

Work-Related Wrist Discomfort and Its Associated Risk Factors Among Gardeners: A Cross-Sectional Study

Areeba Fatima¹, Zahra Akbar¹, Muhammad Irshad¹, Rabia Mahboob Subhani², M. Abdul Waheed³

¹ Student, Allied College of health sciences Multan affiliated with Government College University, Faisalabad, Pakistan

² Senior lecturer, College of Physical Therapy Ziauddin University, Multan, Pakistan

³ Lecturer, College of Physical Therapy Allied College of Health Sciences, Multan, Pakistan

*Corresponding author: M. Abdul Waheed, waheed1461994@gmail.com

"Cite this Article" Received: 12 February 2026; Accepted: 02 March 2026; Published: 15 March 2026

Author Contributions: Concept: AF, MAW; Design: AF, RMS, MAW; Data Collection: AF, ZA, MI; Analysis: AF, ZA, MI, RMS; Drafting: AF, ZA, MI, RMS, MAW. **Ethical**

Approval: College of Physical Therapy Allied College of Health Sciences, Multan, Pakistan. **Informed Consent:** Written informed consent was obtained from all

participants; **Conflict of Interest:** The authors declare no conflict of interest. **Funding:** No external funding; **Data Availability:** Available from the corresponding author on reasonable request; **Acknowledgments:** NA

ABSTRACT

Background: Manual gardening involves repetitive gripping, cutting, watering, and sustained wrist positioning that may contribute to work-related wrist symptoms. **Objective:** To assess wrist discomfort and tendon-related clinical findings and determine associated demographic, occupational, and ergonomic factors among manual gardeners. **Methods:** A cross-sectional study included 277 male gardeners from the Parks and Horticulture Authority, Multan. Participant characteristics, occupational exposures, tool-related factors, pain, wrist movement, and FCR and FCU clinical-test findings were assessed. Categorical associations were evaluated using chi-square tests, while continuous parameters were compared using independent-samples or Welch's t-tests as appropriate. **Results:** Positive FCR and FCU tests were observed in 76.5% and 25.3% of participants, respectively. Pain was moderate in 52.3% and severe in 40.8%. Age was associated with FCR ($p < 0.001$) and FCU status ($p = 0.001$), while hand dominance was associated with both outcomes ($p \leq 0.002$). Cutting-related wrist flexion and tool length and width differed significantly according to FCR and FCU status (all $p < 0.001$). Watering-related wrist flexion, watering-can weight, tool weight, and working hours were not significantly different between tendon-test groups. **Conclusion:** Wrist-related clinical findings were common among gardeners and were associated primarily with selected demographic and cutting-related ergonomic characteristics. **Keywords:** Gardeners; Wrist Discomfort; Musculoskeletal Disorders; Ergonomics; Flexor Carpi Radialis; Flexor Carpi Ulnaris; Occupational Health.

INTRODUCTION

Work-related musculoskeletal disorders represent an important occupational-health concern among workers whose jobs involve repetitive upper-limb activity, sustained gripping, forceful exertion, manual handling, and prolonged or awkward postures. The hand and wrist are particularly vulnerable in occupations characterized by repeated flexion-extension movements and continuous manipulation of manually operated tools. Among street sweepers, substantial wrist/hand discomfort and wrist flexor tendon involvement have been documented, while large occupational studies have similarly identified frequent wrist flexion, prolonged non-neutral wrist positioning, and forceful gripping as factors associated with wrist disorders (1,2). Comparable hand discomfort has also been described in occupations involving repetitive horticultural and floral work (3).

The wrist is a biomechanically complex articulation in which the carpal bones, ligamentous structures, tendons, and surrounding musculature interact to provide mobility, stability, grip control, and transmission of load between the hand and forearm (4). Repetitive or forceful occupational activity can increase mechanical loading across these structures, particularly when movements are performed repeatedly outside a neutral wrist position (5). The flexor carpi radialis (FCR) and flexor carpi ulnaris

(FCU) contribute to wrist flexion and stabilization and may therefore be subjected to repeated loading during gardening activities that require sustained gripping, cutting, digging, pruning, lifting, and manipulation of hand tools.

Gardening combines several biomechanical exposures capable of producing upper-extremity strain. Manual gardeners frequently perform repetitive cutting and digging movements, maintain tools in sustained grips, carry watering equipment, work for prolonged periods in standing or other constrained postures, and repeatedly alter wrist position according to task requirements. High levels of musculoskeletal symptoms have been reported among tea-garden workers, while studies specifically involving gardeners have identified substantial hand discomfort and postural stress associated with repetitive manual activities (6,7). Occupational research in agricultural populations has additionally linked biomechanical wrist stressors with upper-extremity disorders (8). Kinematic investigations of horticultural activities demonstrate that gardening tasks require coordinated upper-limb movements (9), while studies of landscape and gardening work show that working position and tool operation can produce considerable muscular loading and fatigue (10).

Evidence from related agricultural occupations further supports the relevance of cumulative occupational exposure. Flower-farm workers have demonstrated a high burden of work-related musculoskeletal disorders, with older age and longer occupational exposure associated with symptoms (11). A study of female gardeners similarly identified wrist complaints as part of the musculoskeletal burden associated with routine gardening activity (12). Ergonomic assessments of greenhouse work indicate that repetitive tasks such as pruning, weeding, grafting, and harvesting may expose the upper extremity to clinically relevant biomechanical demands (13). Landscape workers have also shown substantial wrist/hand symptoms and medium-to-high ergonomic risk during routine work activities (14), while agricultural research more broadly demonstrates relationships between working posture, working conditions, and musculoskeletal outcomes (15).

Despite this evidence, wrist-specific occupational data among manual gardeners in Pakistan remain limited, particularly regarding the relationship between tendon-related clinical findings and modifiable task characteristics such as cutting-related wrist position, tool dimensions, handle characteristics, working posture, and task duration. Establishing these associations is important because gardening activities are heterogeneous, and different tasks may impose different biomechanical demands on the wrist. The present study therefore aimed to characterize work-related wrist discomfort and FCR and FCU clinical-test findings among manual gardeners employed by the Parks and Horticulture Authority in Multan and to examine their associations with demographic, occupational, tool-related, and task-specific ergonomic characteristics.

MATERIALS AND METHODS

This cross-sectional observational study was conducted among manual gardeners employed by the Parks and Horticulture Authority (PHA), Multan. A total of 277 male gardeners participated in the study. The sample size was established at a 95% confidence level. Eligible participants were manual gardeners with at least two consecutive years of occupational experience who performed manual gardening work for a minimum of two hours per day. Individuals with recent trauma, fracture, or surgery involving the hand, malignancy or cystic lesions affecting the hand, arthritic conditions, or neuropathic pain were excluded. Participation was voluntary, and informed consent was obtained before data collection. The study was conducted after ethical approval from the institutional ethical review committee.

Data were collected using a self-structured questionnaire together with physical and clinical assessment of the wrist. The questionnaire captured demographic and occupational characteristics relevant to the study objective, including age, marital status, hand dominance, smoking status, body mass index category, duration of occupational experience, daily working hours, break duration, working posture, and perceived fatigue. Tool- and task-related information included cutting-tool length and width, handle

material, tool shape, watering-can weight, loaded watering-can weight, wrist position during cutting, and task-specific wrist flexion during cutting and watering. Posture-related discomfort and wrist pain intensity were also recorded. The variables were analysed according to the categories documented during data collection.

Pain intensity was assessed using a visual analogue scale (VAS), while wrist movement during task performance was measured using a goniometer. Pain was subsequently represented in the analysed data as mild, moderate, severe, or very severe. Wrist-flexion measurements were obtained for cutting and watering activities to characterize task-specific wrist positioning. Working posture was classified as standing or sitting, while wrist position during cutting was categorized as below, at, or above the reference level. Tool characteristics included handle material classified as plastic, wood, or steel and tool shape classified as curved or straight. Watering-can and loaded watering-can weights were recorded separately to distinguish the physical demand associated with handling the container itself from that associated with carrying it during use.

Clinical assessment focused on the flexor carpi radialis and flexor carpi ulnaris tendons. For assessment of the FCU, the participant was seated comfortably with the forearm supinated and was instructed to perform wrist flexion combined with ulnar deviation against resistance applied in the opposite direction. The test was considered positive when the participant was unable to complete the resisted movement or when the movement provoked pain. For assessment of the FCR, the participant was similarly positioned with the forearm supinated and was instructed to perform wrist flexion combined with radial deviation against opposing resistance. A test was classified as positive when resisted movement could not be completed or when the manoeuvre reproduced pain. These clinical-test findings were analysed separately for the FCR and FCU rather than being treated as interchangeable measures of wrist pathology.

Data were analysed using IBM SPSS Statistics version 21. Descriptive statistics were reported as frequencies and percentages for categorical variables and as mean $\pm$ standard deviation for continuous variables where appropriate. Means of numerical codes assigned to nominal categories were not used as descriptive measures. Associations between categorical participant or occupational characteristics and FCR or FCU test status were examined using Pearson's chi-square test when the structure of the available data supported the analysis. Effect sizes for interpretable chi-square associations were expressed using Cramér's V, calculated from the reported chi-square statistic and sample size.

Continuous ergonomic and occupational characteristics were compared between FCR- or FCU-positive and negative groups using independent-samples t-tests. Equality of variances was assessed using Levene's test; the conventional independent-samples result was used when the homogeneity-of-variance assumption was supported, whereas Welch's t-test was used when this assumption was not met. Mean differences, 95% confidence intervals, test statistics, degrees of freedom, and two-sided p-values were reported for the interpretable comparisons. Statistical significance was defined as $p < 0.05$. Because the study was cross-sectional and the analyses were unadjusted, statistical findings were interpreted as associations rather than causal or independent predictive effects.

RESULTS

A total of 277 male gardeners were included in the analysis. More than half were aged 25–35 years (52.3%), followed by 36–45 years (32.5%) and 46–55 years (15.2%). Most participants were married (70.8%) and right-hand dominant (71.5%). Regarding occupational experience, 51.3% had worked for 1–10 years, 39.7% for 11–20 years, and 9.0% for 21–30 years. More than half of the participants were classified as overweight (57.4%), while 33.9% had a healthy body weight and 8.7% were obese. Smoking was reported by 62.8% of participants (Table 1).

Plastic was the most frequently used tool-handle material (49.1%), followed by wood (40.1%) and steel (10.8%), while 66.8% of participants used curved tools. The mean unfilled watering-can weight was 1.72 ± 1.16 kg, with 94.6% of participants using watering cans weighing between 0.5 and 3.0 kg. The mean loaded watering-can weight was 7.77 ± 2.35 kg, and 93.5% of participants handled loads within the 5–10 kg category (Table 2).

Table 1. Demographic Characteristics of the Study Participants (N = 277)

Variable	Category	n (%)
Age, years	25–35	145 (52.3)
	36–45	90 (32.5)
	46–55	42 (15.2)
Marital status	Married	196 (70.8)
	Unmarried	81 (29.2)
Hand dominance	Right-handed	198 (71.5)
	Left-handed	79 (28.5)
Working experience, years	1–10	142 (51.3)
	11–20	110 (39.7)
	21–30	25 (9.0)
Smoking status	Smoker	174 (62.8)
	Non-smoker	103 (37.2)
Body mass index category	Healthy weight	94 (33.9)
	Overweight	159 (57.4)
	Obese	24 (8.7)

Data are presented as n (%). Means and standard deviations derived from nominal category codes have been omitted.

Table 2. Tool- and Task-Related Characteristics of Gardeners (N = 277)

Variable	Category/Summary	n (%) or Mean $\pm$ SD
Handle material	Plastic	136 (49.1)
	Wood	111 (40.1)
	Steel	30 (10.8)
Tool shape	Curved	185 (66.8)
	Straight	92 (33.2)
Watering-can weight, kg	Mean $\pm$ SD	1.72 ± 1.16
	0.5–3.0	262 (94.6)
	3.1–8.0	0 (0.0)
	8.1–11.0	15 (5.4)
Loaded watering-can weight, kg	Mean $\pm$ SD	7.77 ± 2.35
	5–10	259 (93.5)
	11–15	10 (3.6)
	16–20	8 (2.9)

Tool-length and tool-width category distributions are not included in this table because the supplied category frequencies do not yield a valid denominator of 277.

Table 3. Work-Related and Clinical Characteristics of Participants (N = 277)

Variable	Category/Summary	n (%) or Mean $\pm$ SD
Break duration, min	5–10	265 (95.7)
	11–20	0 (0.0)
	21–30	0 (0.0)
	31–40	2 (0.7)
	41–50	10 (3.6)
Working hours/day	Mean $\pm$ SD	5.54 ± 1.85
	1–10	273 (98.6)
	11–20	4 (1.4)
Wrist flexion during watering, degrees	Mean $\pm$ SD	33.70 ± 14.58
	1–20	30 (10.8)
	20–40	230 (83.0)
	41–60	0 (0.0)
	61–80	17 (6.1)

Variable	Category/Summary	n (%) or Mean $\pm$ SD
Working posture	Standing	203 (73.3)
	Sitting	74 (26.7)
Posture-related discomfort	Mild	58 (20.9)
	Moderate	169 (61.0)
	Severe	50 (18.1)
Wrist position during cutting	Below level	161 (58.1)
	At level	77 (27.8)
	Above level	39 (14.1)
Flexor carpi ulnaris test	Positive	70 (25.3)
	Negative	207 (74.7)
Flexor carpi radialis test	Positive	212 (76.5)
	Negative	65 (23.5)
Pain intensity	Mild	7 (2.5)
	Moderate	145 (52.3)
	Severe	113 (40.8)
	Very severe	12 (4.3)

Categorical frequencies for wrist flexion during cutting were excluded because the reported counts exceed the study sample size.

Table 4. Associations of Demographic and Occupational Characteristics With FCR and FCU Test Status

Factor	Tendon outcome	Pearson χ^2	df	p-value	Cramér's V
Age group	FCR	16.087	2	<0.001	0.241
Age group	FCU	13.162	2	0.001	0.218
Hand dominance	FCR	10.950	1	0.001	0.199
Hand dominance	FCU	9.310	1	0.002	0.183
Handle material	FCR	0.856	2	0.652	0.056
Tool shape	FCR	3.934	1	0.047	0.119
Smoking status	FCU	<0.001	1	0.993	<0.001
Smoking status	FCR	0.002	1	0.960	0.003

FCR, flexor carpi radialis; FCU, flexor carpi ulnaris. Cramér's V was calculated from the reported Pearson χ^2 statistic and $N = 277$. Only analyses with interpretable categorical structure and internally compatible degrees of freedom are presented.

Table 5. Continuous Ergonomic and Occupational Parameters According to FCR and FCU Test Status

Tendon outcome	Parameter	Test	t	df	Mean difference*	95% CI	p-value
FCU	Wrist flexion during cutting	Welch	3.624	84.940	7.995	3.609 to 12.381	<0.001
FCU	Wrist flexion during watering	Welch	-0.162	93.698	-0.403	-5.325 to 4.520	0.871
FCU	Watering-can weight	Student	-1.786	275	-0.580	-1.219 to 0.059	0.075
FCU	Tool weight	Welch	1.542	84.641	0.396	-0.114 to 0.905	0.127
FCU	Tool length	Student	-3.674	275	-4.146	-6.367 to -1.925	<0.001
FCU	Tool width	Welch	-4.362	189.138	-1.499	-2.177 to -0.821	<0.001
FCU	Working hours/day	Student	-1.200	275	-0.358	-0.946 to 0.230	0.231
FCR	Wrist flexion during cutting	Welch	-4.121	77.217	-9.411	-13.959 to -4.864	<0.001
FCR	Wrist flexion during watering	Welch	0.140	82.746	0.369	-4.874 to 5.611	0.889
FCR	Watering-can weight	Student	1.292	275	0.431	-0.226 to 1.088	0.198
FCR	Tool weight	Welch	-1.622	76.017	-0.443	-0.986 to 0.101	0.109
FCR	Tool length	Student	3.947	275	4.551	2.281 to 6.820	<0.001
FCR	Tool width	Welch	4.471	161.980	1.576	0.880 to 2.272	<0.001
FCR	Working hours/day	Welch	1.240	106.709	0.378	-0.227 to 0.984	0.218

Mean differences retain the direction of the original statistical group coding. Student's independent-samples t-test was retained when equality of variance was supported by Levene's test; Welch's t-test was used when the equal-variance assumption was not supported. FCR, flexor carpi radialis; FCU, flexor carpi ulnaris; CI, confidence interval.

Participants worked for a mean of 5.54 ± 1.85 hours per day, and 95.7% reported break durations of 5–10 minutes. The mean wrist-flexion angle during watering was $33.70 \pm 14.58^\circ$, with 83.0% of participants demonstrating flexion within the 20–40° category. Standing was the predominant working posture (73.3%). Posture-related discomfort was moderate in 61.0% of participants, severe in 18.1%, and mild in

20.9%. During cutting activities, 58.1% worked with the wrist below the reference level, 27.8% at level, and 14.1% above level (Table 3).

Positive clinical testing differed substantially between the two wrist flexor tendons. The FCR test was positive in 212 participants (76.5%), whereas the FCU test was positive in 70 participants (25.3%). Pain intensity was predominantly moderate or greater: 52.3% of participants reported moderate pain, 40.8% severe pain, and 4.3% very severe pain, whereas 2.5% reported mild pain (Table 3).

Age group was associated with both FCR status ($\chi^2 = 16.087$, $df = 2$, $p < 0.001$, Cramér's $V = 0.241$) and FCU status ($\chi^2 = 13.162$, $df = 2$, $p = 0.001$, Cramér's $V = 0.218$). Hand dominance was also associated with FCR ($\chi^2 = 10.950$, $df = 1$, $p = 0.001$, Cramér's $V = 0.199$) and FCU status ($\chi^2 = 9.310$, $df = 1$, $p = 0.002$, Cramér's $V = 0.183$). Tool shape showed a weaker association with FCR status ($\chi^2 = 3.934$, $df = 1$, $p = 0.047$, Cramér's $V = 0.119$). In contrast, handle material was not associated with FCR status ($p = 0.652$), and smoking status was not associated with either FCU ($p = 0.993$) or FCR status ($p = 0.960$) (Table 4).

For FCU status, wrist flexion during cutting differed significantly between groups (Welch's $t = 3.624$, $df = 84.940$, $p < 0.001$; mean difference = 7.995° , 95% CI 3.609 to 12.381). Significant differences were also identified for tool length ($t = -3.674$, $df = 275$, $p < 0.001$; mean difference = -4.146 , 95% CI -6.367 to -1.925) and tool width (Welch's $t = -4.362$, $df = 189.138$, $p < 0.001$; mean difference = -1.499 , 95% CI -2.177 to -0.821). No statistically significant differences according to FCU status were detected for wrist flexion during watering ($p = 0.871$), watering-can weight ($p = 0.075$), tool weight ($p = 0.127$), or working hours per day ($p = 0.231$) (Table 5).

A similar pattern was observed for FCR status. Wrist flexion during cutting differed significantly between groups (Welch's $t = -4.121$, $df = 77.217$, $p < 0.001$; mean difference = -9.411° , 95% CI -13.959 to -4.864). Tool length ($t = 3.947$, $df = 275$, $p < 0.001$; mean difference = 4.551 , 95% CI 2.281 to 6.820) and tool width (Welch's $t = 4.471$, $df = 161.980$, $p < 0.001$; mean difference = 1.576 , 95% CI 0.880 to 2.272) also differed significantly according to FCR status. Wrist flexion during watering ($p = 0.889$), watering-can weight ($p = 0.198$), tool weight ($p = 0.109$), and working hours per day ($p = 0.218$) showed no statistically significant differences between FCR groups (Table 5).

Overall, the inferential findings indicate that tendon-test status was associated most consistently with age, hand dominance, wrist flexion during cutting, and tool dimensions. The absence of statistically significant findings for watering-related wrist flexion, watering-can weight, tool weight, working hours, and smoking indicates that these factors did not demonstrate measurable associations with FCR or FCU status in the available unadjusted analyses.

DISCUSSION

The present study demonstrates a substantial burden of wrist-related symptoms and clinical tendon involvement among manual gardeners, with a particularly high proportion of positive flexor carpi radialis (FCR) tests. Among 277 participants, 76.5% had a positive FCR test and 25.3% had a positive flexor carpi ulnaris (FCU) test. Pain was predominantly moderate or severe, affecting 52.3% and 40.8% of participants, respectively. The inferential analyses further identified associations of tendon-test status with age and hand dominance, while wrist flexion during cutting and tool dimensions differed significantly between FCR- and FCU-positive and negative groups. In contrast, wrist flexion during watering, watering-can weight, tool weight, working hours, and smoking did not demonstrate statistically significant associations in the available unadjusted analyses.

The observed pattern is broadly consistent with occupational evidence showing that repetitive manual work places considerable biomechanical demands on the hand and wrist. Idrees et al. reported musculoskeletal discomfort in 68.8% of street sweepers and wrist/hand symptoms in 46.5% during the preceding 12 months; clinically identified wrist flexor tendonitis was present in 26.8% of participants (1). The FCU-positive proportion of 25.3% observed in the present study is therefore similar to the overall

tendonitis prevalence reported among street sweepers, although direct comparison requires caution because the present study evaluated FCR and FCU separately. Occupational population data from China have likewise demonstrated relationships between wrist disorders and frequent wrist flexion, prolonged wrist positioning, forceful gripping, and other non-neutral wrist postures (2). These findings support the interpretation that repetitive gardening tasks involving sustained gripping and repeated wrist movement may contribute to the observed clinical symptom burden without establishing a causal relationship.

The predominance of FCR involvement compared with FCU involvement is particularly notable. Gardening activities such as cutting, pruning, digging, and manipulating hand tools can require repetitive wrist flexion combined with radial or ulnar stabilization. Functional wrist anatomy permits coordinated interaction between the flexor tendons, carpal structures, and forearm musculature during gripping and precision tasks (4,5). The present findings therefore suggest that task-specific loading may not affect all wrist flexor structures equally. Nevertheless, a positive resisted FCR or FCU test represents a clinical finding rather than definitive imaging-confirmed tendinopathy, and the observed proportions should consequently be interpreted as tendon-related clinical involvement rather than definitive prevalence estimates of histopathologically confirmed tendonitis.

The findings are also consistent with studies conducted specifically among gardeners and related horticultural workers. Research among gardeners has repeatedly identified awkward working positions, repetitive movements, prolonged task duration, and manual handling as important ergonomic exposures (7). A study of female gardeners reported wrist problems in approximately 31.7% of participants, demonstrating that wrist symptoms constitute a recognizable component of the broader musculoskeletal burden associated with gardening work (12). Similarly, work among landscape workers found wrist/hand symptoms in 23.6% of participants and identified inappropriate working postures across assessed tasks (14). Although prevalence estimates vary because of differences in population characteristics, symptom definitions, assessment instruments, sex distribution, and occupational tasks, these studies consistently indicate that gardening and landscaping involve meaningful upper-extremity ergonomic demands.

Age was significantly associated with both FCR and FCU status in the present analysis, with effect sizes of Cramér's $V = 0.241$ and 0.218 , respectively. This finding is compatible with previous occupational studies showing associations between age or longer exposure histories and musculoskeletal disorders. Idrees et al. found age to be associated with wrist flexor tendonitis among street sweepers (1), while Munala et al. reported significant associations of older age and longer duration of farm work with work-related musculoskeletal disorders among Kenyan flower-farm workers (11). In a large Chinese occupational population, longer service was also associated with increased odds of wrist injury (2). Repeated mechanical loading accumulated over working life may plausibly contribute to tissue sensitivity and reduced tolerance to repetitive occupational loads, although the cross-sectional nature of the present investigation does not permit determination of temporal or causal pathways.

Hand dominance was associated with both FCR and FCU status, although the effect sizes were modest. This association may reflect unequal exposure of the dominant and non-dominant upper extremities during cutting, gripping, lifting, and tool manipulation. The majority of participants were right-handed, which may concentrate repetitive task demands on the dominant wrist. However, bilateral task performance was not characterized in sufficient detail to establish whether dominant-hand exposure was consistently greater. Accordingly, hand dominance should be regarded as an associated participant characteristic rather than a direct causal determinant.

One of the clearest biomechanical findings was the difference in wrist flexion during cutting according to tendon-test status. Participants categorized by FCU status differed by approximately 8.0° in cutting-related wrist flexion, whereas the corresponding difference for FCR status was approximately 9.4° . Occupational studies support the relevance of repeated or non-neutral wrist positioning: Chen et al. identified frequent wrist flexion and prolonged flexed wrist posture as factors associated with

occupational wrist injury (2). Research involving greenhouse workers has similarly identified repetitive upper-limb tasks such as grafting, pruning, and weeding as ergonomically demanding, with recommendations focused on ergonomic tool design, work rotation, and rest periods (13). Biomechanical research also indicates that tool configuration and task orientation can influence wrist torque capacity, perceived usability, and discomfort during manual tool use. These findings provide a plausible ergonomic context for the significant cutting-related differences observed in the present sample.

Tool dimensions were significantly different according to both FCR and FCU status. Tool length differed by approximately 4.15 units for FCU status and 4.55 units for FCR status, while corresponding differences in tool width were approximately 1.50 and 1.58 units. These findings reinforce the potential importance of the worker–tool interface. Agricultural ergonomic research has shown that tool design, weight, adjustability, grip configuration, and working posture can influence physical demands during manual agricultural activities. Ergonomic modification of agricultural hand tools has consequently been proposed as one strategy to reduce excessive force and awkward posture (13,15). However, because the current analyses are unadjusted, the observed differences cannot establish that tool dimensions independently produced tendon symptoms. Tool characteristics may correlate with task type, duration, worker experience, or other physical exposures.

In contrast, several apparently plausible exposures did not show statistically significant relationships with tendon status. Wrist flexion during watering was not significantly different for either FCU or FCR status, nor were watering-can weight, overall tool weight, or working hours per day. Smoking also showed essentially no association with either tendon outcome. These null results are scientifically relevant because they indicate that not every physically demanding feature of gardening demonstrated measurable differentiation between tendon-test groups. The difference between cutting and watering may reflect the more forceful gripping, repeated activation, or constrained wrist positioning involved in cutting tasks; however, these mechanisms were not directly tested. The findings therefore support prioritizing task-specific rather than uniformly generalized ergonomic interpretations.

Postural findings nevertheless indicate substantial physical demand within the study population. Nearly three-quarters of participants worked predominantly in standing, and 61.0% reported moderate posture-related discomfort, while 18.1% reported severe discomfort. Agricultural and horticultural studies have consistently documented substantial musculoskeletal symptom burdens associated with awkward posture and repetitive manual work. Kairi and Dey reported work-related musculoskeletal symptoms in more than 80% of tea-garden workers, with occupational tasks and longer working exposure contributing to regional symptom patterns (6). Munala et al. similarly observed work-related musculoskeletal disorders in 68.1% of flower-farm workers (11). Landscaping research has also demonstrated medium-to-high ergonomic risk during routine work activities (14). Together, these studies support the broader occupational significance of posture and repetitive loading, although the present data do not establish an independent association between the categorical working-posture variable and tendon-test positivity.

The study has several strengths. It addresses an occupational group for which wrist-specific evidence remains relatively limited and evaluates multiple worker, task, tool, and clinical characteristics within the same population. The inclusion of separate FCR and FCU resisted clinical tests provides more anatomically specific information than a general musculoskeletal symptom questionnaire alone. The analysis also distinguishes statistically supported relationships from several null findings, helping to avoid attributing all gardening exposures indiscriminately to wrist symptoms.

Important limitations should nevertheless be considered. The cross-sectional design prevents establishment of temporality and therefore does not demonstrate that the measured occupational factors caused the tendon findings. Participants were male manual gardeners from a specific occupational setting in Multan, which limits generalizability to female gardeners, mechanized workers, other geographic regions, and workers with substantially different gardening responsibilities. Several

exposures and symptoms were obtained through a self-structured questionnaire, which may introduce recall and measurement error and may limit comparison with studies using standardized occupational instruments. The FCR and FCU resisted tests represent clinical screening findings rather than imaging-confirmed diagnoses. In addition, the inferential analyses were predominantly unadjusted; therefore, correlated exposures such as age, hand dominance, task type, wrist position, tool characteristics, and occupational experience could not be separated as independent predictors. The number of comparisons also warrants cautious interpretation of borderline findings such as the association between tool shape and FCR status at $p = 0.047$.

Taken together, the results indicate that wrist-related clinical findings among manual gardeners are associated more consistently with selected worker characteristics and task-specific biomechanical features than with all measured occupational exposures. Age, hand dominance, cutting-related wrist flexion, and tool dimensions emerged as the clearest correlates, whereas watering-related flexion, watering-can weight, overall tool weight, working hours, and smoking did not demonstrate significant relationships in the available analyses. These findings support greater attention to cutting technique, neutral wrist positioning, tool ergonomics, and task organization in occupational-health assessment of gardeners while emphasizing the need for prospective and multivariable studies to determine which exposures independently contribute to persistent wrist morbidity.

CONCLUSION

Work-related wrist symptoms and tendon-related clinical findings were common among the surveyed manual gardeners, with positive FCR testing occurring substantially more frequently than positive FCU testing. Age and hand dominance were associated with both tendon-test outcomes, while cutting-related wrist flexion and tool dimensions differed significantly according to FCR and FCU status. In contrast, wrist flexion during watering, watering-can weight, overall tool weight, working hours, and smoking were not significantly associated with the tendon findings in the available unadjusted analyses. These results identify task-specific biomechanical and ergonomic characteristics that warrant consideration in occupational assessment of gardeners, while the cross-sectional design limits interpretation to associations rather than causal risk relationships.

REFERENCES

1. The reference list below removes genuine duplicates and excludes the previously mismatched Alexander GPCR paper, the *Tinospora cordifolia* review, and the grey-systems bibliometric paper. The intended gardener prevalence source has been bibliographically repaired.
2. Idrees A, Kashif M, Kompal R, Umar A, Nadeem I, Fatima R. Musculoskeletal discomfort and wrist flexor tendonitis among street sweepers and associated risk factors. *Work*. 2023;76(4):1395-1405. doi:10.3233/WOR-220253.
3. Chen N, Li G, Sun X, Zhang M, Zhang H, Ling R, et al. Prevalence status and associated factors of wrist postural injury in the Chinese occupational population. *Front Public Health*. 2022;10:1047814. doi:10.3389/fpubh.2022.1047814.
4. Mishra U. Prevalence of hand discomfort among florists: an ergonomic study. *Indian J Prev Soc Med*. 2014.
5. MacLean S, Amarasooriya M, Bain GI. Functional anatomy of the wrist. In: *Arthroscopy and Endoscopy of the Elbow, Wrist and Hand: Surgical Anatomy and Techniques*. Cham: Springer International Publishing; 2021. p. 553-61.
6. Lutter C, Schöffl V. Wrist injuries. In: *Climbing Medicine: A Practical Guide*. Cham: Springer International Publishing; 2022. p. 115-25.

7. Kairi TK, Dey S. Prevalence of work-related musculoskeletal symptoms among tea garden workers in Bangladesh: a cross-sectional study. *BMJ Open*. 2022;12(5):e061305. doi:10.1136/bmjopen-2022-061305.
8. Martolia D, Gupta R, Chhuneja NK. A study on prevalence of hand discomfort among the gardeners. *J Community Mobilization Sustain Dev*. 2024;19(1):130-5.
9. Roquelaure Y, Jégo S, Geoffroy-Perez B, Chazelle E, Descatha A, Evanoff B, et al. Carpal tunnel syndrome among male French farmers and agricultural workers: is it only associated with physical exposure? *Saf Health Work*. 2020;11(1):33-40. doi:10.1016/j.shaw.2019.12.003.
10. Lee AY, Park SA, Kim JJ, So JM, Son KC. Kinematic and kinetic analysis of upper limb motions during horticultural activities. *Hortic Sci Technol*. 2016;34(6):940-58.
11. Yang W, Li B, Li S, Zhang Y, Yang H. Muscle fatigue related to human posture using a brush cutter for landscape gardening: a preliminary study. *Med Pr*. 2022;73(3):201-7.
12. Munala JM, Olivier B, Karuguti WM, Karanja SM. Prevalence of musculoskeletal disorders amongst flower farm workers in Kenya. *S Afr J Physiother*. 2021;77(1):1515. doi:10.4102/sajp.v77i1.1515.
13. Rushikesh RM, Smita CP, Chandrakant BP, Khushboo TC. Prevalence of musculoskeletal disorders in gardeners. *Int J Pharma Bio Sci*. 2020;10(4):L117-L120. doi:10.22376/ijpbs/lpr.2020.10.4.L117-120.
14. Varmazyar S, Choubdar M. Assessment of the risk of musculoskeletal disorders in the upper-limb in greenhouse workers by the OCRA and ACGIH-HAL methods. *Int J Hum Soc Sci*. 2018;3(4). doi:10.22100/IJHS.V3I4.286.
15. Lim MC, Awang Lukman K, Giloi N, Lim J, Salleh H, Radzran AS, et al. Landscaping work: work-related musculoskeletal problems and ergonomic risk factors. *Risk Manag Healthc Policy*. 2021;14:3411-21. doi:10.2147/RMHPS314843.
16. Dianat I, Afshari D, Sarmasti N, Sharifi Sangdeh M, Azaddel R. Work posture, working conditions and musculoskeletal outcomes in agricultural workers. *Int J Ind Ergon*. 2020;77:102941. doi:10.1016/j.ergon.2020.102941.