Computer and Furniture Affecting Musculoskeletal Problems and Work Performance in Work From Home During COVID-19 Pandemic

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Objectives: We surveyed how home-working conditions, specifically furniture and computer use, affected self-reported musculoskeletal problems and work performance. Methods: Questionnaires from 4112 homeworkers were analyzed. The relationship between subjective musculoskeletal problems or work performance and working conditions were determined by logistic regression analyses. Results: More than half the homeworkers used a work desk, work chair, and laptop computer. However, approximately 20% of homeworkers used a low table, floor chair/room cushion, or other furniture that was different from the office setup. Using a table of disproportionate size and height, sofa, floor cushion, and floor chair were associated with neck/shoulder pain or low back pain. Disproportionate table and chair, floor cushion, and tablet computer were associated with poor work performance. Conclusions: Disproportionate desk and chair, floor cushion/room chair, and computer with small screen may affect musculoskeletal problems and home-working performance.

Keywords: work from home, working furniture, low back pain, neck pain, VDT

Telework is a flexible work arrangement in which the employee can work away from the main office and instead work at a private home and satellite office by using information and communication technology. Because of the coronavirus disease 2019 (COVID-19) pandemic, work from home (WFH) has become the new normal around the world. Work from home was suggested to be an effective work style to control the spread of infection, maintain a good work-life balance, and reduce the commuting time. Before the pandemic, WFH was only adopted if home-working conditions, like a home office (desk, chair, computer, etc.), were available. However, the pandemic forced a large number of workers to switch their work style to WFH. The incidence of WFH has increased to 50% since 2020 in Japan. In such a situation, home-working conditions may not be well adapted for an office setup.

The prevalence of musculoskeletal problems in the neck/shoulder and lower back among workers working with visual display terminal (VDT) was reported to be more than 30%. To prevent these health problems, the Ministry of Health, Labour and Welfare in Japan published guidelines for the working environment and health management of VDT workers. The guidelines gave recommendations concerning the working time, furniture (desk and chair), brightness in the room, and health care for VDT workers. The working conditions in the office that were designed according to the guidelines were considered ideal, while the guidelines were difficult to be applied in home-working conditions because of the variety of living furniture and technology devices.

The relationship of working conditions and low back pain of WFH during COVID-19 pandemic was surveyed by previous studies. The desk not well lit, lack of space on the desk, not having enough legroom, etc., were found to be associated with the low back pain, while not using an office desk or chair did not show significant association with the low back pain among homeworkers. There was no detailed information about using living furniture in WFH. In Japan, because of the lifestyle (floor culture) and home space conditions, people seldom have their workspace at home. Living furniture, such as dining table and chair, sofa, etc., would be used in WFH. In addition to this, traditional furniture such as the low table (kotatsu), floor chair (zaisu), and floor cushion (zabuton), which are much different from western furniture, is still widely used in Japanese families. A recent study showed that working with a floor cushion or sofa without a table developed stressful postures to the neck and lower back. There may be some living furniture, which is improper for the health of homeworkers and also affect the work performance. It is important to survey what kind of furniture and computers are used in WFH since the COVID-19 pandemic and the relationship between the home-working conditions and musculoskeletal problems as well as the work performance. As WFH becomes a common workstyle these days, managing health care and work performance of homeworkers are urgent topics. Therefore, the purpose of the study was to survey home-working conditions, especially the living furniture and computer use in terms of how furniture and computer use affects self-reported musculoskeletal problems and work performance for homeworkers.

METHODS

Research Design

The cross-sectional study was conducted among employees working in a major insurance company in Japan through an anonymous, self-administered questionnaire. More than 80% of company employees were WFH since the COVID-19 pandemic, and their jobs varied widely from sales to information technology (IT). The questionnaire was sent via email to 8000 homeworkers in September 2021. The study was approved by the ethics committee of the National Institute of Occupational Safety and Health in Japan (approval number: 2021N11). All participants provided confirmation of informed consent before answering the questionnaire.

Questionnaire

The questionnaire collected data on the baseline characteristics of homeworkers, their work conditions, self-reported musculoskeletal problems, and work performance during their WFH setup. Baseline characteristic included sex, age, height, weight, job description, working hours per day (working time), days of WFH per week (working frequency), and number of breaks per hour (Table 1). Working conditions focused on the type of furniture (desk and chair) and computer used. Specifically, “desk” was subdivided into “work desk/PC desk,” “dining table,” “low table (kotatsu),” and “other tables (side table, kids’ desk, etc),” “Chair” was subdivided into “work chair with backrest,” “dining chair,” “sofa,” “floor chair with backrest,” “floor cushion without backrest,” and “other chairs (chair without backrest and arm
TABLE 2. Baseline Characteristics of Homeworkers

| N = 4112 | % |
|----------|---|
| Sex, %  |   |
| Male    | 46.9 |
| Female  | 53.1 |
| Age, y  |      |
| <40     | 26.3 |
| ≥40, <50| 39.1 |
| ≥50     | 34.7 |
| Height, cm |       |
| <150    | 2.3 |
| ≥150, <160| 27.3 |
| ≥160, <170| 36.1 |
| ≥170, <180| 27.7 |
| ≥180    | 4.6 |
| Weight, kg |      |
| <40     | 0.6 |
| ≥40, <50| 16.8 |
| ≥50     | 27.9 |
| ≥60, <70| 24.3 |
| ≥70, <80| 16.3 |
| ≥80, <90| 6.3 |
| ≥90     | 2.7 |
| Job description | |
| Sales   | 27.4 |
| Damage claims | 30.6 |
| Operation | 21.9 |
| IT      | 3.6 |
| Admin and others (finance, consumer service, etc) | 16.5 |
| Working time in WFH, h/d | |
| ≤7      | 25.3 |
| >7, ≤8  | 31.3 |
| >8, ≤9  | 20.8 |
| >9      | 22.6 |
| WFH frequency, d/wk | |
| <1 d    | 5.3 |
| ≥1, <2 d| 3.0 |
| ≥2, <3 d| 9.7 |
| ≥3, <4 d| 16.4 |
| ≥4, <5 d| 15.4 |
| ≥5 d    | 50.3 |
| No. breaks per hour | |
| Almost 0| 28.0 |
| 1 or 2 times | 58.9 |
| 3–5 times | 10.4 |
| >5 times | 1.8 |

Support, highchair, etc). “Computer” was classified as “desktop computer,” “laptop computer,” “laptop computer with additional monitor,” and “other computers (tablet computer, smartphone, etc).” With regard to work conditions, homeworkers were asked to select the option that was the most frequently used during WFH (eg, using dining table, dining chair, and laptop computer in most of work time but sometimes work with sofa and laptop computer would select dining table, chair, and laptop computer in the questionnaire). Self-reported musculoskeletal problems referred to the history of pain in the neck/shoulder and lower back during the WFH period. The severity of pain was evaluated by our original scale where 4 grades were considered according to previous studies: grade 0 (no pain), grade 1 (pain not interfering with work), grade 2 (pain interfering with work), and grade 3 (pain interfering with work and leading to sick leave). Grade 0 was defined as “pain-free,” grade 1 was defined as “mild pain,” and grade 2 and 3 were combined and defined as “severe pain.” Subjective work performance was evaluated by asking about the feelings of working in the home conditions compared with the office using the following 5-point scale: “high,” “slightly high,” “same,” “slightly low,” and “low.” Of these, “high,” “slightly high,” and “same” were categorized as good work performance, while “slightly low” and “low” were categorized as poor work performance.

Statistical Analyses

Received questionnaires that had missing information on sex, age, and self-reported musculoskeletal problems were excluded for analysis. The descriptive information for each variable was assessed by simple tabulation presenting the proportion in percentages. To determine the association between work conditions and musculoskeletal problems and work performance, logistic regression analyses were used. Dependent variables were the severity of pain (three levels; pain-free, mild pain, severe pain) in the neck/shoulder and lower back, and work performance (2 levels; good performance, bad performance). Individual variables were sex (2 levels; male, female), age (3 levels; <40, 40–49, ≥50 years), working time (4 levels; ≤7, >7 but ≤8, >8 but ≤9, >9 hours), desk (4 levels; working desk/PC desk, dining table, low table, other tables), chair (6 levels; working chair with backrest, dining chair, sofa, floor chair, floor cushion, other chairs), and computers (4 levels; desktop computer, laptop computer, laptop computer with additional monitor, other computers), where the sex, age, and working time were defined as adjusters. Odds ratio (OR) and 95% confidence interval (95% CI) were calculated for each variable. SPSS (version 28; IBM Corp, Armonk, NY) was used for analysis. Statistical significance was set at a P value less than 0.05 and odds ratio greater than 1.5.

RESULTS

A total of 4711 homeworkers completed the questionnaires (response rate, 58.9%). Among these, 4112 questionnaires from 1930 males and 2182 females were included in the analysis.

Baseline Characteristics of Homeworkers

Table 1 provides the baseline characteristics of homeworkers. Most homeworkers (39.1%) were in the 40- to 49-year-old age group. Those belonging to the younger than 40-year group accounted for 26.3%, while those older than 50 years comprised 34.7%. In terms of working time, 31.3% reported working more than 7 hours but less than or equal to 8 hours, 25.3% reported working less than or equal to 7 hours, 22.6% reported working more than 9 hours, and 20.8% reported working more than 8 hours but less than 9 hours. The average working time was 8.37 ± 1.8 hours per day, whereas the prescribed working time of 7 hours, 22.6% reported working more than 9 hours, and 20.8% reported working more than 8 hours but less than 9 hours. The average working time was 8.37 ± 1.8 hours per day, whereas the prescribed working time in the company was only 7 hours. Most respondents (58.9%) reported having 1 or 2 breaks per hour. Twenty-eight percent

TABLE 2. Working Conditions of Homeworkers

| N = 4112 | % |
|----------|---|
| Desk     |   |
| Work desk/PC desk | 63.2 |
| Dining table | 18.6 |
| Low table | 12.9 |
| Other tables | 5.3 |
| Chair    |   |
| Work chair with backrest | 55.7 |
| Dining chair | 21.1 |
| Sofa     | 2.3 |
| Floor chair | 5.6 |
| Floor cushion | 6.0 |
| Other chairs | 9.2 |
| Computer |   |
| Desktop computer | 23.5 |
| Laptop computer | 50.0 |
| Laptop computer with additional monitor | 23.9 |
| Other computers | 2.6 |
| Combinations (>5%) |   |
| Work desk + work chair + laptop computer | 20.6 |
| Work desk + work chair + desktop computer | 14.7 |
| Work desk + work chair + laptop computer with additional monitor | 13.4 |
| Dining table + dining chair + laptop computer | 9.2 |

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TABLE 3. Self-Reported Musculoskeletal Problems and Work Performance in the WFH Setup

| N = 4112 | % |
|----------|---|
| Neck/shoulder pain | |
| Grade 0 (no pain) | 28.1 |
| Grade 1 (pain not interfering with work) | 50.5 |
| Grade 2 (pain interfering with work) | 19.3 |
| Grade 3 (pain leading to sick leave) | 2.1 |
| Low back pain | |
| Grade 0 (no pain) | 32.5 |
| Grade 1 (pain not interfering with work) | 47.1 |
| Grade 2 (pain interfering with work) | 18.3 |
| Grade 3 (pain leading to sick leave) | 2.2 |
| Work performance | |
| High | 11.8 |
| Slightly high | 11.5 |
| Same | 32.8 |
| Slightly low | 32.3 |
| Low | 9.1 |

reported no break time during WFH (28.0%), and 1.8% had more than 5 breaks per hour. In terms of WFH frequency, half of respondents (65.7%) reported having 4 or more days of WFH per week, and only 8.3% reported less than 2 days. Body height, weight, and job description are listed in Table 1.

Working Conditions

Table 2 illustrates the working conditions among homeworkers. The most common desk used in the WFH setup was a work desk/personal computer (PC) desk (63.2%), followed by a dining table (18.6%), and a low table (12.9%). Homeworkers who chose “other tables” provided specific answers such as kids’ desk, camping table, side table, cabinet, and so on. More than half of homeworkers used a work chair with backrest (55.7%), followed by a dining chair (21.1%). The number of those who used a floor chair with backrest and a floor cushion without backrest were 5.6% and 6.0%, respectively. Few homeworkers used a sofa (2.3%). “Other chairs” accounted for 9.2% of all answers, and these included an exercise ball, kids’ chair, camping chair, etc. Half the homeworkers (50.0%) used a laptop computer without additional monitor, whereas 23.5% used a desktop computer, and 23.9% used a laptop computer with an additional monitor. There were 2.6% of homeworkers who used a tablet computer or smartphone. The most common combination of chair, and computer was a work desk, work chair, and laptop computer (20.6%), followed by the combination of a work desk, work chair, and desktop computer (14.7%); work desk, work chair, and laptop computer with additional monitor (13.4%); and a dining table, dining chair, and laptop computer (9.2%).

Musculoskeletal Problems and Work Performance

Table 3 presents the musculoskeletal problems and work performance during WFH. In terms of pain in the neck/shoulder, 28.1% of homeworkers reported being pain-free, whereas 50.5% experienced mild pain and 21.4% experienced severe pain. For low back pain, 62% of homeworkers reported being pain-free, whereas 50.5% experienced mild pain and 20.5% experienced severe pain. The percentage of good performance was 56.1% and poor performance was 43.9%.

Association Between Neck/Shoulder Pain and Working Conditions

Table 4 presents the result of logistic regression analysis on the association between neck/shoulder pain and working conditions.

TABLE 4. The Association Between Neck/Shoulder Pain and Working Conditions in the WFH Setup

| Pain Free (n = 1156) | Mild Neck/Shoulder Pain (n = 2077) | Severe Neck/Shoulder Pain (n = 879) | % | % OR 95% CI | % OR 95% CI | % OR 95% CI |
|---------------------|-----------------------------------|-----------------------------------|---|-------------|-------------|-------------|
| Sex Male | 65.6 | 40.5 | 1.00 | 3.11 | 2.62–3.69 | <0.001*** | 37.5 | 1.00 | 62.5 | 4.47 | 3.62–5.51 | <0.001*** |
| Female | 34.4 | 59.5 | 1.00 | 3.11 | 2.62–3.69 | <0.001*** | 37.5 | 1.00 | 62.5 | 4.47 | 3.62–5.51 | <0.001*** |
| Age, y | | | | | | | | | | | | |
| <40 | 25.2 | 27.4 | 1.00 | | | | | | | | | |
| ≥40, <50 | 38.4 | 39.0 | 0.94 | 0.78–1.14 | 0.554 | | | | | | |
| ≥50 | 36.4 | 33.6 | 1.08 | 0.88–1.31 | 0.480 | | | | | | |
| Working time, h/d | | | | | | | | | | | | |
| ≤7 | 25.9 | 27.0 | 1.00 | | | | | | | | |
| >7, ≤8 | 32.3 | 31.9 | 1.23 | 1.00–1.50 | 0.046* | | | | | | |
| >8, ≤9 | 19.7 | 21.0 | 1.56 | 1.24–1.97 | <0.001*** | | | | | | |
| >9 | 22.1 | 20.1 | 1.56 | 1.24–1.98 | <0.001*** | | | | | | |
| Desks | | | | | | | | | | | | |
| Work desk/PC desk | 69.8 | 61.1 | 1.00 | | | | | | | | |
| Dining table | 14.1 | 20.1 | 1.11 | 0.86–1.44 | 0.416 | | | | | | |
| Low table | 11.4 | 13.7 | 0.74 | 0.49–1.13 | 0.163 | | | | | | |
| Other tables | 4.7 | 5.1 | 1.15 | 0.80–1.65 | 0.466 | | | | | | |
| Chair | | | | | | | | | | | | |
| Work chair | 62.7 | 52.8 | 1.00 | | | | | | | | |
| Dining chair | 16.3 | 23.1 | 1.33 | 1.04–1.69 | 0.023* | | | | | | |
| Sofa | 1.5 | 2.8 | 1.89 | 1.05–3.41 | 0.034* | | | | | | |
| Floor chair | 5.5 | 5.5 | 1.49 | 0.92–2.40 | 0.104 | | | | | | |
| Floor cushion | 4.1 | 7.2 | 2.23 | 1.33–3.74 | 0.002** | | | | | | |
| Other chairs | 9.9 | 8.6 | 0.95 | 0.71–1.26 | 0.706 | | | | | | |
| Computer | | | | | | | | | | | | |
| Desktop computer | 24.5 | 23.6 | 1.00 | | | | | | | | |
| Laptop computer | 48.4 | 50.0 | 1.11 | 0.92–1.35 | 0.268 | | | | | | |
| Laptop computer with additional monitor | 23.6 | 24.0 | 1.15 | 0.93–1.43 | 0.198 | | | | | | |
| Other computers | 3.5 | 2.4 | 0.80 | 0.51–1.27 | 0.341 | | | | | | |

*P < 0.05; ***P < 0.01; ****P < 0.001.
during the WFH setup. Female workers were approximately 3 times more likely to develop mild neck/shoulder pain (OR, 3.11; CI, 2.62–3.69) and approximately 4 times more likely to develop severe neck/shoulder pain (OR, 4.47; CI, 3.62–5.51) compared with their male coworkers. Prolonged working time showed a higher risk for neck/shoulder pain. A working time of more than 9 hours was associated with both mild and severe low back pain. Use of “other tables” showed a significant association with severe neck/shoulder pain (OR, 3.74) and sofa (OR, 1.89; CI, 1.05–3.41) were associated with mild neck/shoulder pain. The age of homeworkers and the type of computer were not significantly associated with either the mild or severe neck/shoulder pain.

**Association Between Low Back Pain and Working Conditions**

Table 5 presents the result of logistic regression analysis on the association between low back pain and working conditions during WFH. Female workers showed a higher risk for developing both mild and severe low back pain (OR, 2.02; CI, 1.33–2.86), and “other computers” (OR, 1.59; CI, 1.59–3.71) were associated with the poor work performance during WFH.

**DISCUSSION**

The study provided an overview of home-working conditions by focusing on the furniture and computer and determined their associations with self-reported musculoskeletal problems and subjective work performance in WFH during the COVID-19 pandemic. Neck/shoulder pain and low back pain were the common complaints in the WFH setup. Female sex and long working hours were associated with more musculoskeletal problems compared with male sex and working 7 hours or less. These findings were consistent with previous studies. More than half of the homeworkers used a work desk, work chair, and laptop computer. However, a considerable proportion of homeworkers also used dining tables and chairs, low tables and floor chairs/floor cushions, and even other furniture different from those used in the typical office setup. Using a work desk and chair, dining table and chair, desktop computer, and laptop computer were considered acceptable setups for WFH, because no association with musculoskeletal problems or poor performance was found. Use of other tables, sofas, floor chairs, floor cushions, and other computers were found to be associated with the neck/shoulder pain, low back pain, and poor work performance among homeworkers.

**TABLE 5. The Association Between Low Back Pain and Working Conditions in the WFH Setup**

| Conditions | Pain Free (n = 1335) | Mild Low Back Pain (n = 1937) | Severe Low Back Pain (n = 840) |
|------------|---------------------|-----------------------------|-----------------------------|
| %          | %                   | OR 95% CI P                  | %                           | OR 95% CI P                  | %                           | OR 95% CI P                  |
| **Sex**    |                     |                             |                             |                             |                             |                             |
| Male       | 54.8                | 43.5 1.00                   | <0.001***                   | 42.3 1.00                   | 57.7 2.08 1.71–2.54         | <0.001***                   |
| Female     | 45.2                | 56.5 1.73 1.47–2.02         | <0.001***                   | 57.7 2.08 1.71–2.54         | <0.001***                   |
| **Age, y** |                     |                             |                             |                             |                             |                             |
| <40        | 25.3                | 27.3 1.00                   | 25.4 1.00                   | 36.5 0.87 0.70–1.10         | 25.4 1.00                   | 36.5 0.87 0.70–1.10         |
| ≥40, <50   | 39.0                | 40.2 0.92 0.77–1.10         | 0.377                       | 38.1 1.14 0.90–1.44         | 28.8 1.00                   | 38.1 1.14 0.90–1.44         |
| ≥50        | 35.7                | 32.5 0.91 0.75–1.10         | 0.314                       | 38.1 1.14 0.90–1.44         | 28.8 1.00                   | 38.1 1.14 0.90–1.44         |
| **Working time, h/d** | |                             |                             |                             |                             |                             |
| ≤7         | 28.2                | 24.7 1.00                   | 22.4 1.00                   | 25.4 1.00                   | 36.5 0.87 0.70–1.10         | 25.4 1.00                   |
| >7, ≤58    | 32.1                | 32.0 1.30 1.08–1.57         | 0.007**                     | 28.2 1.31 1.03–1.67         | 21.9 1.89 1.44–2.48         | <0.001***                   |
| >8, ≤59    | 19.3                | 21.4 1.61 1.29–2.00         | <0.001***                   | 21.9 1.89 1.44–2.48         | <0.001***                   |
| ≥9         | 20.4                | 21.9 1.70 1.36–2.12         | <0.001***                   | 21.9 1.89 1.44–2.48         | <0.001***                   |
| **Desks**  |                     |                             |                             |                             |                             |                             |
| Work desk/PC desk | 68.9                | 61.6 1.00                   | 57.7 1.00                   | 20.7 1.25 0.93–1.67         | 14.8 0.86 0.53–1.41         | 6.8 1.70 1.12–2.57         |
| Dining table | 16.4                | 19.1 1.16 0.92–1.48         | 0.215                       | 20.7 1.25 0.93–1.67         | 14.8 0.86 0.53–1.41         | 6.8 1.70 1.12–2.57         |
| Low table  | 10.6                | 13.7 0.68 0.45–1.03         | 0.068                       | 14.8 0.86 0.53–1.41         | 6.8 1.70 1.12–2.57         | 0.012*                     |
| Other tables | 4.0                 | 5.6 1.40 0.98–1.99         | 0.067                       | 6.8 1.70 1.12–2.57         | 14.8 0.86 0.53–1.41         | 6.8 1.70 1.12–2.57         |
| **Chair**  |                     |                             |                             |                             |                             |                             |
| Work chair | 61.4                | 54.2 1.00                   | 50.1 1.00                   | 23.3 1.19 0.90–1.57         | 21.9 1.89 1.44–2.48         | 0.007**                     |
| Dining chair | 19.3                | 21.4 1.06 0.85–1.33         | 0.690                       | 23.3 1.19 0.90–1.57         | 21.9 1.89 1.44–2.48         | 0.007**                     |
| **Sofa**   |                     |                             |                             |                             |                             |                             |
| Floor chair | 2.0                 | 2.2 1.11 0.66–1.86         | 0.709                       | 3.1 1.49 0.82–2.69         | 6.5 2.29 1.29–4.04         | 0.004**                     |
| Floor cushion | 4.3                | 6.1 2.26 1.40–3.65         | <0.001***                   | 6.5 2.29 1.29–4.04         | 6.5 2.29 1.29–4.04         | 0.004**                     |
| Other chairs | 9.0                 | 9.0 1.10 0.83–1.44         | 0.517                       | 6.5 2.29 1.29–4.04         | 6.5 2.29 1.29–4.04         | 0.004**                     |
| **Computer** |                   |                             |                             |                             |                             |                             |
| Desktop computer | 24.4                | 23.8 1.00                   | 21.4 1.00                   | 24.4 1.00                   | 24.4 1.00                   | 24.4 1.00                   |
| Laptop computer | 47.7                | 51.0 1.09 0.91–1.31         | 0.352                       | 24.4 1.00                   | 24.4 1.00                   | 24.4 1.00                   |
| Laptop computer with additional monitor | 24.9                | 22.9 0.95 0.78–1.17         | 0.646                       | 24.4 1.00                   | 24.4 1.00                   | 24.4 1.00                   |
| Other computers | 3.0                 | 2.3 0.84 0.53–1.34         | 0.465                       | 2.7 1.08 0.62–1.90         | 2.7 1.08 0.62–1.90         | 0.784                       |

*P < 0.05; **P < 0.01; ***P < 0.001.*
The Association Between Work Performance and Working Conditions During WFH

| Sex          | Good Performance (n = 2306) | Poor Performance (n = 1806) | %   | %   | OR  | 95% CI | P     |
|--------------|-----------------------------|-----------------------------|-----|-----|-----|-------|-------|
| Male         |                             |                             | 49.7| 43.5| 1.00|       |       |
| Female       |                             |                             | 50.3| 56.5| 1.24| 1.08–1.43| 0.002**|

| Age, y       |                             |                             | 26.6| 25.8| 1.00|       |       |
| <40          |                             |                             |     |     |     |       |       |
| ≥40, <50     |                             |                             | 40.5| 37.2| 0.92| 0.78–1.08| 0.293 |
| ≥50          |                             |                             | 32.9| 37.0| 1.20| 1.01–1.42| 0.039**|

| Working time, h/d | %   | %   | OR  | 95% CI | P     |
|-------------------|-----|-----|-----|-------|-------|
| ≥7                | 23.6| 27.6| 1.00|       |       |
| >7, ≤8            | 32.2| 30.1| 0.86| 0.72–1.02| 0.075 |
| >8, ≤9            | 21.8| 19.6| 0.86| 0.71–1.04| 0.115 |
| >9                | 22.5| 22.7| 1.04| 0.86–1.26| 0.701 |

| Desks             | %   | %   | OR  | 95% CI | P     |
|-------------------|-----|-----|-----|-------|-------|
| Work desk/PC desk | 69.3| 55.3| 1.00|       |       |
| Dining table      | 16.4| 21.3| 1.17| 0.95–1.44| 0.139 |
| Low table         | 10.1| 16.6| 1.32| 0.93–1.87| 0.122 |
| Other tables      | 4.2 | 6.8 | 1.59| 1.18–2.13| 0.002**|

| Chair             | %   | %   | OR  | 95% CI | P     |
|-------------------|-----|-----|-----|-------|-------|
| Work chair        | 62.5| 47.0| 1.00|       |       |
| Dining chair      | 18.6| 24.4| 1.42| 1.16–1.73| <0.001***|
| Sofa              | 2.0 | 2.8 | 1.47| 0.95–2.26| 0.084 |
| Floor chair       | 4.9 | 6.5 | 1.35| 0.96–2.01| 0.144 |
| Floor cushion     | 4.2 | 8.4 | 1.88| 1.24–2.86| 0.003**|
| Other chairs      | 11.0| 14.0| 1.49| 1.18–1.90| 0.001**|

| Computer          | %   | %   | OR  | 95% CI | P     |
|-------------------|-----|-----|-----|-------|-------|
| Desktop computer  | 26.3| 19.9| 1.00|       |       |
| Laptop computer   | 46.3| 54.7| 1.39| 1.18–1.63| <0.001***|
| Laptop computer with additional monitor | 23.7 | 21.6 | 1.11 | 0.92–1.33 | 0.293 |
| Other computers   | 1.7 | 3.8 | 2.43| 1.59–3.71| <0.001***|

*P < 0.05; **P < 0.01; ***P < 0.001.

Use of “other tables” was found to be significantly associated with severe neck/shoulder and severe low back pain. This option mainly consisted of small desks with a disproportionate height, such as side tables, counter tables, kid’s desks, camping tables, dressers, and so on. This finding supported the previous studies, which reported that lack of space on the desk is associated with higher odds of low back pain among homeworkers.8,9 The desk plays an important role when working in a sitting position because it provides support and carries the weight of the arms and upper torso. A sitting position without arm support was reported to increase the load on the lumbar spine16 and may increase the risk of low back pain. The height difference between the desk and the seat affects arm posture and the load on the shoulders.16 A desk height above the elbow results in arm abduction while working, and this increases the muscle active contraction of the deltoids. On the other hand, a desk height lower than the elbow results in static contraction of the shoulder muscles while supporting the weight of the upper arms. Prolonged stressful posture leads to muscle fatigue and poor work posture, which may ultimately result in musculoskeletal problems. In addition to this, the desk height also determines the location of the display, hence affecting the neck angle. A neck flexion angle greater than 25 degrees is a critical zone according to the ISO 11226 ergonomics evaluation of static working.17 Improper postures when using “other tables” with disproportionate size and height is a possible reason for severe neck/shoulder pain or low back pain.

Floor chairs and floor cushions are traditional furniture common in Japanese homes. However, this furniture was found to be associated with musculoskeletal problems. Using floor cushions and sofas was found to have a high risk for mild neck/shoulder pain. After conducting a study on working postures in VDT work with various furniture including floor chair, floor cushion, and sofa, results showed that the neck flexion angle when using a sofa and a floor cushion was significantly larger when compared with using a dining chair.19 Specifically, the neck angle created when using a sofa was in the critical zone of the ISO 11226 standard.17 The poor posture on using sofas and floor cushions may explain the high risk of mild neck/shoulder pain in the WFH setup. Using the floor chairs and cushions were found to increase the risk twofold for developing severe low back pain compared with work chair. A recent experimental study showed that the lower back flexion angles when using a floor cushion or floor chair were in the stressful range of motion.20 Without a backrest to support the weight of the upper body when seated on a floor cushion, the stressful low back flexion would be a harmful posture that can lead to the development of low back pain. This is supported by the guidelines for VDT work published by the Ministry of Health, Labour and Welfare, which recommends that chair height should be 37 to 43 cm with a free space under the seat for the movement of lower limbs.7 None of the floor chairs nor the floor cushions satisfy this requirement.

ISO evaluation of static working postures17 also did not recommend low limbs postures of extreme hip and knee angles that occur while sitting with a floor chair or cushion due to the health risks. These documents indicate a risk of health problems when working on a floor chair or cushion.

The type of computer was found to have no association with neck/shoulder pain or low back pain in the present study. This is opposite to the previous epidemiology studies, which reported that using laptop computers is associated with neck pain.18,19 In addition, a study reported that the location of the computer monitor (not in front of the operator) is associated with low back pain.14 Experimental studies10,20 reported that using a laptop computer developed a large angle of neck flexion compared with using a desktop computer. However, the neck
flexion angle of using a laptop computer was suggested to be in the critical range of neck pain only in a setup without a proper desk. 21,22 Besides, using an adjuster to elevate the screen height and modify the keyboard location of a laptop computer was reported to reduce the neck flexion angle and relative muscle activities. 21 No significant association between computers and neck pain or low back may be due to part of the participants in the present study using proper furniture and adjusters. Future cohort studies that controls tables, monitor location, and adjuster devices should be conducted to investigate the effect of computer on musculoskeletal problems among homeworkers. Poor performance in the WFH setup was associated with the use of “other tables,” floor cushions, and “other computers.” “Other tables” included tables that were not designed for work or for adults, such as kids’ desk, camping tables, dresser tables, foldable tables, and so on. “Other computers” included tablet computers and smartphones. These are seldom used in the office setup. Homeworkers may be unfamiliar with using these furniture and devices, feel uncomfortable, 21,22 and find it difficult to focus on the work. This result suggests that a work setup different from the office setup would decrease subjective perception of work performance. Using a work desk and chair, dining set, low table and floor chair, desktop computer, or a laptop computer with an additional monitor would be a way to ensure good performance in the WFH setup. The main limitation in the present study was that the survey was conducted in only one insurance enterprise, although the age, height, weight, and job description of the sample were extensive and varied. Future studies should be conducted to examine enterprises in other fields. The musculoskeletal problems and work performance may be varied across income, jobs, and work fields. It is possible that lower incomes and smaller rooms may result in more homeworkers using disproportionate tables and chairs. Accordingly, specific work conditions associated with musculoskeletal problems may be identified, and the health promotion of homeworkers can be discussed in detail. The second limitation was that this was a cross-sectional study. The results cannot determine whether the working conditions associated with musculoskeletal problems are the cause or the result of the WFH setup. Follow-up studies for the same population or a comparison study between the office condition and WFH should be conducted to examine the risk factors and solutions for musculoskeletal problems associated with WFH. The third limitation is that the musculoskeletal problems and work performance reported in the present study were collected based on the self-reported data. Because no clinical documents on the musculoskeletal problems were required, its prevalence may be lower than the self-reported data. Similarly, no provision was made to evaluate the work performance among post graduate students. Int J Physiother Res. 2017;5:2271–2275.

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