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Reliability of O*NET physical exposures between Italian and US databases

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Abstract

Background: Comparison between cross-national job-exposure matrices (JEMs) may provide indications on their reliability, particularly if created using the same items. This study evaluated concordance between two JEMs created from United States (US) and Italian O*NET data, using job codes linked through international job codes.

Methods: 21 physical exposures were obtained from the US and Italian O*NET databases. Italian O*NET items were direct translations of US O*NET items. 684 US and 586 Italian job codes were linked via crosswalks to 281 ISCO-08 job codes. A sensitivity study also assessed concordance on 258 jobs matched one to one across the two national job classifications. Concordance of US and Italian O*NET exposures was estimated by Intraclass Correlation Coefficients (ICC) in multilevel models adjusted and not adjusted for country.

Results: ICCs showed moderate to poor agreement for all physical exposures in jobs linked through ISCO-08 codes. There was good to moderate agreement for 14 out of 21 exposures in models with one-to-one matched jobs between countries; greater agreement was found in all models adjusted for country. Exposure to whole-body vibration, time standing, and working outdoor exposed to weather showed the highest agreement.

Conclusions: These results showed moderate to good agreement for most physical exposures across the two JEMs when US and Italian jobs were matched one-to-one and the analysis was adjusted for country. Job code assignments through crosswalks and differences in exposure levels between countries might greatly influence the observed cross-country agreement. Future multinational epidemiological studies should consider the quality of the cross-national job matching, and potential cross-national differences in exposure levels.

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Keywords

concordance; work; ergonomic factors; cross-national comparison; job-exposure matrix

Background

Job-Exposure Matrices (JEMs) are a common means to estimate exposures in epidemiological surveillance studies and to guide selecting priorities for exposure interventions when no other reliable data is available (Fadel et al., 2019, 2020). JEMs were originally used to impute environmental exposures for cancer health outcomes and more recently used to impute psychosocial (Choi, 2020; Niedhammer et al., 2020) and physical exposures (Boyer et al., 2009; Dale et al., 2015; Madsen et al., 2018). JEMs use job titles to assign exposures, with numerical or ordinal values computed from past known exposure data (Kauppinen et al., 1998). An important feature of JEMs is that their application in epidemiological studies prevents differential misclassification bias of the exposure due to health status, which allows them to be employed in cross-sectional and retrospective studies (Peters, 2020). One drawback of JEMs is that all workers holding the same job title are assigned the same exposure value without accounting for individual differences, thus decreasing within-job variance and attenuating the exposure-outcome relationship.

Several JEMs with exposure to occupational physical factors have been developed in recent years in the US and in different European countries (Solovieva et al., 2012; Garcia et al., 2013; Dale et al., 2015; Evanoff et al., 2019a; Dalbøge et al., 2016; Rubak et al., 2014; Dembe et al., 2014; Descatha et al., 2018). JEMs with physical exposures are often constructed from expert and worker-reported ratings, as data collected by direct or observed methods are too costly and may not capture a representative sample of tasks in complex and variable production jobs (Kilbom, 1994).

In the US, a JEM of physical exposures constructed from the Occupational Network (O*NET) US databases is particularly promising, as O*NET exposure estimates have demonstrated moderate to good agreement with several observed and self-reported ergonomic exposures (Gardner et al. 2010), and good validity in predicting incident carpal tunnel syndrome (CTS) (Dale et al. 2018) and osteoarthritis (Dembe et al., 2014). O*NET contains information on hundreds of physical and mental descriptors on more than 900 occupations, classified according to the US Standard Occupational Classification (SOC), with descriptors on job skills, job knowledge, job activities, and work context (www.onetcenter.org). O*NET databases are available for each occupation with scores for each descriptor to show the level of importance, frequency of activity, or presence of workplace characteristics; scores were assigned either by experts or by self-reports from workers.

JEMs have been used to apply exposure estimates in cross-national studies, although the validity of this method is not well-established for several types of exposures (Cifuentes et al., 2010). Cross-national use of JEMs requires linking job titles between countries to assign the JEM exposure estimates. Linking job titles may create imperfect job matches, thus introducing misclassification of JEM estimates. In addition, past studies comparing agreement of JEMs created by two different countries have had to match JEM items by similarity in exposure type and frequency of occurrence (Evanoff et al., 2019). No studies have had the ability to compare identical JEM items created within two different countries, providing the opportunity to compare the effects of the job title linkage.

In 2013, the new Italian national Survey on Professions incorporated directly translated items from the US O*NET survey into data collection on the national survey (https://inapp.org/it/archivio_rilevazioni/indagine-campionaria-sulle-professioni). The survey sampled workers from identified job codes to provide a sample representative of the general population of workers, and captured the job title in each survey. The data from the O*NET items on the national survey were used to create the Italian O*NET JEM, using the same methods as for creating the US O*NET JEM (www.onetcenter.org). Since the Italian and US O*NET JEMs used identical exposures, the data was available to compare cross-national physical exposures in matched jobs between the US and Italy. The purpose of the study was to assess concordance between physical exposure values on cross-matched jobs using the US O*NET JEM and the Italian O*NET JEM.

Methods

US and Italian O*NET Data

We used data from the US O*NET JEM and the Italian O*NET JEM with jobs that were matched using a crosswalk to the ISCO-08 job codes (http://www.ilo.org/public/english/bureau/stat/isco/docs/draft08.pdf), so the datasets contained the same job categories. The US O*NET is the primary source of occupational information for all US jobs from the US Department of Labor. Data is systematically collected by US federal agencies including the Bureau of Labor Statistics (https://www.dol.gov/agencies/eta/onet) from workers' survey or occupational analyst ratings of 967 job codes based on the US Standard Occupational Classification (SOC) system (SOC 2010). Each year, a random sample of companies in each of the job codes are selected and a random sample of workers from the selected companies are invited to complete one of the surveys. The data collected from workers are used to update the US O*NET databases.

The Italian O*NET JEM was created from interviews of approximately 20 workers for each of 796 job codes of the Italian job code classification system (CP2011). The Italian O*NET items were collected as part of the Italian Survey on Profession (ISP) in 2013, a survey conducted every five years by the National Institute for the Analysis of Public Policies (INAPP) together with the National Institute of Statistics (ISTAT). The sample of workers includes all current professions in the Italian labor market from the private sector, institutions and public sectors, and self-employed.

Three US O*NET domains (Work Abilities, Activities, and Work Context) and corresponding databases provided the data for the 21 physical exposures selected for this study. The items, databases, and scores are shown in Table 1. The Italian O*NET used a direct translation of the questions on each survey from the US O*NET, and collected data from a sample of Italian workers in each job code.

The US O*NET items were collected by two methods: the Abilities domain collected data from occupational experts while the items from the Activities and Work Context domains collected data from worker self-completed questionnaires. The Italian O*NET items for all the three domains (Abilities, Activities, and Work Context) collected data from workers through interviews using the CAPI technique (Computer Assisted Personal Interviewing) as is the methodology used to collect items in the ISP survey.

The scoring of items in the US and Italian O*NET JEMs were identical. Items from the Ability and Activity domains each had two part response scores: a) measure of the importance of the characteristic (range 1 to 5, 1= not important, 5= extremely important), and b) the level of the characteristic (range 1 to 7, anchor responses varied by item). The scores were combined so that a score of "1" on importance (not important) was imputed as a "0" on the level of the characteristic. For analysis, the level scores for each job code were reclassified to range from 0 to 7. The 11 variables from the Work Context domain were scored from 1 to 5 as shown in Table 1.

Crosswalk of US and Italian Job Codes

The US SOC 2010 job code system includes 967 occupations and the Italian CP 2011 job code system contains 796 occupations. To create datasets that contained the same jobs in the US and Italian datasets, we conducted a crosswalk of each country's job codes to the International Standard Classification Code (ISCO-08, 4-digit). The US crosswalk from SOC 2010 to ISCO-08 matched 684 US SOC job codes to 281 ISCO-08 job codes (http://www.bls.gov/soc/soccrosswalks.htm). The Italian crosswalk from CP 2011 to ISCO-08 matched 586 Italian job codes to the same 281 ISCO-08 job codes (http://www.istat.it/it/archivio/18132). The 684 US and 586 Italian occupations that matched to the 281 ISCO-08 job codes were used to create databases with comparable but cross-national jobs. We excluded the jobs from each country's databases that did not match to a common 4-digit ISCO-08 code (excluding 283 SOC 2010 6-digit jobs for US and 210 CP 2011 5-digit jobs for Italy). On average, 5.5 US SOC job codes (range: 1–35), and 4.8 Italian CP job codes (range: 1–33) mapped into each 4-digit ISCO-08 job code.

An example of results of the crosswalk from national job codes into ISCO-08 job codes for Group 8 of the ISCO-08 codes (Plant and Machine Operators and Assemblers) is shown in Supplementary Table 1.

Data analysis—The US O*NET database version 23.2 was downloaded from the O*NET website (https://www.onetcenter.org/db_releases.html), selecting 21 physical exposures as was used in a previous study of physical exposures (Evanoff et al., 2019b).

In the Italian O*NET dataset containing individual level data for approximately 16,000 workers, we computed the mean and standard deviation of each physical exposure from the approximately 20 workers (5–95%: 11–25) for each Italian 5-digit job code (PC 2011). For the analysis, we selected the data of these physical exposures from the US and Italian job codes that matched to the 281 ISCO-08 codes.

First, we assessed the correlation between the mean values of the 21 physical exposures in the US and Italian O*NET JEMs using Spearman’s rho coefficient for ordinal values. Then, we assessed agreement of the items accounting for job groups using the Intraclass Correlation Coefficient (ICC). We assessed the ICC absolute agreement using a two-level random intercept effects models, with exposure scores representing different jobs in the first level, nested within ISCO-08 job codes at the second level. To explore the effects of country, we ran ICCs using a two-level mixed effects model, with exposure scores and country (US or Italy) at the first level (fixed effects), nested within ISCO-08 job codes at the second level (random effects). We interpreted the correlation categories for Spearman rho values as poor <0.40, moderate 0.40–0.70, or good >0.70 (Dancey & Reidy, 2006). The level of agreement for the ICC following Koo & Li (2016) was classified as poor < 0.50, moderate 0.50–0.75, or good >0.75.

In order to assess whether the job matching through ISCO-08 codes, conducted using existing crosswalks linking the Italian and US job classifications, had an influence on agreement between exposure scores in the two JEMs, we conducted a sensitivity analysis restricted only to jobs with one-to-one match between the US and the Italian job codes. This was completed by a manual search and selection by one of the authors, expert in job classification (FG), of US job codes (from SOC 2010) and Italian job codes (from CP 2011) that matched in the two job classifications. The selection of jobs was reviewed by an occupational epidemiologist (AD), and discrepancies between the two experts were solved through discussion. In the sensitivity analysis, agreement was assessed using Spearman’s rho coefficient and ICC as previously described. All analyses were performed using Stata, version 13.

Results

The crosswalk process matched 684 (70.7%) US job codes (SOC 2010) and 586 (73.6%) Italian job codes (CP 2011) to 281 ISCO-08 job codes. Through manual search of the two national job classifications, we identified 258 job codes with one-to-one match between US SOC-2010 6-digit and Italian 5-digit job codes. Table 2 shows the mean and standard deviation scores for each country’s cross-national jobs matched to the 281 ISCO-08 job codes, and for the 258 national job codes with one-to-one matches between US and Italian jobs. We examined comparability between US SOC 6-digit jobs matched through ISCO-08 and those with one-to-one matches with the Italian job classification by conducting a chi-square test on the frequency distribution of SOC 6-digit jobs aggregated at the 2nd digit level of the SOC 2010 code and found no significant differences between the job distributions in each job group (p=0.19). The mean scores shown for the 21 physical exposures were generally higher in the exposure range for the US data than for the Italian data (Table 2), except for a few exposures (dynamic strength, trunk strength, wrist-finger speed) in the 281 ISCO-08 job code dataset, and wrist-finger speed exposure in the 258 job codes with one-to-one job code matches.

Concordance of physical exposures with national jobs matched at ISCO-08

Table 3 shows the comparisons between the US and Italian jobs using all jobs matched to the ISCO-08 job codes (n=281 job codes). Spearman correlation showed strong associations, with 5 good correlations of the physical exposures and 13 moderate correlations of exposures. We found lower agreement using an unadjusted ICC, with 8 exposures in the moderate category, and 13 exposures in the poor category. Agreement improved when we adjusted the ICC analysis to account for country, with 16 exposures in the moderate category and 5 in the poor category.

Concordance of physical exposures with national jobs matched one-to-one

Table 4 shows results of the sensitivity analysis, with the jobs restricted to those with one-to-one match between US and Italian jobs codes. The correlation results were stronger, with 15 exposures in the good category and 5 in the moderate category. Agreement results also improved for the unadjusted ICCs, with 5 exposures having good agreement, 9 having moderate agreement and 7 having poor agreement. The ICC models adjusted for country were also better, with 11 exposures having good agreement, 9 exposures having moderate agreement and 1 having poor agreement. The results in this model showed good agreement across a wide range of exposures including strength (dynamic and static strength), dexterity (manual dexterity, handling and moving objects), interacting with computers, driving vehicles, exposure to vibration, working outdoors, working in some postures (kneeling/crouching/stooping, standing), and using hands. There was consistently poor agreement for the exposure about the importance of repeating same tasks in all models.

Discussion

This study found moderate to good agreement for physical exposure items from the US O*NET JEM and an Italian O*NET JEM derived from a representative sample of workers and jobs in a 2013 national survey. There was stronger agreement across more physical exposure variables when the models were adjusted for country (US and Italy). A sensitivity analysis restricted to one-to-one match between US and Italy job codes showed the strongest agreement, with moderate to good agreement for the majority of the 21 physical exposures. Matching US and Italian jobs through the standard international job codes (ISCO-08) retained about 70% of jobs from each national job database. These results showed that using identical exposures of directly translated items produced reasonable comparative results, and the results were improved when the analysis included directly matched job codes. The improvement in concordance of physical items obtained selecting only one-to-one matches suggests there is heterogeneity of national jobs within ISCO codes, i.e. that the occupations included in each ISCO code in one country do not perfectly correspond to occupations from another country. The crosswalk matches from the national jobs to the ISCO-08 codes show some of the variation in the job titles. There may also be differences in the job activities performed in the same job codes in different countries.

The improvement in agreement estimated by means of ICC after adjusting for country may be due to systematically higher exposure levels in the US JEM compared to the Italian JEM. It is unclear whether the higher exposure observed in the US compared to Italy is actually attributable to higher exposure in US workplaces or to differences in perception or reporting of exposure between the working populations in the two countries. The fact that in the US O*NET data exposure was assessed through expert rating for part of the physical factors examined does not seem to have had an influence, as higher exposure was observed in the US data similarly for self-reported and expert rated variables. However, this finding suggests there is a country effect that should be accounted for in multinational studies.

Our results also suggest it is important to consider the quality of the cross-national job matching when using exposure values from a single JEM in cross-national studies. Assigning JEM exposure values from a JEM created using one country's job coding system may bias exposure value assignment for jobs in a different country unless the differences in the job codes between countries have been explored. Using a crosswalk through an international job code system is helpful but greater accuracy was found when jobs were matched more directly. For studies involving more than one country, accounting for a country effect seems useful and has the benefit of leaving the job rankings unaffected for exposures.

Higher agreement was found for physical factors related to strength and to carrying or manipulating objects, as well as for standing and kneeling, crouching, stooping or crawling, whereas variables related to repetition, wrist-finger speed and awkward postures displayed the lowest level of agreement. Similar findings were reported in a comparison of US O*NET to a French JEM (Evanoff et al., 2019b), with moderate to high agreement for most physical exposures, as well as higher agreement for factors related to intense physical work and for handling/moving objects, bending of the trunk, and kneeling or squatting, and lower agreement for repetitive movements and awkward postures. The higher agreement between the US O*NET and the French Constances JEM estimated for different physical factors using Spearman's rho, compared to weighted kappa, also suggests greater differences in absolute scores than in job ranking between the two JEMs (Evanoff et al., 2019b). The lower level of agreement found in the Evanoff study, compared to our sensitivity analysis, for some physical exposures, such as repetition, vehicle driving, or keyboard use, is possibly attributable to differences between variables used in the construction of the two JEMs, which were similar but did not overlap perfectly. In spite of the efforts made by these authors to thoroughly match French and US job codes, the multistep process employed (from French to ISCO-88 job codes, from ISCO-88 to ISCO-08 job codes, and from ISCO-08 to SOC job codes) may have reduced comparability of the matched jobs between the two countries and, consequently, reduced the level of agreement between exposures in the two JEMs.

Our results appear consistent with the few studies that have assessed inter-method validity of O*NET data, although a smaller number of factors was compared in most of them. Among these, Gardner et al. (2010) found moderate to good agreement between exposure to different physical factors for the upper extremities assigned through O*NET and exposure to the same factors collected through observations, with the strongest level of agreement found for factors related to handling/moving objects and to force, and the lowest for repetitive movements. Also, good agreement has been reported between combined measures of cumulative exposure to physical workload and knee bending assessed through self-reports and O*NET data (Ezzat et al., 2013), while in another study most of O*NET physical exposures examined were moderately to strongly correlated with expert ratings (D'Souza et al., 2007).

Strengths

A main strength of the study was the possibility to evaluate cross-country agreement of exposure to physical factors using two JEMs constructed from identical exposure items, using appropriate statistics (two-level ICC). Furthermore, the whole set of physical factors contained in the O*NET database was evaluated for concordance between the two countries, providing a fuller picture of the reliability of the exposure estimates in the JEMs. Another strength was the ability to compare different sets of jobs obtained through different methods of matching between countries. One method linked jobs to a set of job codes in the widely used ISCO job classifications. A second dataset was restricted only to jobs with direct one-to-one correspondence. The results showed greater comparability of exposures with more direct matching of jobs. Finally, having comparable data from two different countries provided the opportunity to explore a country effect, suggesting difference in jobs, tasks, and exposures unique to each country.

Limitations

The use of the ISCO job crosswalk to obtain a comparable group of jobs between the two countries required a loss of approximately 30% of the jobs in each country. Only 30% of the jobs were retained for the one to one match, suggesting there may be selection bias of jobs in the sensitivity analysis. However, an examination of the distributions (by SOC 2-digit codes) of the 258 SOC jobs with one-to-one match showed no difference from the larger group of jobs crosswalked to the 281 ISCO-08 jobs, indicating that such a selection was unlikely.

An unfavourable characteristic of the O*NET JEM is the lack of physical exposure metrics which are known or suspected risk factors for musculoskeletal disorders. These include postures of specific joints of upper and lower limbs, pinch or grip force, or hand vibration. Since exposure data were self-reported using ordinal scales, it is possible that differing work conditions or perceptions of work between Italy and the USA could have affected reported exposure levels and concordance in exposure estimates between the two countries. Recent data on differential effects of exposures on men and women suggest a need for sex-specific JEMs (Quinn & Smith, 2018). Lastly, the information contained for each item is limited to exposure intensity or frequency on an ordinal scale, which does not allow precise estimation of workers' cumulative exposure, which is relevant in epidemiologic studies, nor to compare their exposure with normative values, which is important for assessing compliance with exposure standards. Further research is needed to establish the correspondence between O*NET values and workplace exposures measured through objective methods, such as observations and direct measurements, for physical factors which pose an increased risk of developing musculoskeletal disorders.

Conclusions

The present study found moderate to good agreement between the US and the Italian O*NET JEMs for exposure to most physical factors at work, but only when the analysis included US and Italian jobs with a one-to-one matching, suggesting that available crosswalks between job classification systems produce imperfect job matches. Adjustment for country produced a further improvement in the agreement estimated by ICCs, as exposure levels in the US O*NET were systematically higher than in the Italian one. Consistent with other studies, variables related to repetitive work and awkward postures were among those showing a lower concordance. Our results provide further evidence on the ability of the O*NET JEMs to assess in a reproducible way exposure to many physical factors at work, indicating that they could be meaningfully employed in epidemiological studies and for priority setting of hazards control.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Description of the O*NET exposures from the US and Italian O*NET databases

Exposure	Domain	Question/definition	Response scale
Dynamic Strength	Abilities	The ability to exert muscle force repeatedly or continuously over time. This involves muscular endurance and resistance to muscle fatigue.	Importance: 1–5 Level: 1–7
Static Strength	Abilities	The ability to exert maximum muscle force to lift, push, pull, or carry objects.	Importance: 1–5 Level: 1–7
Trunk Strength	Abilities	The ability to use your abdominal and lower back muscles to support part of the body repeatedly or continuously over time without 'giving out' or fatiguing.	Importance: 1–5 Level: 1–7
Wrist-Finger Speed	Abilities	The ability to make fast, simple, repeated movements of the fingers, hands, and wrists.	Importance: 1–5 Level: 1–7
Finger Dexterity	Abilities	The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.	Importance: 1–5 Level: 1–7
Manual Dexterity	Abilities	The ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.	Importance: 1–5 Level: 1–7
Handling and Moving Objects	Activities	Using hands and arms in handling, installing, positioning, and moving materials, and manipulating things.	Importance: 1–5 Level: 1–7
Interacting With Computers	Activities	Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.	Importance: 1–5 Level: 1–7
Driving Vehicles, Mechanized Devices, or Equipment	Activities	Running, maneuvering, navigating, or driving vehicles or mechanized equipment, such as forklifts, passenger vehicles, aircraft, or water craft.	Importance: 1–5 Level: 1–7
General Physical Activities	Activities	Performing physical activities that require considerable use of your arms and legs and moving your whole body, such as climbing, lifting, balancing, walking, stooping, and handling of materials.	Importance: 1–5 Level: 1–7
Awkward Positions	Context	How often does this job require working in cramped work spaces that requires getting into awkward positions?	1 (never) to 5 (every day)
Exposed to Whole Body Vibration	Context	How often does this job require exposure to whole body vibration (e.g., operate a jackhammer)?	1 (never) to 5 (every day)
Working Outdoors, Exposed to Weather	Context	How often does this job require working outdoors, exposed to all weather conditions?	1 (never) to 5 (every day)
Working Outdoors, Under Cover	Context	How often does this job require working outdoors, under cover (e.g., structure with roof but no walls)?	1 (never) to 5 (every day)
Time Bending or Twisting the Body	Context	How much does this job require bending or twisting your body?	1 (never) to 5 (all the time)
Time Kneeling, Crouching, Stooping, or Crawling	Context	How much does this job require kneeling, crouching, stooping or crawling?	1 (never) to 5 (all the time)
Time Making Repetitive Motions	Context	How much does this job require making repetitive motions?	1 (never) to 5 (all the time)
Time Standing	Context	How much does this job require standing?	1 (never) to 5 (all the time)

Exposure	Domain	Question/definition	Response scale
Time Using Your Hands	Context	How much does this job require using your hands to handle, control, or feel objects, tools or controls?	1 (never) to 5 (all the time)
Spend Time Walking and Running	Context	How much does this job require walking and running?	1 (never) to 5 (all the time)
Importance of Repeating Same Tasks	Context	How important is repeating the same physical activities (e.g., key entry) or mental activities (e.g., checking entries in a ledger) over and over, without stopping, to performing this job?	1 (not important) to 5 (extremely important)

Table 2.

Descriptive data for 21 O*NET physical exposures of US and Italian jobs matched to 281 ISCO-08 codes and one-to-one match of 258 national job codes

	Cross-national jobs matched to ISCO-08 codes (N=281)[a]				One-to-one match of national jobs (N=258)[b]			
	US O*NET JEM		Italian O*NET JEM		US O*NET JEM		Italian O*NET JEM	
Exposure[c]	Mean (sd)	N. analysts' ratings/ workers	Mean (sd)	N. workers	Mean (sd)	N. analysts' ratings/ workers	Mean (sd)	N. workers
Dynamic strength[$]	1.28 (1.00)	5,464	2.68 (1.46)	11,494	1.25 (1.06)	2,392	0.81 (0.98)	5,266
Static strength[$]	1.69 (1.28)	5,464	1.30 (0.85)	11,494	1.67 (1.33)	2,392	1.09 (1.13)	5,266
Trunk strength[$]	2.05 (1.02)	5,464	2.41 (0.68)	11,494	2.08 (1.06)	2,392	0.94 (1.03)	5,266
Wrist-finger speed[$]	1.22 (0.85)	5,464	1.32 (0.52)	11,494	1.16 (0.88)	2,392	1.25 (0.91)	5,266
Finger dexterity[$]	2.60 (0.73)	5,464	1.00 (0.72)	11,494	2.54 (0.84)	2,392	1.71 (1.21)	5,266
Manual dexterity[$]	2.15 (1.11)	5,464	1.60 (0.84)	11,494	2.11 (1.21)	2,392	1.78 (1.29)	5,266
Handling and moving objects[$]	3.65 (1.56)	18,662	2.45 (0.47)	11,494	3.58 (1.60)	8,196	1.97 (1.32)	5,266
Interacting with computers[$]	2.95 (1.13)	18,717	1.34 (1.42)	11,494	2.93 (1.26)	8,226	2.59 (1.42)	5,266
Driving vehicles or mechanized devices[$]	1.82 (1.26)	18,727	0.65 (0.93)	11,494	1.77 (1.32)	8,233	0.76 (1.13)	5,266
General physical activity[$]	3.02 (1.42)	18,693	0.89 (0.94)	11,494	3.03 (1.51)	8,217	1.26 (1.09)	5,266
Awkward postures[&]	2.03 (0.78)	19,049	2.04 (1.13)	11,494	1.98 (0.79)	8,341	1.35 (0.46)	5,266
Exposed to whole body vibration[&]	1.36 (0.61)	19,076	0.88 (0.91)	11,494	1.35 (0.63)	8,367	1.28 (0.61)	5,266
Working outdoor, exposed to weather[&]	2.29 (1.20)	19,064	1.91 (1.32)	11,494	2.26 (1.22)	8,358	2.09 (1.24)	5,266
Working outdoor, under cover[&]	1.74 (0.67)	19,060	0.80 (1.00)	11,494	1.70 (0.67)	8,359	1.54 (0.67)	5,266
Time bending or twisting the body[&]	2.40 (0.89)	19,032	1.85 (0.76)	11,494	2.34 (0.94)	8,340	1.77 (0.69)	5,266
Time kneeling, crouching, stooping, crawling[&]	1.90 (0.67)	19,042	1.52 (0.62)	11,494	1.89 (0.72)	8,347	1.58 (0.63)	5,266
Time making repetitive motions[&]	3.20 (0.70)	19,007	2.18 (0.93)	11,494	3.12 (0.78)	8,318	2.44 (0.71)	5,266
Time standing[&]	3.15 (1.00)	19,055	3.08 (0.96)	11,494	3.11 (1.00)	8,352	3.06 (0.93)	5,266
Time using hands[&]	3.43 (0.94)	18,986	2.08 (0.83)	11,494	3.39 (0.99)	8,309	3.13 (0.94)	5,266
Time walking and running[&]	2.57 (0.78)	19,036	1.79 (0.62)	11,494	2.53 (0.82)	8,344	2.41 (0.64)	5,266
Importance of repeating same tasks[&]	3.31 (0.63)	18,965	1.58 (1.15)	11,494	3.19 (0.65)	8,304	2.49 (0.47)	5,266

sd = standard deviation

[a]684 US jobs and 586 Italian jobs,

[b] 258 US jobs matched by expert opinion to 258 Italian jobs

For US data only, Dynamic, Static and Trunk Strength, Wrist-finger speed, Finger and Manual dexterity assessed through expert rating. All other US and all Italian exposures were assessed through workers' interview.

Score range: $ = 0 to 7, & = 1 to 5; higher score means greater amount of the exposure

Table 3.

Agreement between US and Italian O*NET scores from national jobs[a] matched to ISCO-08 codes (N=281)

Exposure	Spearman rho	Correlation category[$]	ICC (95% CI)	Level of agreement[#]	ICC (95% CI) adjusted for country	Level of agreement[#]
Dynamic strength	0.77	***	0.48 (0.42–0.54)		0.64 (0.59–0.69)	**
Static strength	0.82	***	0.66 (0.61–0.71)	**	0.68 (0.63–0.73)	**
Trunk strength	0.61	**	0.54 (0.49–0.60)	**	0.56 (0.50–0.61)	**
Wrist-fingers speed	0.49	**	0.49 (0.43–0.55)		0.49 (0.43–0.55)	
Finger dexterity	0.50	**	0.19 (0.15–0.25)		0.45 (0.39–0.51)	
Manual dexterity	0.75	***	0.57 (0.51–0.62)	**	0.62 (0.56–0.67)	**
Handling and moving objects	0.39		0.30 (0.24–0.36)		0.40 (0.34–0.47)	
Interacting with computers	-0.60		0.06 (0.03–0.11)		0.06 (0.03–0.12)	
Driving vehicles or mechanized devices	0.56	**	0.46 (0.40–0.52)		0.61 (0.55–0.66)	**
General physical activity	0.46	**	0.25 (0.20–0.32)		0.54 (0.48–0.59)	**
Awkward postures	0.49	**	0.56 (0.50–0.61)	**	0.56 (0.50–0.61)	**
Exposed to whole body vibration	0.54	**	0.51 (0.45–0.57)	**	0.57 (0.52–0.63)	**
Working outdoor, exposed to weather	0.30		0.49 (0.43–0.55)		0.50 (0.44–0.56)	**
Working outdoor, under cover	0.46	**	0.37 (0.31–0.43)		0.50 (0.45–0.56)	**
Time bending or twisting the body	0.80	***	0.64 (0.59–0.69)	**	0.71 (0.66–0.75)	**
Time kneeling, crouching, stooping, crawling	0.48	**	0.53 (0.48–0.59)	**	0.58 (0.53–0.63)	**
Time making repetitive movements	0.48	**	0.38 (0.32–0.44)		0.54 (0.48–0.59)	**
Time standing	0.63	**	0.66 (0.61–0.71)	**	0.66 (0.61–0.71)	**
Time using hands	0.73	***	0.41 (0.35–0.47)		0.66 (0.61–0.71)	**
Time walking and running	0.51	**	0.37 (0.31–0.44)		0.51 (0.45–0.57)	**
Importance of repeating same tasks	-0.11[b]		0.12 (0.08–0.18)		0.25 (0.20–0.32)	

ICC = Intraclass correlation coefficient

[a] 684 US jobs and 586 Italian jobs,

[b] p>0.05

[$] Correlation category of Spearman rho: poor <0.40, moderate (**) 0.40–0.70, or good (***) >0.70

[#] Level of ICC agreement: poor <0.50, moderate (**) 0.50–0.75, or good (***) >0.75

Table 4.

Agreement between US and Italian O*NET scores from one-to-one match of national job codes (N=258)

Exposure	Spearman rho	Correlation category[$]	ICC (95% CI)	Level of agreement[#]	ICC (95% CI) adjusted for country	Level of agreement[#]
Dynamic strength	0.79	***	0.70 (0.69–0.71)	**	0.77 (0.72–0.82)	***
Static strength	0.84	***	0.71 (0.70–0.72)	**	0.79 (0.74–0.83)	***
Trunk strength	0.79	***	0.33 (0.24–0.45)		0.74 (0.68–0.79)	**
Wrist-fingers speed	0.61	**	0.60 (0.52–0.67)	**	0.60 (0.52–0.68)	**
Finger dexterity	0.73	***	0.44 (0.34–0.54)		0.67 (0.60–0.73)	**
Manual dexterity	0.80	***	0.75 (0.69–0.80)	**	0.78 (0.73–0.82)	***
Handling and moving objects	0.80	***	0.37 (0.27–0.48)		0.79 (0.74–0.83)	***
Interacting with computers	0.81	***	0.78 (0.72–0.82)	***	0.80 (0.76–0.84)	***
Driving vehicles or mechanized devices	0.73	***	0.56 (0.47–0.64)	**	0.82 (0.77–0.85)	***
General physical activity	0.78	***	0.18 (0.09–0.33)		0.72 (0.66–0.77)	**
Awkward postures	0.68	**	0.30 (0.21–0.42)		0.62 (0.54–0.69)	**
Exposed to whole body vibration	0.69	**	0.83 (0.79–0.87)	***	0.84 (0.80–0.87)	***
Working outdoor, exposed to weather	0.80	***	0.82 (0.78–0.86)	***	0.83 (0.79–0.87)	***
Working outdoor, under cover	0.65	**	0.63 (0.55–0.70)	**	0.65 (0.58–0.72)	**
Time bending or twisting the body	0.79	***	0.54 (0.45–0.62)	**	0.72 (0.66–0.77)	**
Time kneeling, crouching, stooping, crawling	0.79	***	0.69 (0.62–0.75)	**	0.78 (0.72–0.82)	***
Time making repetitive movements	0.65	**	0.36 (0.26–0.47)		0.64 (0.57–0.71)	**
Time standing	0.83	***	0.83 (0.79–0.86)	***	0.83 (0.79–0.86)	***
Time using hands	0.82	***	0.78 (0.73–0.82)	***	0.81 (0.77–0.85)	***
Time walking and running	0.71	***	0.67 (0.59–0.73)	**	0.68 (0.61–0.74)	**
Importance of repeating same tasks	0.17		0		0.17 (0.08–0.32)	

ICC = Intraclass correlation coefficient

258 US jobs matched one-to-one by expert opinion to 258 Italian jobs

[$] Correlation category of Spearman rho: poor <0.40, moderate (**) 0.40–0.70, or good (***) >0.70

[#] Level of ICC agreement: poor <0.50, moderate (**) 0.50–0.75, or good (***) >0.75