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Addressing health inequities: validating the Chinese-WSF28 workstyle for work-related musculoskeletal symptoms among cleaners

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Abstract

Background This pioneering study examined the psychometric properties of workstyle related to work-related musculoskeletal symptoms (WRMS) among cleaners, a neglected workforce. Like many low-income, low-skilled workers, cleaners have unique workstyles. This research assessed the Workstyle-Short Form (WSF) to identify WRMS in various body parts among cleaners.

Methods 433 cleaners were surveyed in the study. The items were modified from Chinese-WSF24 (C-WSF24) and new items were added according to the unique working environment of Chinese cleaners. A scale with 33 items of the workstyle was rigorously analysed for its psychometric properties through content validity, factor analysis, known group validity and convergent validity.

Results A panel of 13 experts reviewed the scale over three rounds until a consensus was reached. Factor analysis generated a four-factor solution using exploratory factor analysis, which included working through pain, social reactivity at work, demands at work and breaks. This solution comprised 28 items and accounted for 46.12% of the total variance. The overall results of the confirmatory factor analysis further support this hypothesized factor structure, supported by the Workstyle Model. Validation against known groups also showed that the Chinese-WSF28 (C-WSF28) can discriminate between cleaners with and without WRMS in various body parts. Furthermore, C-WSF28 demonstrated convergent validity through statistically significant association with factors contributing to WRMS.

Conclusion The C-WSF28 is a valid instrument, enabling comprehensive measurement of cleaners' workstyle and facilitating rigorous evaluation of workstyle interventions for enhanced outcomes.

Keywords Cleaners, Construct validity, Factor analysis, Work-related musculoskeletal symptoms, Workstyle

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Introduction

Work-related musculoskeletal symptoms (WRMS) are a global health concern, significantly limiting workers' productivity and well-being [1]. Cleaners face unique challenges, working in unpredictable environments—such as extreme weather outdoors [2] or ergonomically unfavorable conditions indoors [3, 4]. Their tasks often require excessive force, involve repetitive movements like sweeping and mopping, and may necessitate awkward postures [3, 5]. Additionally, many cleaners work alone [6, 7] with limited equipment [3, 8]. Consequently, approximately 47–90% of street, institutional, or hospital cleaners experience one or more WRMS [3, 9, 10, 11, 12, 13].

Research suggests that WRMS are associated with workers' workstyle [14, 15, 16, 17, 18, 19, 20]. The Workstyle Model by Feuerstein [17] defines workstyle as a worker's response to hectic work demands, influenced by physical tasks, job stressors, workplace culture, interpersonal relationships, and the exposure to ergonomic and psychological risks [21]. Adverse workstyles, such as working through discomfort and not reporting unfavorable conditions, contribute to WRMS and functional limitations [17, 21, 22]. Cleaners, often part of the low-income, low-skilled workforce, are more likely to endure pain due to financial pressures and job insecurity [23]. Therefore, an appropriate assessment tool is essential to identify cleaners' specific workstyles, yet most existing instruments do not accommodate their unique circumstances.

Feuerstein and Nicholas [21] developed an English-version 32-item self-report Workstyle-Short Form (E-WSF32) for upper extremity WRMS among office workers in the United States. The E-WSF includes seven subscales: "Working through pain" (6 items), "Social reactivity at work" (5 items), "Limited workplace support" (4 items), "Deadline pressure" (4 items), "Self-imposed workplace/workload" (3 items), "Breaks" (2 items) and "Mood autonomic" (8 items). It demonstrated good reliability ($\alpha = 0.89$) and test-retest reliability ($r = .88$). Moreover, E-WSF32 showed significant positive correlations with musculoskeletal discomfort ($p < .01$); upper extremity symptoms ($p < .01$); functional limitation ($p < .01$) and a negative correlation with overall physical health ($p < .01$).

The E-WSF32 was translated into Chinese and assessed among Chinese cooks in Hong Kong with upper extremity WRMS [24]. Factor analyses revealed six subscales, retaining four from the original: "Working through pain" (6 items), "Social reactivity at work" (5 items), "Self-imposed workplace/workload" (3 items) and "Breaks" (2 items). The subscales "Limited workplace support" (4 items) and "Deadline pressure" (4 items) were combined into "Workplace Stressors" (8 items). The "Mood autonomic" (8 items) was renamed "Responses to increased work demand" (8 items). This Chinese-version WSF

(C-WSF32) showed good reliability with Cronbach alphas ranging from 0.71 to 0.91 except "Break" (0.65) and "Self-imposed workplace/workload" (0.69), accounting for 62.49% of the total variance. And demonstrating good construct and discriminant validity.

The E-WSF32 was further assessed for its psychometric properties among office workers with upper extremity WRMS in Malaysia [18]. This assessment resulted in a 24-item E-WSF (E-WSF24) with four subscales: "Working through pain" (7 items), "Demand at work" (11 items), "Over-commitment" (4 items) and "Breaks" (2 items). E-WSF24 showed good reliability, with Cronbach alphas ranging from 0.81 to 0.93, and explained 62.6% of the total variance [18]. It also demonstrated construct validity with the total score and the subscales were significantly correlated with upper extremity WRMS ($p < .01$).

Recognizing that labor-intensive jobs like nursing and cleaning involve the whole body, Cheung and colleagues [14] modified the C-WSF32 to assess body parts such as the neck, back, and lower extremities. This modified Chinese version, the 24-item C-WSF24, was evaluated among nursing assistants in Hong Kong and included four subscales: "Working through pain" (6 items), "Social reactivity at work" (4 items), "Demand at work" (12 items), and "Breaks" (2 items). The C-WSF24 demonstrated good reliability, with Cronbach alphas ranging from 0.86 to 0.93, except for "break" (0.55), and accounted for 56.45% of the total variance. While the WSF has seen widespread use, further studies across different occupations, like cleaning, are needed to assess its psychometric properties. This study aims to address this gap by determining the psychometric properties of the modified C-WSF24 for cleaners.

Methods

Design and participants

This cross-sectional survey study recruited cleaners using convenience sampling from outreach programs organized by Caritas Community Development Service (CCDS) across four Hong Kong districts: Kwai Tsing, Southern, Central and Western, and Eastern. Cleaners working in public refuse collection points, industrial buildings, shopping centers, or residential buildings were invited to complete a questionnaire at CCDS centers or their workstations. A total of 463 Chinese cleaners participated, although 30 questionnaires were invalid and excluded. The individuals who did not understand Chinese were excluded from the study. The study received approval from the Institutional Review Board. Research personnel explained the study's objectives and ensured participants of the questionnaire's confidentiality, stating that responses would remain anonymous and not be reported to employers. Completing the survey implied participants' consent to participate.

Table 1 Summary of the revised 33-item WSF for cleaners derived from the original C-WSF24

Nursing Home Workers C-WSF-24 (24 items)		Cleaners – 33 items		Change
Q1. I keep working when I feel aching or discomfort, so that the quality of my work will not be affected. 我會在疼痛、不舒適的情況下繼續工作，這樣才不會影響我的工作質量。	Q1. I keep working when I feel aching or discomfort, so that the quality of my work will not be affected. 我會在疼痛、不舒適的情況下繼續工作，這樣才不會影響我的工作質量。	Q1. I keep working when I feel aching or discomfort, so that the quality of my work will not be affected. 我會在疼痛、不舒適的情況下繼續工作，這樣才不會影響我的工作質量。	Q1. I keep working when I feel aching or discomfort, so that the quality of my work will not be affected. 我會在疼痛、不舒適的情況下繼續工作，這樣才不會影響我的工作質量。	✓ (Q1)
Q2. My neck/shoulders/hands/arms/back/hips/thighs/calves/feet get tired at work 在工作時，我的頸/肩膀/雙手/雙臂/背/臀/大小腿/膝蓋/腳會感到疲勞。	Q2. My neck/shoulders/hands/arms/back/hips/thighs/calves/feet get tired at work 在工作時，我的頸/肩膀/雙手/雙臂/背/臀/大小腿/膝蓋/腳會感到疲勞。	Q2. My neck/shoulders/hands/arms/back/hips/thighs/calves/feet get tired at work 在工作時，我的頸/肩膀/雙手/雙臂/背/臀/大小腿/膝蓋/腳會感到疲勞。	Q2. My neck/shoulders/hands/arms/back/hips/thighs/calves/feet get tired at work 在工作時，我的頸/肩膀/雙手/雙臂/背/臀/大小腿/膝蓋/腳會感到疲勞。	✓ (Q2)
Q3. I feel aching while at work 在工作時，我會感到疼痛。	Q3. I feel aching while at work 在工作時，我會感到疼痛。	Q3. I feel aching while at work 在工作時，我會感到疼痛。	Q3. I feel aching while at work 在工作時，我會感到疼痛。	✓ (Q3)
Q4. As I do not know how to relieve my aching neck/ shoulders/ hands/ arms/ back/ hips/ thighs/feet, I keep on working with pain. 因為我對自己的頸/上肢/腰背/下肢痛毫無辦法，所以只能忍痛繼續工作。	Q4. As I do not know how to relieve my aching neck/ shoulders/ hands/ arms/ back/ hips/ thighs/feet, I keep on working with pain. 因為我對自己的頸/上肢/腰背/下肢痛毫無辦法，所以只能忍痛繼續工作。	Q4. As I do not know how to relieve my aching neck/ shoulders/ hands/ arms/ back/ hips/ thighs/feet, I keep on working with pain. 因為我對自己的頸/上肢/腰背/下肢痛毫無辦法，所以只能忍痛繼續工作。	Q4. As I do not know how to relieve my aching neck/ shoulders/ hands/ arms/ back/ hips/ thighs/feet, I keep on working with pain. 因為我對自己的頸/上肢/腰背/下肢痛毫無辦法，所以只能忍痛繼續工作。	✓ (Q4)
Q5. I do not know how to eliminate or relieve various symptoms of my neck/shoulders/hands/arms/back/hips/thighs/calves/feet. 我實在沒有辦法消除或緩解自己頸/上肢/背/下肢所出現的各種症狀。	Q5. I do not know how to eliminate or relieve various symptoms of my neck/shoulders/hands/arms/back/hips/thighs/calves/feet. 我實在沒有辦法消除或緩解自己頸/上肢/背/下肢所出現的各種症狀。	Q5. I do not know how to eliminate or relieve various symptoms of my neck/shoulders/hands/arms/back/hips/thighs/calves/feet. 我實在沒有辦法消除或緩解自己頸/上肢/背/下肢所出現的各種症狀。	Q5. I do not know how to eliminate or relieve various symptoms of my neck/shoulders/hands/arms/back/hips/thighs/calves/feet. 我實在沒有辦法消除或緩解自己頸/上肢/背/下肢所出現的各種症狀。	✓ (Q5)
Q6. My neck/upper extremities/back/lower extremities (over or more places) may make some abrupt, fierce, fast or sudden movements. 我的頸/上肢/背/下肢(其中一處或多處)會做一些急促、猛烈、快速、突然的動作。	Q6. My neck/upper extremities/back/lower extremities (over or more places) may make some abrupt, fierce, fast or sudden movements. 我的頸/上肢/背/下肢(其中一處或多處)會做一些急促、猛烈、快速、突然的動作。	Q6. My neck/upper extremities/back/lower extremities (over or more places) may make some abrupt, fierce, fast or sudden movements. 我的頸/上肢/背/下肢(其中一處或多處)會做一些急促、猛烈、快速、突然的動作。	Q6. My neck/upper extremities/back/lower extremities (over or more places) may make some abrupt, fierce, fast or sudden movements. 我的頸/上肢/背/下肢(其中一處或多處)會做一些急促、猛烈、快速、突然的動作。	✓ (Q6)
Q7. I cannot interrupt my work because my other team members will be unhappy with me. 我不能中途停工，因為這樣做會讓其他同事對我有意見。	Q7. I cannot interrupt my work because my other team members will be unhappy with me. 我不能中途停工，因為這樣做會讓其他同事對我有意見。	Q7. I cannot interrupt my work because my other team members will be unhappy with me. 我不能中途停工，因為這樣做會讓其他同事對我有意見。	Q7. I cannot interrupt my work because my other team members will be unhappy with me. 我不能中途停工，因為這樣做會讓其他同事對我有意見。	New item
Q8. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q8. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q8. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q8. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	New item
Q9. I cannot interrupt my work because my boss will be unhappy with me. 我不能中途停工，因為這樣做會讓上司對我有意見。	Q9. I cannot interrupt my work because my boss will be unhappy with me. 我不能中途停工，因為這樣做會讓上司對我有意見。	Q9. I cannot interrupt my work because my boss will be unhappy with me. 我不能中途停工，因為這樣做會讓上司對我有意見。	Q9. I cannot interrupt my work because my boss will be unhappy with me. 我不能中途停工，因為這樣做會讓上司對我有意見。	New item
Q10. I cannot interrupt my work because the public/citizens will be unhappy with me. 我不能中途停工，因為這樣做會讓公眾/市民對我有意見。	Q10. I cannot interrupt my work because the public/citizens will be unhappy with me. 我不能中途停工，因為這樣做會讓公眾/市民對我有意見。	Q10. I cannot interrupt my work because the public/citizens will be unhappy with me. 我不能中途停工，因為這樣做會讓公眾/市民對我有意見。	Q10. I cannot interrupt my work because the public/citizens will be unhappy with me. 我不能中途停工，因為這樣做會讓公眾/市民對我有意見。	✓ (Q7) Modified
Q11. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q11. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q11. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q11. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	New item
Q12. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q12. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q12. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q12. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	New item
Q13. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q13. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q13. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	Q13. I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工，因為這樣做會讓上司失望或增加他的負擔。	✓ (Q8)
Q14. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q14. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q14. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q14. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	✓ (Q10) Modified
Q15. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q15. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q15. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	Q15. I cannot interrupt my work, because it would affect my appraisal, promotion, and/or cause me to lose my job. 我不能中途停工，因為這樣做會影響我的評估、晉升、和/或讓我丟掉工作。	✓ (Q11)
Q16. Although I have worked very hard, I still do not know whether my work has been duly recognized. 儘管我在工作中付出了很大努力，但我還是真的不知道我的工作是否得到應有的認同。	Q16. Although I have worked very hard, I still do not know whether my work has been duly recognized. 儘管我在工作中付出了很大努力，但我還是真的不知道我的工作是否得到應有的認同。	Q16. Although I have worked very hard, I still do not know whether my work has been duly recognized. 儘管我在工作中付出了很大努力，但我還是真的不知道我的工作是否得到應有的認同。	Q16. Although I have worked very hard, I still do not know whether my work has been duly recognized. 儘管我在工作中付出了很大努力，但我還是真的不知道我的工作是否得到應有的認同。	✓ (Q12) Modified

Table 1 (continued)

Nursing Home Workers C-WSF-24 (24 items)		Cleaners – 33 items	Change
Q13. If I have not finished my work, my boss will give me a hard time. 如果我沒完成自己的工作, 上司不會讓我好過。		Q17. If I have not finished my work, my boss will give me a hard time. 如果我沒完成自己的工作, 上司不會讓我好過。	✓ (Q13)
Q15. I feel very depressed, as my boss' expectations on the quality of work are different from mine. 上司或其他人對工作質量的要求與我不同, 這一點讓我感到很沮喪。		Q18. I feel very depressed, as my boss' expectations on the quality of work are different from mine. 上司或其他人對工作質量的要求與我不同, 這一點讓我感到很沮喪。	✓ (Q15)
Q16. I have too many deadlines and I can never finish my work. 我的工作有太多的最後期限, 所以工作總是做不完。		Q19. I have too much work and I can never finish it. 我有太多的工作, 總是做不完。	✓ (Q16) Modified
Q17. Although I arrange my work in good order so that I can finish it before the deadline, things change so frequently that I have to work even harder to finish it on time. 儘管我會有條理地安排自己的工作, 以便能夠在最後期限前完成工作, 但情況在不斷變化, 自己還是要更加努力地工作, 以便按時完成。		Q20. Although I arrange my work in good order so that I can finish it before the deadline, things change so frequently that I have to work even harder to finish it on time. 儘管我會有條理地安排自己的工作, 以便能夠在最後期限前完成工作, 但情況在不斷變化, 自己還是要更加努力地工作, 以便按時完成。	✓ (Q17)
Q18. My work schedule is hard to control. 我的工作時間表很難控制。		Q21. I find it is hard to control my work schedule. 我很難控制自己的工作時間。	✓ (Q18) Modified
Q19. I feel pressure at work. 我在工作時會感到壓力。		Q22. I feel pressure at work. 我在工作時會感到壓力。	✓ (Q19)
Q20. I motivate myself to work harder and set up targets that are higher than those my boss and other colleagues have expected. 工作中我會敦促自己, 確立自己的表現高於上司和其他人的預期目標。		Q23. I motivate myself to work harder and set up targets that are higher than others (the public/citizens/Food and Environmental Hygiene Department) have expected. 工作中我會敦促自己, 確立自己的表現高於其他人(市民大眾/食環署)的預期目標。	✓ (Q20) Modified
Q22. Others tell me to slow down and not to work so intensely. 別人會告訴我應該放慢節奏, 工作不要那麼拼命。		Q24. Weather (good or bad) and littering cause me to take up more work. 天氣好壞或市民隨地拋垃圾, 我就得承擔更多的工作。	New item
		Q25. Others tell me to slow down and not to work so intensely. 別人會告訴我應該放慢節奏, 工作不要那麼拼命。	✓ (Q22)
		Q26. I often do my best because I have expectations for myself. 我經常都會做到最好, 因為我對自己有要求。	New item
		Q27. At work, I need to work alone. 在工作時, 我需要獨自工作。	New item
		Q28. I believe that the inadequate provision of tools by the company affects my work quality and progress. 我認為公司提供的工具不足而影響我的工作質量或進度。	New item
		Q29. I keep working under the inadequate provision of tools by the company so that my work quality will not be affected. 我會在公司提供之工具不足情況下繼續工作, 這樣才不會影響我的工作質量。	New item
		Q30. If workers' rights are exploited, I will not communicate it to the supervisor because this would have no effect. 若然勞工權益被剝削時, 我不會向主管反映, 因為這根本起不了什麼作用。	New item
		Q31. I have no time at all for breaks because everything must be completed on time. 我完全沒有時間小休, 因為每件事都必須準時做妥。	New item
		Q32. During my regular workday I take breaks to do some stretches. 在日常工作期間, 我會中途停下來休息, 做做伸展運動。	✓ (Q23)
		Q33. While at work I occasionally stop working to take a break. 在工作時, 我會不時停下來休息。	✓ (Q24)

Table 1 (continued)

Nursing Home Workers C-WSF-24 (24 items)

Deleted Q9, Q14 and Q21.

Cleaners – 33 items

Change

Modification of C-WSF24

The modification of the C-WSF24 involved three rounds of expert panel reviews, including cleaners, using the Delphi technique [25] to reach a consensus to evaluate its content validity. The panel consisted of one occupational researcher, three nurses, one psychological researcher, two social workers, and five cleaners. They assessed each item for relevance, clarity, and comprehensiveness. Three items were removed as they did not apply to cleaners, while six items were modified to better reflect their workstyle. Additionally, twelve new items were added, such as “If I report my musculoskeletal problems to the supervisor, it seems I cannot handle the work.” The final 33-item version achieved a content validity index of 1.00.

This revised WSF was pilot tested [26, 27] by five cleaners to ensure appropriateness and readability, confirming that it was clear, relevant, and easy to understand. For a summary of the revised 33-item WSF compared to the C-WSF24, please refer to Table 1.”

Measurement

Besides the 33-item WSF, the study questionnaire included three more parts, details below:

Part one: Personal Information. Personal information included age, marital status, gender, education level, self-rated health condition, work capability, work ability and job-related information.

Part two: Factors Associated with WRMS. Job stress and satisfaction were measured using a single item—the cleaners were asked if they were satisfied or felt stressed with their work, rated on a 4-point Likert scale (0 = very unsatisfied/not at all stressful and 4 = very satisfied/very stressful). Intention to leave was assessed with dichotomous responses regarding whether the cleaners had considered quitting their job. Additionally, cleaners rated their current work ability on a scale from zero (completely no work ability) to ten (completely full ability) [14].

Part three: WRMS and Severity Level. Self-reported musculoskeletal symptoms, like pain, aches or discomfort, in various body parts were measured by the Nordic Musculoskeletal Questionnaire (NMQ) [28]. The Chinese version of the NMQ was used [14, 15, 16, 30]. Participants were asked to rate the severity of each body part’s symptoms in the previous month with a 5-point Likert scale (1 = very light while 5 = very serious). The sum of the severity level of all body-part symptoms was calculated, with high scores denoting greater seriousness of the overall WRMS [14]. The NMQ is widely used to determine the prevalence of musculoskeletal symptoms among various working populations [3, 11, 28, 29] and to evaluate the effectiveness of intervention programs in managing these symptoms [20, 29, 30].

Data analyses

Data were analyzed using IBM SPSS Statistics version 26. The construct validity of the modified 33-item WSF for cleaners was evaluated through four methods: (1) exploratory factor analysis with principal component extraction (eigenvalue > 1) [31] and varimax rotation to assess factor structure; (2) confirmatory factor analysis (CFA) to validate the hypothesized factor structure identified in the exploratory analysis, ensuring that the data fit the proposed model; (3) known-groups validity [32] to test the hypothesis that mean scores for cleaners with WRMS would be higher than those without; and (4) convergent validity by examining relationships between the WSF and WRMS-associated factors.

Normality was tested using the Shapiro–Wilk test ($p < .05$), indicating non-normal distribution. Non-parametric statistics, including Spearman's rho and the Mann–Whitney U test, were applied, with significance set at $p < .05$. Bonferroni correction was used to adjust significance levels for known-groups (12 comparisons, $p < .004$) and convergent validity (24 comparisons, $p < .002$) to mitigate the risk of type I errors.

Results

Participants' characteristics

433 valid questionnaires were used for the analysis. The average age of the cleaners was 62.3 (S.D.=8.52) and the majority of them were female ($n=305$, 71.3%), married ($n=325$, 75.9%), with primary school education ($n=206$, 50.4%). Majority of them were employed by out-sourced contractors ($n=385$, 91.2%), direct employed ($n=20$, 4.7%) and self-employed ($n=17$, 4%). The average working experience with a current cleaning job of 5.42 years (S.D.=8.52). 89.9% ($n=383$) of them were satisfied with their jobs, 39.1% ($n=167$) of them felt stressed with their jobs, 17.3% ($n=73$) had thought of resigning and 76.1% ($n=322$) were sure that they could continue working at their current position for two more years. On the 0–10-point scale, the cleaners reported a medium level of physical rigor of the job (mean = 4.8; S.D.=2.35) and high current work capability (mean = 7.71; S.D.= 1.67).

Approximate half of them perceived they had good overall health status ($n=255$, 59.9%), physical health status ($n=237$, 55%), mental health status ($n=277$, 64.7%), sleeping quality ($n=218$, 50.6%) and eating habit ($n=335$, 78.5%). However, nearly half participants reported that they had poor exercise habits ($n=186$, 43.4%) and 45.2% ($n=190$) of them reported they never do exercise. For lifestyle, there were only 14.3% ($n=61$) smokers and 7% ($n=30$) alcoholics. Only 20.9% ($n=89$) were injured from work in the last 12 months and 81% ($n=332$) felt satisfied with the occupational safety provided by employers. Table 2 shows the details.

Exploratory factor analysis

Table 3 shows the results of the factor analysis. The significant value of $p < .001$ for Bartlett's test of sphericity demonstrated relationships between the items, indicating that factor analysis was appropriate for the collected data. Additionally, the Kaiser–Meyer–Olkin test score of 0.865 indicated adequate sampling, suggesting a medium probability of yielding distinct and reliable factors [33]. Pairwise deletion was used to handle missing data, allowing cases with non-missing values to be included in the analysis of other variables [34]. There was less than 10% missing data in the current study. Goretzko [35] noted that the number of factors can be accurately determined by all methods when 10% of the data is missing.

Initially, eight factors were generated automatically; however, four factors consisted of fewer than four items. Only the two-item factor for “Break” was retained, as it was consistently found in all WSF versions, including E-WSF32 [21], C-WSF32 [24], E-WSF24 [18], and C-WSF24 [14]. As a result, five factors with 33 items were identified: the first factor (Q1-6, Q8-9), the second factor (Q7, 10–15, Q17-18), the third factor (Q16, Q19-22, Q28-31), the fourth factor (Q23-27), and the last factor (Q32-33).

The reliability of the first factor (Q1-6, Q8-9), second factor (Q7, 10–15, Q17-18), and third factor (Q16, Q19-22, Q28-31) were 0.854, 0.884, and 0.748, respectively, which are acceptable. However, the reliability of the fourth factor (Q23-27) and the last factor (Q32-33) were 0.596 and 0.572, respectively, indicating poor reliability. Although the last factor (Q32-33) had a low reliability of 0.572, the corrected item-total correlation for this factor was 0.401, greater than 0.3, suggesting that each of these two items correlated well with the overall subscale [36]. In contrast, the corrected item-total correlation for the fourth factor (Q23-27) ranged from 0.227 to 0.489, indicating that not all items were above 0.3, suggesting they might not correlate well with the total of this subscale [33].

After reviewing the content of these items, Q23, Q24, Q26, and Q27 were newly added and modified in the revised version. Consequently, these four items were deleted, and the remaining 29 items underwent analysis again. Seven factors were generated, with three factors consisting of fewer than four items, along with the factor containing Q32 and Q33. Ultimately, four factors were identified: the first factor (Q1-6, Q8-9), the second factor (Q7, 10–15, Q17-18), the third factor (Q16, Q19-22, Q28-31), and the last factor (Q32, Q33). The cutoff criterion for factor loading was set at less than 0.3. Consequently, item Q25 was removed from the analysis due to its factor loading falling below this threshold.

The four-factor solution accounted for 46.1% of the total variance, with eigenvalues greater than one. Based

Table 2 Demographic information of the participants (N=433)

		N	%		
Gender	Male	123	28.7		
	Female	305	71.3		
Age	31–40	6	1.4	Mean	S.D.
	41–50	35	8.1	62.25	8.52
	51–60	134	30.9		
	61–70	180	41.6		
	71–80	70	16.2		
	> 80	8	1.8		
Marital Status	Single/Divorced/Window/Other	103	24.1		
	Married	325	75.9		
Education	No school	70	17.1		
	Primary school	206	50.4		
	Secondary school	128	31.3		
	Tertiary or above	5	1.2		
Employment mode	Direct employed	20	4.7		
	Out-sourced	385	91.2		
	Self-employed	17	4		
Years of Working Experience in the Current Job				Mean	S.D.
Current Job Satisfaction				5.42	5.85
	unsatisfied	43	10.1		
	satisfied	383	89.9		
Current Job Stress	relaxed	260	60.9		
	stressed	167	39.1		
Thoughts of Resigning	no	350	82.7		
	yes	73	17.3		
Continue Working at Current Position for two more years	no	12	2.8		
	not sure	89	21		
	yes	322	76.1		
Perceived Physical Health Status	Poor	47	10.9		
	Fair	147	34.1		
	Good	237	55		
Perceive Mental Health Status	Poor	37	8.6		
	Fair	114	26.6		
	Good	277	64.7		
Perceived Sleep Quality	Poor	118	27.4		
	Fair	95	22		
	Good	218	50.6		
Perceived Eating Habits	Poor	23	5.4		
	Fair	69	16.2		
	Good	335	78.5		
Perceived Exercise Habits	Poor	186	43.4		
	Fair	95	22.1		
	Good	148	34.5		
Overall Perceived Health Status	Poor	30	7		
	Fair	141	33.1		
	Good	255	59.9		
Smoking Habits	Non-smoker	366	85.7		
	Smoker	61	14.3		
Drinking Habits	Non-alcoholic	396	93		
	Alcoholic	30	7		
Exercise	Never	190	45.2		
	Seldom	84	20		

Table 2 (continued)

	<i>N</i>	%		
	Sometimes	69	16.4	
	Always	77	18.3	
			Mean	S.D.
Level of Physical Rigor of the Job (0–10)			4.8	2.35
Current Work Capability (0–10)			7.71	1.67

on the main themes of loaded items and relevant literature [18, 21, 24], the Chinese WSF with 28 items (C-WSF28) identified the following factors: the first (Q1-6, Q8-9) as “work through pain,” the second (Q7, 10–15, Q17-18) as “social reactivity at work,” the third (Q16, Q19-22, Q28-31) as “demand at work,” and the last (Q32-33) as “break.” Reliability scores for the subscales were acceptable: “work through pain” (0.854), “social reactivity” (0.884), and “demand at work” (0.711), while the reliability of “break” was lower at 0.572, consistent with previous studies [14]. Overall, the reliability of the 28 items was high at 0.876. Among the subscales, “work through pain,” “social reactivity,” and “demand at work” were significantly correlated ($p < .01$), whereas “break” did not correlate significantly with the other factors.”

Table 4 shows the floor and ceiling effects, along with item-total correlations for the C-WSF28. All items had ceiling effect values below 20%, indicating no ceiling effect, but all items exhibited floor effects exceeding 20%. Item-total correlations ranged from 0.284 to 0.632, except for Items 32 and 33, which had correlations of 0.125 and 0.014, respectively. The acceptable threshold is 0.2 or above [37].

Confirmatory factor analysis

The results of the model fit indices include: (1) χ^2/df : $889.95/344 = 2.59$, this is < 3 indicates a perfect fit [39]; (2) RMSEA: 0.06, this is within the range of 0.05 and 0.08, suggesting a good fit [38, 39]; (3) CFI: 0.86, this is close to a good fit of 0.90, suggesting an acceptable fit [38]; (4) TLI: 0.84 and IFI: 0.86, both are also close to a good fit of 0.90, suggesting an acceptable fit [38, 39]. Thus, the overall CFA results support the hypothesized factor structure identified in the exploratory analysis, ensuring that the data fit the proposed model.

Known-groups validity

The total and subscale scores of the C-WSF28 significantly discriminate cleaners with and without WRMS in various body parts and in at least one body part, except for the upper back. Additionally, cleaners with WRMS in various body parts and in at least one body part, excluding the upper back and legs, reported higher levels of “Working through pain” compared to those without WRMS ($p < .001$).

Furthermore, cleaners with low back ($p < .001$), knee ($p < .001$), and at least one body part with WRMS ($p < .001$) reported significantly higher “Social Reactivity.” Those with wrist ($p < .001$) and lower back WRMS ($p < .001$) also experienced higher “Demand at work” levels than those without. Cleaners with at least one body part with WRMS ($p < .001$) showed significantly higher levels of adverse “Break” than those without WRMS. For the total scores, cleaners with WRMS experienced higher adverse workstyle levels ($p < .001$) except for the upper back, hip/thigh, and legs. Details are provided in Table 5.

Convergent validity - relationships between the Chinese WSF28 for cleaners and WRMS-associated factors

Table 6 illustrates the relationship between the total score of the C-WSF28 for cleaners and WRMS-associated factors. The employment mode showed no significant correlation with all subscales of workstyle and the total workstyle score. The total workstyle score, along with the subscales “Working through pain,” “Social reactivity,” and “Demand at work,” showed significant positive associations with self-rated job physical rigor and job stress. Additionally, higher scores in these areas were linked to thoughts of resigning and negatively correlated with job satisfaction. Current working capacity was also negatively related to total workstyle and the subscales “Working through pain” and “Social reactivity.”

Regarding perceived health status, cleaners reporting better physical health, mental health, sleeping quality and overall health status had significantly lower total workstyle scores across the subscales “Working through pain,” “Social reactivity,” and “Demand at work,” all with $p < .001$.

The total scores and subscale scores of the C-WSF28 were positively associated with WRMS severity levels, except for the “Break” subscale. For “Working through pain,” higher adverse workstyle levels correlated with severity in all body parts ($p < .001$), except for the thigh and legs. “Social reactivity” scores were positively associated with severity in the neck, shoulder, and arms ($p < .001$), while “Demand at work” scores were positively associated with severity in the neck, upper back, and ankles ($p < .001$). Overall, total workstyle scores correlated positively with severity in neck, shoulders, arms, upper and lower back, knees and ankles ($p < .001$). The number of body parts with WRMS was also significantly

Table 3 Factor structure of the C-WSF28 after principal component analysis using varimax rotation

Work through pain Q1-6, Q8-9 (8 items)		Factor loading	Variance 15.387	Cronbach's 0.854
Q1.	I keep working when I feel aching or discomfort, so that the quality of my work will not be affected. 我會在疼痛、不舒適的情況下繼續工作, 這樣才不會影響我的工作質量。	0.684		
Q2.	My neck/shoulders/hands/arms/back/hips/thighs/calves/feet get tired at work. 在工作時, 我的頸/肩膀/雙手/雙臂/背/臀/大小腿/膝蓋/腳會感到疲勞。	0.767		
Q3.	I feel aching while at work. 在工作時, 我會感到疼痛。	0.843		
Q4.	As I do not know how to relieve my aching neck/ shoulders/ hands/ arms/ back/ hips/thighs/ calves/feet, I keep on working with pain. 因為我對自己的頸/上肢/腰背/下肢痛毫無辦法, 所以只能忍痛繼續工作。	0.816		
Q5.	I do not know how to eliminate or relieve various symptoms of my neck/ shoulders /hands /arms /back /hips /thighs /calves /feet. 我實在沒有辦法消除或緩解自己頸/上肢/背/下肢所出現的各種症狀。	0.701		
Q6.	My neck/upper extremities/back/lower extremities (over or more places) may make some abrupt, fierce, fast or sudden movements. 我的頸/上肢/背/下肢(其中一處或多處)會做一些急促、猛烈、快速、突然的動作。	0.431		
Q8.	I will take medicine to reduce muscle and bone tension or pain, which can maintain my work ability. 我會服藥來減低肌肉筋骨緊張或痛楚, 這樣能維持我的工作能力。	0.514		
Q9.	I feel exhausted every day. 我每天都感到筋疲力盡。	0.687		
Social reactivity at work Q7, Q10-15, Q17-18 (9 items)			15.122	0.884
Q7.	If I tell my boss about my muscle and bone problems, it would seem like I can't handle my job. 若然我對上司說出自己的肌肉筋骨問題, 這就會看似我不能勝任自己的工作。	0.42		
Q10.	I can't stop working halfway because doing so would make my boss have an opinion about me. 我不能中途停工, 因為這樣做會讓上司對我有意見。	0.676		
Q11.	I can't stop working halfway because doing so would make the Food and Environmental Hygiene Department staff have an opinion about me. 我不能中途停工, 因為這樣做會讓食環署職員對我有意見。	0.771		
Q12.	I can't stop working halfway because doing so would make the public/citizens have an opinion about me. 我不能中途停工, 因為這樣做會讓公眾/市民對我有意見。	0.778		
Q13.	I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工, 因為這樣做會讓上司失望或增加他的負擔。	0.816		
Q14.	I can't stop working halfway because doing so would make the public/citizens complain about me and/or make me lose my job. 我不能中途停工, 因為這樣做會讓公眾/市民投訴我和/或讓我失去工作。	0.758		
Q15.	If I take a break from work for relaxation or physical exercises, my colleagues/boss will be unhappy with me. 如果我關心自己的健康而放下工作, 放鬆一下或做運動, 我的上司會對我有意見。	0.644		
Q17.	If I have not finished my work, my boss will give me a hard time. 如果我沒完成自己的工作, 上司不會讓我好過。	0.608		
Q18.	I feel very depressed, as my boss' expectations on the quality of work are different from mine. 上司或其他人對工作質量的要求與我不同, 這一點讓我感到很沮喪。	0.427		
Demand at work Q16, Q19-22, Q28-31 (9 items)			10.329	0.711
Q16.	Despite my great efforts at work, I really don't know if my work is appreciated. 儘管我在工作中付出了很大努力, 但我還是真的不知道我的工作是否得到肯定。	0.432		
Q19.	I have too much work and I can never finish it. 我有太多的工作, 總是做不完。	0.583		
Q20.	Although I arrange my work in good order so that I can finish it before the deadline, things change so frequently that I have to work even harder to finish it on time. 儘管我會有條理地安排自己的工作, 以便能夠在最後期限前完成工作, 但情況在不斷變化, 自己還是要更加努力地工作, 以便按時完成。	0.536		
Q21.	I find it hard to control my working hours. 我很難控制自己的工作時間。	0.57		
Q22.	I feel pressure at work. 我在工作時會感到壓力。	0.333		

Table 3 (continued)

Work through pain Q1-6, Q8-9 (8 items)		Factor loading	Variance 15.387	Cronbach's 0.854
Q28.	I think the lack of tools provided by the company affects my work quality or progress. 我認為公司提供的工具不足而影響我的工作質量或進度。	0.586		
Q29.	I will continue to work even if the company does not provide enough tools, so as not to affect my work quality. 我會在公司提供之工具不足情況下繼續工作, 這樣才不會影響我的工作質量。	0.617		
Q30.	If workers' rights are exploited, I won't report to my supervisor because it won't make any difference. 若然勞工權益被剝削時, 我不會向主管反映, 因為這根本起不了什麼作用。	0.456		
Q31.	I have absolutely no time to take a break because everything must be done on time. 我完全沒有時間小休, 因為每件事都必須準時做妥。	0.414		
Break Q32-33 (2 items)			5.286	0.572
Q32.	During my regular workday I take breaks to do some stretches. 在日常工作期間, 我會中途停下來休息, 做做伸展運動。	0.781		
Q33.	While at work I occasionally stop working to take a break. 在工作時, 我會不時停下來休息。	0.815		
Total 28 items			46.124	0.876

positively correlated with total workstyle and its subscales ($p < .001$).

Discussion

This study was the first study to evaluate the psychometric properties of WSF for cleaners, a neglected workforce. The exploratory and confirmatory factor analyses revealed that the modified C-WSF28 exhibited robust applicability to the cleaners with WRMS across various body parts.

In terms of its reliability, “Working through pain” had $\alpha = 0.854$, comparable to the C-WSF24 for nursing assistants ($\alpha = 0.87$) [14] and the original C-WSF32 for cooks ($\alpha = 0.84$) [24]. “Social reactivity” had a reliability of $\alpha = 0.884$, similar to the original C-WSF24 ($\alpha = 0.93$) [14]. The “Demands at work” subscale had acceptable reliability at $\alpha = 0.711$, comparable to C-WSF24 ($\alpha = 0.86$) [14]. Although the reliability of “Breaks” was lower, it aligned with findings from C-WSF24 ($\alpha = 0.55$) [14] and C-WSF32 ($\alpha = 0.65$) [24]. The low Cronbach's alpha for “Breaks” may be due to its two-item structure, which can affect inter-item correlations [33, 40]. Further studies should explore expanding this subscale with additional items to increase its internal consistency. Additionally, low reliability may also reflect the workers' occupational reality; the concept of “Breaks” might not be well defined within their work routines. For instance, the positive factor loading for “Breaks” suggests a link to an “adverse workstyle” [21, 24, 40]. This finding aligns with studies involving Hong Kong nursing assistants [14] and Malaysian office workers [18], but differs from research on U.S. and Hong Kong cooks [24, 41]. These variations may stem from cultural differences in work commitment and practices regarding breaks. As noted in Leung's field study [6], cleaners in Hong Kong work independently

and flexibly, managing specific duties without oversight. This independence may lead to varied interpretations of what constitutes a “break”. Many cleaners work outdoors in varying weather conditions, while those cleaning indoors often experience discomfort in confined spaces. Consequently, they may rush to complete tasks to maximize their break time, potentially increasing the risk of WRMS and contributing to the observed positive loading of “Breaks” in this study.

For the exploratory factorial structure, the C-WSF28 for cleaners aligns with previous scales, such as E-WSF32 [21], C-WSF-32 [24], and C-WSF24 [14]. The first factor, “Working through pain” (Q1-6, Q8-9), includes items consistent with C-WSF24 and C-WSF32, with Q8-Q9 added to reflect how cleaners manage workability through medication and fatigue. The second factor, “Social reactivity at work” (Q7, Q10-15, Q17-18), differs slightly from past studies. New items (Q7, Q11, Q12) were added, and Q10 and Q14 were modified based on the cleaners' culture. While Q13 and Q15 loaded as expected, Q17 and Q18, previously categorized as “workplace stressors,” were reassigned. This shift may reflect the flexible working conditions cleaners experience [6]. The third factor, “Demand at work” (Q16, Q19-Q22, Q28-31), aligns well with earlier studies, with Q28-Q31 newly detailing cleaners' job duties. The last factor, “Break,” remains consistent across all WSFs [14, 18, 21, 24]. The explained variance in this study (46%) is slightly lower than C-WSF24 (56.45%) but still acceptable, as the average explained variance in psychology studies is 42.8% [42]. This lower variance may stem from sample heterogeneity, as different cleaning tasks can vary widely among participants.

The CFA further supports this hypothesized factor structure identified in the exploratory analysis, which

Table 4 Floor and ceiling effects of the C-WSF28 after principal component analysis using varimax rotation

Work through pain Q1-6, Q8-9 (8 items)		Floor effect n(%)	Ceiling effect n(%)	Item-total correlation
Q1.	I keep working when I feel aching or discomfort, so that the quality of my work will not be affected. 我會在疼痛、不舒適的情況下繼續工作, 這樣才不會影響我的工作質量。	99(23.5)	84(19.9)	0.452
Q2.	My neck/shoulders/hands/arms/back/hips/thighs/calves/feet get tired at work. 在工作時, 我的頸/肩膀/雙手/雙臂/背/臀/大小腿/膝蓋/腳會感到疲勞。	100(23.7)	61(14.5)	0.499
Q3.	I feel aching while at work. 在工作時, 我會感到疼痛。	149(35.4)	46(10.9)	0.596
Q4.	As I do not know how to relieve my aching neck/ shoulders/ hands/ arms/ back/ hips/thighs/calves/feet, I keep on working with pain. 因為我對自己的頸/上肢/腰背/下肢痛毫無辦法, 所以只能忍痛繼續工作。	164(39.2)	50(12)	0.632
Q5.	I do not know how to eliminate or relieve various symptoms of my neck/ shoulders/hands/arms/back/hips/thighs/calves/feet. 我實在沒有辦法消除或緩解自己頸/上肢/背/下肢所出現的各種症狀。	178(42.5)	31(7.4)	0.547
Q6.	My neck/upper extremities/back/lower extremities (over or more places) may make some abrupt, fierce, fast or sudden movements. 我的頸/上肢/背/下肢(其中一處或多處)會做一些急促、猛烈、快速、突然的動作。	185(43.8)	45(10.7)	0.387
Q8.	I will take medicine to reduce muscle and bone tension or pain, which can maintain my work ability. 我會服藥來減低肌肉筋骨緊張或痛楚, 這樣能維持我的工作能力。	233(55.7)	19(4.5)	0.381
Q9.	I feel exhausted every day. 我每天都感到筋疲力盡。	144(34.1)	50(11.8)	0.507
Social reactivity at work Q7, Q10-15, Q17-18 (9 items)				
Q7.	If I tell my boss about my muscle and bone problems, it would seem like I can't handle my job. 若然我對上司說出自己的肌肉筋骨問題, 這就會看似我不能勝任自己的工作。	281(67.4)	11(2.6)	0.491
Q10.	I can't stop working halfway because doing so would make my boss have an opinion about me. 我不能中途停工, 因為這樣做會讓上司對我有意見。	266(63.3)	19(4.5)	0.543
Q11.	I can't stop working halfway because doing so would make the Food and Environmental Hygiene Department staff have an opinion about me. 我不能中途停工, 因為這樣做會讓食環署職員對我有意見。	281(67.4)	14(3.4)	0.445
Q12.	I can't stop working halfway because doing so would make the public/citizens have an opinion about me. 我不能中途停工, 因為這樣做會讓公眾/市民對我有意見。	294(70.2)	7(1.7)	0.515
Q13.	I cannot interrupt my work, because it would disappoint my boss or increase his/her responsibility. 我不能中途停工, 因為這樣做會讓上司失望或增加他的負擔。	285(68)	9(2.1)	0.539
Q14.	I can't stop working halfway because doing so would make the public/citizens complain about me and/or make me lose my job. 我不能中途停工, 因為這樣做會讓公眾/市民投訴我和/或讓我失去工作。	289(69)	5(1.2)	0.508
Q15.	If I take a break from work for relaxation or physical exercises, my colleagues/boss will be unhappy with me. 如果我關心自己的健康而放下工作, 放鬆一下或做運動, 我的上司會對我有意見。	285(68.2)	9(2.2)	0.497
Q17.	If I have not finished my work, my boss will give me a hard time. 如果我沒完成自己的工作, 上司不會讓我好過。	302(72.2)	11(2.6)	0.492
Q18.	I feel very depressed, as my boss' expectations on the quality of work are different from mine. 上司或其他人對工作質量的要求與我不同, 這一點讓我感到很沮喪。	325(72.2)	11(2.6)	0.396
Demand at work Q16, Q19-22, Q28-31 (9 items)				
Q16.	Despite my great efforts at work, I really don't know if my work is appreciated. 儘管我在工作中付出了很大努力, 但我還是真的不知道我的工作是否得到肯定。	232(53.6)	20(4.8)	0.45
Q19.	I have too much work and I can never finish it. 我有太多的工作, 總是做不完。	284(67.5)	13(3.1)	0.37
Q20.	Although I arrange my work in good order so that I can finish it before the deadline, things change so frequently that I have to work even harder to finish it on time. 儘管我會有條理地安排自己的工作, 以便能夠在最後期限前完成工作, 但情況在不斷變化, 自己還是要更加努力地工作, 以便按時完成。	174(42.1)	36(8.7)	0.326
Q21.	I find it hard to control my working hours. 我很難控制自己的工作時間。	290(70.6)	19(4.6)	0.314
Q22.	I feel pressure at work. 我在工作時會感到壓力。	213(50.7)	11(2.6)	0.499

Table 4 (continued)

Work through pain Q1-6, Q8-9 (8 items)		Floor effect n(%)	Ceiling effect n(%)	Item-total correlation
Q28.	I think the lack of tools provided by the company affects my work quality or progress. 我認為公司提供的工具不足而影響我的工作質量或進度。	236(56.5)	31(7.4)	0.347
Q29.	I will continue to work even if the company does not provide enough tools, so as not to affect my work quality. 我會在公司提供之工具不足情況下繼續工作,這樣才不會影響我的工作質量。	220(52.8)	32(7.7)	0.468
Q30.	If workers' rights are exploited, I won't report to my supervisor because it won't make any difference. 若然勞工權益被剝削時,我不會向主管反映,因為這根本起不了什麼作用。	227(54.6)	43(10.3)	0.365
Q31.	I have absolutely no time to take a break because everything must be done on time. 我完全沒有時間小休,因為每件事都必須準時做妥。	211(50.4)	20(4.8)	0.284
Break Q32-33 (2 items)				
Q32.	During my regular workday I take breaks to do some stretches. 在日常工作期間,我會中途停下來休息,做做伸展運動。	168(39.8)	24(5.7)	0.125
Q33.	While at work I occasionally stop working to take a break. 在工作時,我會不時停下來休息。	93(22)	35(8.3)	0.014
Total 28 items				

is derived from the Workstyle Model [17, 21]. The CFA revealed acceptable fit indices, reinforcing the validity of the four-factor solution. This additional analysis confirms that the C-WSF28 effectively captures the multifaceted nature of work-related factors among cleaners.

Regarding ceiling and floor effects, there was no ceiling effect (all values below 20%), but a floor effect was present. Previous research did not clearly document these effects, making direct comparisons difficult [14, 18, 21, 24]. The floor effect may relate to cultural attitudes toward authority, as participants might have been hesitant to express true feelings despite assurances of confidentiality. This reluctance can lead to underreporting of certain experiences, potentially skewing the data and limiting the interpretability of results. Thus, this may also lead to an underestimation of the impact of certain factors associated with the four subscales. In future studies, ensuring that participants understand the purpose of the study and feel comfortable sharing their experiences may help reduce hesitancy in expressing true feelings. Further validation studies are also needed to refine the measure and enhance its explanatory power.

The modified C-WSF28 demonstrated good known-groups validity, showing significant differences in scores between cleaners with and without WRMS in various body parts, except for the upper back and legs. Cleaners with WRMS in various body parts, excluding the upper back, were more likely to exhibit adverse workstyle. The low prevalence of upper back WRMS ($n=18$, 4.48%) may explain this exception, as it was the lowest among all body parts and aligns with previous studies reporting upper back WRMS prevalence between 0.0% [5, 43] and 28% [44]. In those studies, upper back WRMS ranked from seventh to ninth among body parts in Thailand [45], Taiwan [44], and Vadodara [46]. This low prevalence may

be due to the nature of cleaning work, which typically has less impact on the upper back. The situation with leg WRMS may be related to difficulties distinguishing knee issues from general leg discomfort, as prior research has mainly focused on knees and ankles, often neglecting a broader analysis of leg WRMS. This selective focus may have led to an incomplete understanding of the musculoskeletal discomfort cleaners experience [44–46].

Additionally, the C-WSF28 demonstrated good convergent validity, with total scores and subscales positively associated with the number and severity of WRMS body parts. These findings align with previous studies indicating that adverse workstyles are linked to developing WRMS and increased severity [47]. The C-WSF28 also revealed that psychosocial factors related to WRMS are associated with adverse workstyle. Cleaners with more adverse workstyles reported higher physical job demands, increased job stress, and thoughts of resigning, along with lower job satisfaction and work capacity. These results are consistent with prior studies [3, 11].

The study results indicated that adverse workstyles were negatively associated with perceived physical health, mental health, sleep quality, and overall health status. These findings align with previous research showing that cleaners with poorer self-rated health are more likely to develop WRMS [11]. Another study found that cleaners with poor sleep quality and duration also reported more musculoskeletal complaints [3]. Understanding cleaners' workstyles allows for targeted interventions to reduce WRMS based on their specific patterns. The validated C-WSF28 provides a comprehensive measure of cleaners' workstyles, aiding in the evaluation of interventions. For example, since many cleaners work alone and receive little social support, group stretching exercises could help

Table 5 The differences between the cleaners with and without WRMS in different factors of C-WSF28 and its total score

Name of Factors (Items #)	Body Parts n (with WRMS, without WRMS)	With WRMS Mean (SD)		Without WRMS Mean (SD)		Mann–WhitneyU	p-Value	
Work through pain Q1-6, Q8-9	Neck (67,335)	15.93	7.41	10.67	7.39	6923.50	< 0.001	***
	Shoulder (147,255)	14.55	6.82	9.81	7.56	11822.00	< 0.001	***
	Elbow (86,316)	15.21	7.20	10.54	7.46	8804.00	< 0.001	***
	Wrist (55,346)	15.31	7.02	10.96	7.58	6378.00	< 0.001	***
	Fingers (64,328)	14.78	7.61	10.93	7.50	7819.50	< 0.001	***
	Upper back (18,384)	14.50	6.78	11.40	7.66	2621.00	0.08	
	Low back (128,274)	14.27	7.33	10.27	7.46	12144.00	< 0.001	***
	Hip/thigh (37,365)	26.91	15.65	11.11	7.56	4384.50	< 0.001	***
	Knee (177,225)	14.43	7.04	9.27	7.33	12012.50	< 0.001	***
	Leg (52,350)	14.25	7.72	11.14	7.56	7029.50	0.01	
	Ankle (76,326)	15.52	7.49	10.61	7.38	7945.00	< 0.001	***
	At least 1 (347,54)	12.92	7.17	2.80	3.89	1878.50	< 0.001	***
Social reactivity at work Q7, Q10-15, Q17-18	Neck (66,326)	5.45	6.84	4.80	5.94	9916.00	0.31	
	Shoulder (138,254)	5.35	6.96	4.67	5.57	17157.50	0.73	
	Elbow (85,307)	6.36	7.27	4.51	5.68	10929.00	0.02	
	Wrist (54,337)	7.00	7.73	4.58	5.75	7204.50	0.01	
	Fingers (64,328)	5.64	6.10	4.77	6.10	8975.00	0.06	
	Upper back (18,374)	4.89	5.13	4.91	6.15	3193.50	0.71	
	Low back (123,269)	6.20	6.73	4.32	5.70	13473.50	< 0.001	***
	Hip/thigh (37,355)	6.97	8.24	4.70	5.80	5718.50	0.19	
	Knee (170,222)	5.75	6.24	4.27	5.92	15307.00	< 0.001	***
	Leg (48,344)	6.56	7.84	4.68	5.79	7164.00	0.13	
	Ankle (74,318)	5.16	5.51	4.85	6.23	10650.50	0.20	
	At least 1 (57,334)	5.29	6.31	2.70	4.08	6859.00	< 0.001	***
Demand at work Q16, 19–22, 28–31	Neck (60,324)	9.70	6.44	8.13	6.03	8304.50	0.07	
	Shoulder (136,248)	8.71	6.29	8.19	6.02	16101.50	0.46	
	Elbow (82,302)	9.01	6.40	8.20	6.04	11579.50	0.37	
	Wrist (54,330)	11.00	5.96	7.94	6.04	6190.50	< 0.001	***
	Fingers (59,325)	9.03	5.80	8.25	6.17	8683.00	0.25	
	Upper back (16,368)	8.13	5.93	8.38	6.13	2888.00	0.90	
	Low back (118,266)	9.86	6.71	7.71	5.73	12764.00	< 0.001	***
	Hip/thigh (37,347)	9.14	6.60	8.29	6.07	5968.50	0.48	
	Knee (166,218)	9.05	5.91	7.86	6.23	15628.50	0.02	
	Leg (49,335)	9.41	5.78	8.22	6.16	7118.50	0.13	
	Ankle (69,315)	9.64	5.90	8.10	6.14	9027.00	0.03	
	At least 1 (58,326)	8.88	6.22	5.53	4.62	6389.00	< 0.001	***
Break Q32-33	Neck (68,346)	3.41	2.30	3.07	2.10	10727.50	0.25	
	Shoulder (148,266)	3.33	2.16	3.01	2.11	17980.00	0.14	
	Elbow (87,327)	3.45	2.22	3.04	2.10	12660.00	0.11	
	Wrist (51,357)	3.43	2.15	3.08	2.13	9002.50	0.23	
	Fingers (66,348)	3.39	2.15	3.07	2.13	10509.50	0.27	
	Upper back (18,396)	3.78	2.21	3.10	2.13	2958.50	0.22	
	Low back (129,285)	3.43	2.25	2.99	2.07	16289.50	0.06	
	Hip/thigh (38,376)	3.34	2.30	3.10	2.12	6701.00	0.52	
	Knee (181,233)	3.29	2.13	3.00	2.13	19532.50	0.19	
	Leg (52,362)	3.62	2.29	3.06	2.10	7987.50	0.07	
	Ankle (79,335)	3.53	2.17	3.03	2.12	11576.00	0.08	

Table 5 (continued)

Name of Factors (Items #)	Body Parts <i>n</i> (with WRMS, without WRMS)	With WRMS Mean (SD)		Without WRMS Mean (SD)		Mann–WhitneyU	<i>p</i> -Value	
Total scores	At least 1 (59,354)	3.23	2.14	2.53	2.05	8450.00	0.02	
	Neck (59,303)	34.85	17.02	26.25	15.56	6313.50	< 0.001	***
	Shoulder (130,232)	32.18	15.91	25.11	15.68	11176.00	< 0.001	***
	Elbow (79,283)	34.14	16.54	25.84	15.53	8005.00	< 0.001	***
	Wrist (51,311)	36.45	16.49	26.21	15.60	5114.50	< 0.001	***
	Fingers (55,355)	33.58	14.06	26.59	16.23	6045.00	< 0.001	***
	Upper back (16,346)	30.94	14.73	27.50	16.17	2362.00	0.32	
	Low back (113,249)	33.55	15.89	24.97	15.50	9627.50	< 0.001	***
	Hip/thigh (36,326)	34.33	18.66	26.91	15.65	4539.00	0.03	
	Knee (156,206)	32.81	15.10	23.74	15.77	10435.00	< 0.001	***
	Leg (45,317)	34.31	17.03	26.70	15.77	5330.50	0.01	
	Ankle (67,295)	33.65	15.28	26.28	16.00	7078.50	< 0.001	***
	At least 1 (53,309)	30.17	15.53	12.96	10.70	2813.50	< 0.001	***

Note: ***<0.004

Table 6 The correlation between the workstyle and the variables

	Working through pain	Social Reactivity	Demand at work	Break	Total score
Employment mode	0.070	0.064	0.099	0.051	0.103
Level of Physical Rigor of the Job	0.396***	0.176***	0.336***	-0.076	0.382***
Job Satisfaction	-0.168***	-0.197***	-0.235***	0.013	-0.251***
Job Stress	0.198***	0.231***	0.268***	0.019	0.294***
Thoughts of Resigning	0.130***	0.111	0.084	-0.027	0.148***
Current Work Capability	-0.235***	-0.091	-0.136***	-0.054	-0.215***
Continue Working at Current Position for two more years	-0.196***	-0.044	-0.048	0.05	-0.123
Physical Health	-0.415***	-0.217***	-0.174***	0.015	-0.364***
Mental Health	-0.355***	-0.181***	-0.274***	0.008	-0.359***
Sleep Quality	-0.270***	-0.184***	-0.213***	-0.007	-0.288***
Eating Habit	-0.084	-0.108	-0.094	0.01	-0.111
Exercise Habit	-0.059	-0.033	-0.102	0.091	-0.062
Overall Health	-0.357***	-0.159***	-0.165***	0.024	-0.321***
Neck Severity	0.494***	0.367***	0.373***	0.122	0.524***
Shoulder Severity	0.259***	0.240***	0.158	0.019	0.275***
Arm Severity	0.290***	0.313***	0.151	-0.045	0.327***
Wrist Severity	0.427***	0.034	0.002	0.206	0.232
Finger Severity	0.415***	0.082	0.058	0.085	0.325
Upper Back Severity	0.724***	0.12	0.630***	0.446	0.756***
Lower Back Severity	0.508***	-0.023	0.016	0.091	0.266***
Thigh Severity	0.324	0.152	0.236	0.083	0.298
Knee Severity	0.363***	0.182	0.133	0.13	0.345***
Calf Severity	0.277	-0.107	0.011	0.103	0.074
Ankle Severity	0.336***	0.14	0.551***	0.109	0.508***
Number of Body Parts with Discomfort	0.557***	0.202***	0.195***	0.169***	0.458***

Note: ***<0.002

alleviate musculoskeletal discomfort while enhancing social support and reducing stress.

This study has several limitations. First, the use of convenience sampling may introduce selection bias. Second, self-reported data could be affected by response and recall biases. Objective indicators, such as health

examination data and workplace environment assessments, should be considered in future studies to supplement subjective questionnaires. This approach would reduce the subjectivity bias and enhance the reliability of the study's findings. Third, although the sample of 433 cleaners from various job types likely represents the

Hong Kong cleaning workforce, this broad approach may introduce confounding factors. As job task heterogeneity could influence WRMS development. Additionally, demographic heterogeneity should also be considered, including socioeconomic status, health perceptions, and local versus migrant populations. While this study focused on overarching workstyle factors, future research should collect demographics and job data and consider stratified and interaction effect analyses to reveal differences between various groups and their impact on the study results. Fourth, although we have adopted the commonly used NMQ to measure WRMS, pain perception is multifactorial and can be influenced by job security, macroeconomic environment, culture, and individual factors. Further studies should include these pain perception factors in the analysis to examine their relationship with cleaners' pain perception and to explore the mediating or moderating role of job security in pain perception. In addition, including a reference group in the questionnaire design can help more accurately assess the pain perception of cleaners. For example, "How would you rate your pain compared to others who are not a cleaner?" Moreover, the scale could be further evaluated for applicability among cleaners in other countries and occupational settings. Although establishing "known-groups" and "convergent" validity is a significant first step, further validation of the C-WSF28 is needed, including cross-cultural validation. Lastly, despite the low Cronbach alpha for the two-item "Break" factor, we chose to retain it due to its theoretical importance in preventing WRMS [48, 49] and the potential for improvement through future item additions and rephrasing that align with Chinese cultural and job contexts.

Conclusion

This is the first study to examine the known-groups and convergent validity of the modified C-WSF28 for cleaners who work independently in a relatively flexible working environment and with various body parts of WRMS. The results demonstrated that C-WSF28 presented with acceptable internal consistency, and good construct validity, further supported by the results of the CFA, which confirmed the hypothesized factor structure. These findings indicate that the C-WSF28 is a reliable and valid tool for assessing workstyle factors among cleaners.

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Author contributions

All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was written by Ka Yan Ma and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript. Conceptualization: KC and KYM; Methodology: KC, KYM, ESPC, YKK, SMT, NHL, KYL, WWMN, and PSBC; Validation, all authors; Formal analysis, KC and KYM; Data collection: YKK, SMT, NHL, and KYL;

Resources, BCS, KWM, YKK, KC, HCL, YHBL; Data Curation: KC; Writing - original draft preparation: KYM, ESPC, and KC; Writing - review and editing: all authors; Project Administration: SMT, NHL, and KYL; Funding Acquisition: BCS, KWM, YKK, KC, HCL, YHBL. All authors have read and agreed to the published version of the manuscript.

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Data availability

The author confirms that all data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board of The Hong Kong Polytechnic University on 04 May 2022 (HSEARS20220315001). Informed consent was obtained from all individual participants included in the study. Anonymity and confidentiality of the data were respected throughout the study.

Competing interests

The authors declare no competing interests.

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