear that the sample as a whole had not received much formal training on vibration or its management” (p. 271). No other S&H practitioner WBV-knowledge surveys were located.

Palmer, Griffin, Bendall, Pannett, and Coggon (2000) reported the findings of their worker self-reporting survey study assessing WBV exposures among working-age adults in Great Britain. It was estimated that a total of 9 million workers were exposed to WBV on a weekly basis, due to 35.1% of the working-age men and 7.9% of working-age women in the national population who experienced weekly WBV exposure. Of these workers exposed to WBV, 43.3% exceeded the action levels in proposed British standards.

Based upon: (a) the scarcity of available standards at universities, (b) the relative minority of WBV articles published by U.S. researchers, (c) general S&H seminars without WBV presentations in the United States, and (d) conversations with S&H professionals, an assumption was made that the topic of WBV is not very well known or understood in the United States. It was hypothesized that at least one-half of the U.S. S&H professional community knew little or nothing about WBV.

Objectives of this survey included:

- Assessment of occupational S&H professionals' knowledge of WBV,
- Identification of the primary source of knowledge about WBV,
- Identification of industry, personal education, and experiential factors associated with WBV knowledge or the lack thereof, and
- Demonstration of a need to enhance WBV education for improvement of exposure reduction.

2. Method

Because in cross-sectional epidemiological studies exposure and outcome status are assessed simultaneously, these studies are typically subject to a specific methodological limitation, the "chicken or egg" dilemma. It may be difficult or even impossible to determine in such studies whether the exposure preceded and caused the outcome of interest. However, our study is not subject to this limitation because the development of outcome (WBV knowledge) does not result in alteration of exposure status (level of professional qualification in occupational safety). Since our study is free from this limitation, it is appropriate to consider it as a type of analytic epidemiological study (Hennekens & Buring, 1987) and thus use it to test our hypothesis.

The survey was directed to members of the American Society of Safety Engineers (ASSE) who represent the U.S. professional S&H community. These professionals hold the responsibility within occupational settings to anticipate, recognize, evaluate, and control hazards. The knowledge of and ability to identify WBV is a requisite to the ultimate control of hazards. The ASSE provided an ideal source for contact with the professional S&H community due to its tenure (founded in 1911), membership of over 30,000 individuals (ASSE, 2007), and willingness to collaborate. The ASSE mailing list was filtered to exclude members under 18 years of age, students, foreign Chapter members, non-U.S. residents residing in the United States, and those opting to not receive email communications. It was estimated that 24,000 people would be contacted. The expected minimum response rate was 10%, based on estimates provided by ASSE personnel. This response rate should result in at least 2,400 responses. Qualifying members were contacted directly by the ASSE via email on May 14, 2007.

The email message distributed by the ASSE asked members to participate in a survey of professional knowledge about a specific topic in safety and health. At this point, no mention of WBV was made, with the intention of not dissuading unacquainted people from participating. The message also provided the average time needed, confidentiality issues, consent, the method of access to the survey (a link to the survey's host website), and the author's contact information. SurveyMonkey was chosen for the survey due to its availability of existing design templates, flexibility, data collection, anonymity, and economy (SurveyMonkey, 2007).

The survey introduction thanked participants and credited Ohio University and the ASSE for support. Participants were advised to use their best personal judgment in response to questions requiring an assessment of knowledge or skills. An alert was given regarding the use of a skip pattern so participants would not be alarmed by non-sequential question numbering. The confidentiality and consent information was repeated along with author contact information. The survey questions were organized into three general categories - WBV knowledge, employer information, and participant characteristics.

The initial category requested information about the participants' WBV knowledge. Question #1 asked about the source of initial WBV knowledge. Responses included specific class or course, written, conversational, or internet sources and the option of "I haven't" for those unacquainted with WBV. The "I haven't" response resulted in an automatic skip to the next section on employer data because all other WBV knowledge questions would have to be truthfully answered as "none" if a participant had never heard of the topic. Those indicating that they had heard of WBV were asked additional questions regarding when WBV was first known, other sources of information, and knowledge of specific issues such as basic WBV understanding (descriptive, exposures, monitoring and health effects) and standards (ISO, BS, ANSI, or ACGIH®). The questions solicited responses using a Likert scale ranging from 1 'None' to 5 'Clearly, completely, comprehensively', with suggestions devised by the researchers to provide guidance for intermediate levels of knowledge such as 2 (Awareness, but without a depth of understanding), 3 (Basic understanding), and 4 (Most aspects, lacking some detail issues). Questions #1 through #12 are presented in Table 2.

The second section gathered information about the employer's economic (industrial) sector and size according to the number of employees. The first economic sector question offered 10 broad categories for response, and through skip patterns directed the participants to select specific sectors. Employer sectors were derived from the U.S. Census Bureau 2002 North American Industry Classification System (NAICS) and combined to manageable groupings (U.S. Census Bureau, 2007).

Finally, the participant was asked to provide educational, experiential, and certification information. Categories included ASSE membership level, university education degrees and subject matter, professional certifications, years of experience, participation in seminars, gender, and age. The responses for questions requesting years of experience or age allowed five choices, similar to a Likert scale. The experience responses were based on categories of beginner, novice, intermediate, proficient, and expert according to a logarithmic transformation of general learning curve distributions based on personal experiential observation.
The Ohio University Institutional Review Board reviewed the survey and determined it was exempt from formal review-required status due to the survey nature of the study, exclusion of minors, and information that could not be used to identify individuals.

ASSE volunteers were solicited at a monthly meeting of its Central Columbus Chapter and through the ASSE Region III Vice President by email to respond to a pilot study. The pilot survey contained an additional final question allowing comments or questions. During the period March 14 to 29, 2007, 6 of 31 respondents offered suggestions that resulted in minor modifications to several questions and the addition of an alert about the use of a skip pattern to explain non-sequential question numbers. The average time to complete the pilot survey, including the extra survey-critique question, was about six minutes.

3. Results

A total of 21,292 requests to participate in the survey were distributed by the ASSE on May 14, 2007. Over a period of several weeks, 2,764 responses were received, for a response rate of 13%.

Table 2
Survey Questions #1 to #12.

<table>
<thead>
<tr>
<th>Question number</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Where have you FIRST heard of or learned about WBV?</td>
</tr>
<tr>
<td>2</td>
<td>When did you first hear of or learn about WBV?</td>
</tr>
<tr>
<td>3</td>
<td>Where else have you heard of or learned about WBV? Check all that apply.</td>
</tr>
<tr>
<td>4</td>
<td>What is your ability to define or explain WBV?</td>
</tr>
<tr>
<td>5</td>
<td>What is your ability to identify or describe human health effects from exposure to WBV?</td>
</tr>
<tr>
<td>6</td>
<td>If you are able to identify WBV’s human health effects, how would you characterize your identification of WBV illness trends within the scope of your workplace authority?</td>
</tr>
<tr>
<td>7</td>
<td>What is your ability to identify sources or causes of WBV within the scope of your workplace authority?</td>
</tr>
<tr>
<td>8</td>
<td>What is your ability to measure and quantify the employee exposure to WBV within the scope of your workplace authority?</td>
</tr>
<tr>
<td>9</td>
<td>Rate your acquaintance with the following WBV standards:</td>
</tr>
<tr>
<td>11</td>
<td>British Standards BS 6841 (1987)</td>
</tr>
<tr>
<td>12</td>
<td>American National Standards Institute ANSI S3.18-2002</td>
</tr>
<tr>
<td>13</td>
<td>ISO 2631-1-1997</td>
</tr>
<tr>
<td>14</td>
<td>American Conference of Governmental and [sic] Industrial Hygienists ACGIH TLVs for Physical Agents (for WBV).</td>
</tr>
</tbody>
</table>

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During the first day of the survey, the forced question-response function and the skip-pattern function for question #1 were inadvertently disabled; therefore, some incomplete surveys occurred (not all questions were answered) and participants who responded as having never heard of WBV were presented with questions that were not relevant. The skip-pattern errors were managed by manually skipping the unnecessarily-forced questions. In some cases, participants chose to list their employer’s classification under “other” with a descriptive response instead of choosing the appropriate listed selection. These responses were recoded to the specific economic sector classification when possible.

Question #1 “Where have you FIRST heard of or learned about WBV?” had 2,764 responses. The largest response category was “I haven’t,” 38.6% of the total (Paschold, 2008). The second largest category was “Publications,” a combination of responses including magazines, periodical, journal, and textbooks, with 37.2% of the total. A response summary is presented in Fig. 1. “When did you first hear of or learn about WBV?” Question #2, as depicted in Fig. 2, showed a decline in responses in the first four 2-year periods. Question #3, “Where else have you heard of or learned about WBV” was similar to Question #1; however, multiple responses were allowed (refer to Fig. 3). Similarly, the publications category was the dominant secondary source of WBV knowledge. Analysis of this data subset revealed that 11.0% of the survey participants (n = 303) had been exposed to only one source of WBV information.

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Fig. 1. Responses to Question #1, “Where have you FIRST heard of or learned about WBV?”.

Fig. 2. Responses to Question #2, “When did you first hear of or learn about WBV?”.

Fig. 3. Responses to Question #3, “Where else have you heard of or learned about WBV?”.
Tables 3 and 4 provide the mean, standard deviation, median, and number (n) for responses to Questions #4 to #8 according to industrial classification. The median was included due to several sub-classifications with sample sizes below 30. The Knowledge Level 1 to 5 (KL1-5) values were the responses to the 5-point scale, ranging from 1 (none) to 5 (expert).

The KL1-5 for Question #4 “Define or explain WBV” for all industrial sectors combined had a mean value of 1.94±1.00 and specific subgroups ranged from 1.63 to 2.25, with National Security (Armed Forces) reporting the highest value. Similar results were found for Questions #5 to #8, with the National Security classification having the highest ranked mean KL1-5 for all questions. Combined responses of “never heard of WBV” for Question #1 and “none, not at all” for Question #4 totaled 38.6% of the respondents. For Question #4, 30.9% of all respondents reported that their ability to define or explain WBV was “Awareness, but without a depth of understanding.”

Table 5 presents a summary of descriptive statistics for data from Questions #9 to #12 about the four WBV standards according to industrial classification. The mean KL1-5 values for standards with all groups combined were 1.22±0.55 for ISO, 1.10±0.39 for BS, 1.36±0.69 for ANSI, and 1.53±0.86 for ACGIH®. The highest individual mean KL1-5 value in Table 5 was 1.89 for the National Security classification and the ACGIH® standard. All median values were 1, with the exception of National Security and the ACGIH® standard.

4. Discussion

A total of 38.6% of the participants had not heard of WBV. An additional 30.9% reported that their ability to define or explain WBV was “Awareness, but without a depth of understanding,” which is the category below a “basic understanding.” Combining these two responses, 69.5% of the participants report less than a basic understanding of WBV. Within the industrial classifications, the National Security group consistently has high values by ranking; however, this should be viewed with caution due to the low n=28. As shown in Fig. 3, the number of people learning about WBV during a 2-year period is showing an increase. The apparent increase for 8+ years is explained by the large range of years covered (8 to over 30) as compared to the other 2-year increments.

With regard to the knowledge of WBV standards, the KL1-5 mean values are relatively low, ranging from 1.10 to 1.53 and all median values equal 1 with the exception of one cell in Table 3. The highest KL1-5 mean value for all groups combined is associated with the ACGIH® standard (1.53), the lowest (1.10) with the British Standard. The ACGIH® standard is a U.S. based standard and is much more likely to be encountered by the surveyed professionals than the British Standard. The slightly higher KL1-5 for the ANSI standard as opposed to the ISO standard may be explained by greater familiarity by the U.S. occupational S&H professionals with the many ANSI safety and health standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing. The overall low KL1-5 means for WBV standards; however, the inclusion of ISO standards in U.S. business practice is increasing.
Table 5

Knowledge level (KL1–5) according to industrial classification for four WBV standards.

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<tbody>
<tr>
<td>Agriculture</td>
<td>1.12 ± 0.33</td>
<td>1.06 ± 0.24</td>
<td>1.29 ± 0.59</td>
<td>1.24 ± 0.44</td>
</tr>
<tr>
<td>Mining</td>
<td>1.14 ± 0.40</td>
<td>1.04 ± 0.20</td>
<td>1.36 ± 0.63</td>
<td>1.38 ± 0.73</td>
</tr>
<tr>
<td>Construction</td>
<td>1.25 ± 0.58</td>
<td>1.13 ± 0.44</td>
<td>1.43 ± 0.74</td>
<td>1.44 ± 0.77</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1.21 ± 0.54</td>
<td>1.11 ± 0.40</td>
<td>1.34 ± 0.67</td>
<td>1.52 ± 0.83</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>1.23 ± 0.56</td>
<td>1.06 ± 0.25</td>
<td>1.34 ± 0.73</td>
<td>1.47 ± 0.95</td>
</tr>
<tr>
<td>Transportation, warehousing</td>
<td>1.18 ± 0.44</td>
<td>1.05 ± 0.27</td>
<td>1.35 ± 0.63</td>
<td>1.48 ± 0.81</td>
</tr>
<tr>
<td>and utilities</td>
<td>1 (n=221)</td>
<td>1 (n=221)</td>
<td>1 (n=221)</td>
<td>1 (n=221)</td>
</tr>
<tr>
<td>Services</td>
<td>1.24 ± 0.59</td>
<td>1.12 ± 0.41</td>
<td>1.41 ± 0.74</td>
<td>1.65 ± 0.95</td>
</tr>
<tr>
<td>Healthcare and social assistance</td>
<td>1.35 ± 0.68</td>
<td>1.13 ± 0.44</td>
<td>1.44 ± 0.87</td>
<td>1.71 ± 1.11</td>
</tr>
<tr>
<td>National security</td>
<td>1.25 ± 0.65</td>
<td>1.14 ± 0.59</td>
<td>1.46 ± 0.79</td>
<td>1.89 ± 1.13</td>
</tr>
<tr>
<td>Other or unknown</td>
<td>1.13 ± 0.43</td>
<td>1.07 ± 0.31</td>
<td>1.21 ± 0.53</td>
<td>1.31 ± 0.69</td>
</tr>
<tr>
<td>All combined</td>
<td>1.22 ± 0.55</td>
<td>1.10 ± 0.39</td>
<td>1.36 ± 0.69</td>
<td>1.53 ± 0.86</td>
</tr>
</tbody>
</table>

Question #4 about basic knowledge of WBV is similar to that posed by Edwards and Holt (2007) in their study of UK construction professionals—“What do you know about WBV?” (p. 267) that uses a “mean index, M,” based on a 0 to 4 scale. To equate studies, adding 1 to the M adjusts for the difference in scales. The overall M1 of 1.30, for all surveyed (n=88) is equivalent to a KL1–5 of 2.30, slightly higher than the 1.94 for U.S. safety professionals. When the UK S&H professional subgroup is isolated (n=6), the M1 is 2.33. Adjustment to an equivalent KL1–5 of 3.33 results in a value much higher than that reported for the United States. It may be expected that knowledge of WBV in the United States will increase if compliance is mandated by law such as in the UK; however, with the small sample sizes no statistical certainty can be implied in such an assumption.

Palmer et al. (2000) reported 35.1% and 7.9% of working age men and women respectively were exposed to WBV in Great Britain, with 4.3% of the exposed group exceeding a proposed British Standard action level, expressed as an equivalent exposure dose of vibration (eVDV) exceeding 15 ms⁻¹.²⁵. A 2000 U.S. Census report (Fronczek & Johnson, 2000) states a total of 69.1 million male and 60.1 million female employed civilians. When the exposure percentages with an assumption that occupational categories and workplaces in the United States and Great Britain are similar, it could be estimated that 29 million U.S. workers are exposed to WBV at any level; and, 4.3% or 1.2 million may be exposed to WBV at significant levels. The National Occupational Exposure Survey (NOES) conducted by NIOSH between 1981 and 1983 estimated that 1,082,217 U.S. workers had occupational WBV exposure (NIOSH, 1983). The ACIGH® (2001) reported that nearly 7 million workers in the United States are exposed to WBV, citing a previous study published over 30 years ago. Wasserman, Badger, Doyle, and Margolies (1974) utilized non-quantitative vibration-activity observations based on plant visits and BLS employment figures to estimate the total number of vibration-exposed U.S. workers at approximately 8 million, which includes both segmental vibration exposure and WBV. More recently, a study of the U.S. construction trade estimated that 540,000 operating engineers (workers performing work with dozers, excavators, loaders, cranes, etc.) had occupational WBV exposure (Kittusamy & Buchholz, 2004). This high number of WBV-exposed workers in just one segment of the U.S. workforce implies that the NOES results greatly underestimate current WBV exposures in the United States. With 69.5% of the survey sample reporting little or no knowledge of WBV, a large number of U.S. workers are exposed to environments attended by occupational S&H professionals with inadequate knowledge to anticipate, recognize, evaluate, and control WBV hazards.

WBV knowledge may be slightly overestimated due to possible human bias. The email invitation intentionally omitted reference to “WBV” with the reasoning that people with no WBV knowledge would be less likely to participate, perhaps under the assumption that they would have nothing to contribute. The survey started with, “Thank you for participating in this safety, health and environmental professional survey that is intended to help assess awareness of the whole body vibration topic.” It is possible that respondents may have exited the survey due to a lack of WBV knowledge which would result in no recorded survey response.

Also, survey respondents tend to underestimate or overstate responses in a fashion reflecting favorably on the respondents (Donaldson & Grant-Vallone, 2002). Questionnaire respondents have a social desirability bias with a tendency to claim recognition or knowledge of an item as opposed to no recognition (Paulhus, Harms, Bruce, & Lysy, 2003). With this in mind, the extent of WBV knowledge determined by this survey may be overestimated. The actual level of occupational S&H professionals’ WBV knowledge may be lower than estimated by our survey due to social desirability bias.

The final section of the survey requested information about the participant’s professional characteristics – education, training, experience, and certification. Further analysis of the data will be performed to find and explain relationships between these characteristics and knowledge of WBV. Additional similar surveys of another S&H professional grouping such as the American Industrial Hygiene Association, along with U.S. occupational medicine practitioners, may also provide further crucial insight.

5. Summary

Occupational S&H professionals reporting little or no knowledge of WBV comprised 69.5% of the survey sample, consistent with the original hypothesis. Applying the Great Britain study findings to U.S. demographics, it is estimated that 29 million U.S. workers have occupational WBV exposure. Of these, about 1.2 million may have WBV exposures at potentially significant levels and these at-risk workers may not be adequately supported by occupational S&H professionals with sufficient WBV knowledge.
Based on the extent of potential exposures to the occupational population and the relatively low WBV knowledge levels among surveyed occupational S&H professionals, the need for enhanced WBV education and training is indicated. The low knowledge level inhibits the S&H professional's task in being able to anticipate, recognize, evaluate, and control WBV hazards. An updated WBV exposure assessment for industrial sectors in the United States is indicated and would assist in better targeting S&H education.

Acknowledgement

Gratitude is expressed to the American Society of Safety Engineers for their kind and generous assistance in the distribution of this survey.

References

naiscd2/naics02.htm
Helmut W. Paschold holds B.S. and M.S. degrees in Industrial Engineering with a Ph.D. in Environmental Science and Engineering. He is currently employed as an Assistant Professor in the School of Public Health Sciences & Professions, Ohio University, Industrial Engineering and Environmental Science and Engineering. He is currently employed as an Assistant Professor of Epidemiology and Biostatistics in the School of Public Health Sciences & Professions, Ohio University. Previously, Dr. Paschold was the owner and principle consultant in a safety and health consulting firm. His current research interests include whole-body vibration, indoor air quality, and occupational safety.
Alexander V. Sergeev holds an M.D., Ph.D. in Medical Sciences and M.P.H. in Epidemiology. He is currently an Assistant Professor of Epidemiology and Biostatistics in the School of Public Health Sciences & Professions, Ohio University. Previously, Dr. Sergeev worked at the Institute for Health and the Environment (University at Albany) and the New York State Department of Health. He also taught at a medical school and practiced as an attending physician at a teaching hospital in Russia. Dr. Sergeev’s research interests focus on emerging risk factors of chronic disease and quantitative methods in health research.