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Original Article

Physiotherapy Section

Effectiveness of Neck and Scapular Stability Exercises on Pain and Disability of Neck and Shoulder among Toy Makers of Neelasandra, Channapatna Taluk, Ramanagara District, Karnataka, India: A Quasi-experimental Study

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ABSTRACT

Introduction: Toy makers are exposed to prolonged repetitive upper-limb activity and sustained postures, placing them at high-risk for Work-Related Musculoskeletal Disorders (WMSDs), particularly affecting the neck and shoulder regions. Despite this occupational burden, limited research has examined targeted rehabilitation strategies for this artisan population.

Aim: To determine the prevalence of WMSDs and evaluate the effectiveness of neck and scapular stability exercises on neck and shoulder pain and disability among toy makers in Channapatna, Karnataka, India.

Materials and Methods: A quasi-experimental study was conducted among 210 toy makers (30-60 years) working minimum of one hour/day with chronic neck and shoulder pain (>3 months). Baseline WMSD prevalence was assessed using the Standardised Nordic Musculoskeletal Questionnaire. Outcomes included Shoulder Pain and Disability Index (SPADI), Neck Disability Index (NDI), shoulder rotator strength (hand-held dynamometry), and deep cervical flexor performance {Cranio-Cervical Flexion Test (CCFT) using pressure biofeedback}. The intervention followed a hybrid model over four weeks with supervised in-person sessions and telerehabilitation via video call, using standardised progression. Pre-post assessments were performed by a blinded assessor. As data were non normally distributed (Kolmogorov-Smirnov), pre-post changes were analysed using Wilcoxon signed-rank test (p-value <0.05).

Results: Twelve-month prevalence of WMSDs was highest for shoulder (91.4%) and neck (72.9%), with work limitation reported in 47.1% and 41.9%, respectively. Postintervention, SPADI and NDI scores reduced significantly (both p-value <0.001). Bilateral shoulder rotator strength and CCFT performance improved significantly (all p-value <0.001), with reduced pressure variation indicating improved cervical motor control.

Conclusion: A hybrid supervised-telerehabilitation neck and scapular stability program produced clinically meaningful reductions in pain and disability with significant gains in strength and cervical motor control, supporting targeted stabilisation as a scalable intervention for occupational WMSDs.

Keywords: Handicraft workers, Neck stabilisation, Scapular stabilisation, Telerehabilitation, Work-related musculoskeletal disorders

INTRODUCTION

Toys help children explore their surroundings, aiding in physical, emotional, cognitive, and social development [1]. China is the largest toy supplier [2]. Globalisation has led to low-cost Chinese goods flooding Indian markets, impacting the Indian toy industry, which sees 70% of imports from China [2,3] mostly made of PVC. These affordable toys are preferred over traditional Indian ones. The major issue is toxic substances like phthalates and heavy metals (Lead, Cadmium, Nickel, Arsenic), which harm the nervous and immune systems and can be fatal over time [2,4]. In India, traditional toys are made of natural materials such as wood, plant shoots, clay, cow dung, sawdust, coconut, cloth and other biodegradable materials [3]. One example is Channapatna softwood toys made in Channapatna (Toy-town of Karnataka). These toys are painted using natural dyes, which, even when ingested, do not have any such negative impact.

Channapatna is 60-70 km from Bangalore, in Karnataka's rural district, where over 300 families make wooden toys sold nationwide and abroad. Known as the Town of Toys ("Gombegala nagara"), it is a Geographical Indication (GI) protected under the World Trade Organisation, administered by Karnataka's government.

Some toys require one worker others need multiple workers for design, parts, and assembly. Making eco-friendly toys takes one to four hours. Financial strain may lead individuals to take on more physically demanding work, work longer hours, and neglect rest or proper ergonomics, thereby increasing the risk of Musculoskeletal Disorders (MSDs). MSDs affect muscles, tendons, nerves, and the vascular system due to inflammatory and degenerative changes. Work movement cause these painful disorders, termed WMSDs. WMSDs are a common occupational hazard among industrial workers, leading to work absence, poor performance, disability, and reduced quality of life [5]. The handicraft industry encompasses diverse occupations with shared characteristics like prolonged static sitting, repetitive movements, and fine dexterity. As this industry commercialises, workers face pressure to increase production speed. To maximise productivity, they often endure long hours in poor postures and intensive hand work [6].

Occupational exposure to stressful posture, force, and repetitive shoulder-arm movements burdens the musculoskeletal system, potentially causing WMSDs. In developing countries, handicraft workers often belong to small, unorganised enterprises not covered by governmental welfare or social security. Channapatna toy makers fall in this category of small-scale artisans [6]. The shoulder region is highly affected among handicraft workers. Prevalence of musculoskeletal symptoms in the shoulder varies from 40-91% among textile workers [7], stone carvers [8] and other craft workers [9,10]. Musculoskeletal symptoms in the neck were also high in other handicraft groups like sculptors, golden thread workers, and those in knitting, soft toy and bag making [10-16]. Therapeutic exercise regimes are advocated to restore shoulder mobility and stability by improving ROM and glenohumeral and scapulothoracic muscle function [17-21].

Despite existing evidence on the high prevalence of WMSDs among handicraft workers, there is a paucity of literature focusing on Channapatna toy makers and the effectiveness of targeted interventions such as neck and scapular stability exercises. Given the common occupational risk factors and the potential for broader applicability to similar unorganised sectors, this study aims to address this gap and contribute to evidence-based management of WMSDs.

Aim

- To assess the effectiveness of neck and scapular stability exercises on pain and disability of neck and shoulder among toy makers of Neelasandra, Channapatna Taluk, Ramanagara District, Karnataka, India.

Objectives

Primary objective:

- To assess the effectiveness of neck and scapular stability exercises on pain and disability of neck and shoulder among toy makers.
- To find the prevalence of scapular dyskinesis among toy makers.

Secondary objective:

- To find the prevalence of WMSDs among toy makers.

Hypothesis: The study hypothesises that there may be a significant effect of neck and scapular stability exercises on pain and disability of the neck and shoulder among toy makers of Neelasandra, Channapatna Taluk, Ramanagara District, against the null hypothesis that no significant effect exists.

MATERIALS AND METHODS

This quasi-experimental study was conducted among toy makers in small-scale units and independent settings in Neelasandra, Channapatna Taluk, Ramanagara District, Karnataka, India over a period of six months (April 2024- September 2024). Ethical clearance was obtained from the Institutional Ethics Committee on 30.5.2023 (RVCP/RESEARCH/2023-24/103).

Inclusion criteria: Subjects aged 30-60 years, with at least one year of work experience in toy making, involved in all phases of toy production, working minimum of one hour per day, having neck and shoulder pain for more than three months, and willing to provide written informed consent were included in the study.

Exclusion criteria: Subjects with neurological disorders, recent trauma (within six months) to the neck or upper limb, congenital deformities, pregnant and lactating women, or history of neck or upper limb surgeries were excluded from the study.

Sample size calculation: The sample size was calculated based on a reported prevalence of WMSDs of 76.83% [16].

Considering this proportion, the sample size was calculated using the following formula:

$n=\{Z\alpha/2+Z(1-\beta)\}^2\ pq \div d^2\}$

Where,

$\alpha=0.05$, $Z\alpha/2=1.96$,

$\beta=0.10$,

$Z(1-\beta)=1.282$(for 90% power)

p=76.83%=0.768,

q=1-p

=1-0.768=0.232

d=10%=0.1

Therefore,

Adjusting for Non response (10%):

n=187.27+10 % of 187=187+18.7=205.7

Rounded and adjusted for feasibility:

=210 participants

Considering a 10% addition, the final sample size was rounded to 210 participants. Convenience sampling was used.

Study Procedure

Participants were recruited after obtaining informed consent. Baseline demographic data were recorded. Pretest assessment was performed at baseline using the Standardised Nordic Musculoskeletal Questionnaire (NMQ) [21], to determine the prevalence of WMSDs, which includes dichotomous (Yes/No) responses across body regions, with prevalence interpreted as the proportion of participants reporting symptoms.

Pain and functional disability were assessed using the SPADI [22], NDI [23]. SPADI consists of 13 items scored on a 0-10 scale and converted to a percentage (0-100%), with higher scores indicating greater pain and disability, while NDI comprises 10 items scored from 0-5, with total scores expressed as a percentage, where higher scores denote greater disability. Pressure biofeedback unit for deep neck flexor strength, Activforce 2 dynamometer [24] for scapular muscle strength, and scapular dyskinesis was assessed using the Scapular Dyskinesis Test (SDT) [25], wherein subjects performed repeated weighted shoulder flexion and abduction and were graded as normal, subtle, or obvious dyskinesis based on scapular movement patterns.

Following baseline assessment, participants underwent a 4-week progressive cervical and scapular stabilisation program. Due to the large sample size and logistical considerations across multiple toy-making units, participants were grouped to facilitate structured delivery and monitoring. Each toy-making unit, comprising more than 50 workers, was subdivided into 5-6 smaller groups (approximately 8-12 participants per group) to facilitate effective supervision, individualised feedback, and better compliance during the intervention. Each group received a total of four supervised sessions, over four weeks (i.e., approximately one session per week), comprising two on-site (offline) sessions and two sessions via video consultation, each lasting 40-45 minutes. The supervised sessions focused on correct technique, progression, and feedback. The exercise protocol included activation of deep neck flexors using pressure biofeedback, cervical bracing and retraction exercises, and scapular stabilisation exercises such as scapular retraction, eccentric retraction, forward punch, dynamic hug, and inclined push-ups, with progressive resistance using elastic bands. Participants were additionally provided with a structured Home Exercise Program (HEP) through printed handouts and were instructed to perform exercises regularly between supervised sessions. As pressure biofeedback devices were not feasible for home use, participants continued cervical bracing and retraction exercises independently, while adherence and technique were monitored and reinforced through video consultations. Post-test assessment of SPADI, NDI, and muscle strength parameters was conducted at the end of four weeks by the same assessor. The assessor was blinded to pre- and post-test values. To minimise bias, the assessor was blinded to previously recorded baseline values during post-assessment, as data were coded and not accessible at the time of evaluation.

STATISTICAL ANALYSIS

Data were entered in Microsoft Excel and analysed using R software (version 4.1.0). Descriptive statistics were used to summarise the data, with categorical variables presented as frequencies and percentages, and continuous variables expressed as mean±standard deviation or median with interquartile range based on normality. Standard Error of Mean (SEM) and 95% confidence intervals were calculated for continuous outcome variables to estimate the precision of the mean values. However, inferential analysis was performed using non parametric tests. Inferential statistics were applied to assess the difference between pretest and post-test values of outcome measures (SPADI, NDI, and neck/scapular muscle strength). Paired t-test or Wilcoxon signed-rank test was used depending on the normality of data. A p-value < 0.05 was considered statistically significant. The prevalence of WMSDs was also estimated.

RESULTS

A total of 210 toy makers participated, with 192 (91.4) reporting prolonged daily work exposure (6-10 hours per day). A total of 137 (65.2%) participants belonged to middle class as per the Standard of Living Index [Table/Fig-1] [26]. Participants were primarily engaged in repetitive upper limb tasks across different stages of toy making [Table/Fig-2]. Work-related musculoskeletal symptoms were most prevalent in the shoulder {192 (91.4%)} and neck regions {153 (72.9%)}, which also contributed most to work limitation [Table/Fig-3].

Sociodemographic data		
Age (Years): Mean±SD	43.34±9.58* (*Mean and SD estimated from grouped age data)	
Gender; N (%)	Male	126 (60)
	Female	84 (40)
Working hours per day, N (%)	1-5	16 (7.6)
	6-10	192 (91.4)
	11-15	2 (1.0)
Body Mass Index (BMI) N (%)	Under weight	18 (8.6)
	Normal	116 (55.2)
	Over weight	50 (23.8)
	Obese	26 (12.4)
SLI	Low (11-14)	26 (12.4)
	Middle (15-19)	137 (65.2)
	High (20-24)	47 (22.4)

[Table/Fig-1]: Demographic and clinical characteristics of subjects included in the study.
SD: Standard deviation; SLI: Standard of living index [26]

Dominant work exposure	n (%)
Seasoning-related tasks	62 (29.5)
Cutting-related tasks	46 (21.9)
Carving-related tasks	44 (21.0)
Painting-related tasks	39 (18.6)
Pruning-related tasks	33 (15.7)
Quality checking/packaging	14 (6.7)

[Table/Fig-2]: Occupational work profile of toy makers (multiple responses).

Body region	Trouble in Last 12 Months n (%)	Trouble in Last 7 Days n (%)	Prevented from Work (Last 12 Months) n (%)
Neck	153 (72.9)	79 (37.6)	88 (41.9)
Shoulder	192 (91.4)*	108 (51.4)*	99 (47.1)
Elbow	14 (6.7)	14 (6.7)	10 (4.8)
Wrist/Hand	37 (17.6)	7 (3.3)	21 (10.0)
Upper back	18 (8.6)	17 (8.1)	15 (7.1)
Lower back	63 (30.0)	37 (17.6)	43 (20.5)
Hips/Thighs/Buttocks	4 (1.9)	4 (1.9)	2 (1.0)
Knees	54 (25.7)	46 (21.9)	37 (17.6)
Ankles/Feet	19 (9.0)	19 (9.0)	16 (7.6)

[Table/Fig-3]: Prevalence of work-related musculoskeletal symptoms by body region using the standardised Nordic musculoskeletal questionnaire (n=210).

Variables	Mean	Median	SD	IQR
Age (y)	43.34	44.00	9.58	14.00
No. of working hours	7.70	8.00	1.44	1.00
BMI (Kg/m^2)	24.13	23.92	4.54	5.20
SPADI (pretest)	68.30	67.00	18.16	29.25
SPADI (post-test)	47.74	47.00	16.36	29.00
NDI (pretest)	17.31	16.00	5.27	5.00
NDI (post-test)	10.15	9.00	4.27	6.00
Strength ER (Right)- Pre (Kg)	4.65	4.56	2.18	2.48
Strength ER (Right)- Post (Kg)	6.77	5.89	2.35	2.65
Strength IR (Right)- Pre (Kg)	5.17	4.62	2.86	2.64
Strength IR (Right)- Post (Kg)	7.21	6.45	2.64	3.35
Strength ER (Left)- Pre (Kg)	4.34	4.05	2.10	2.84
Strength ER (Left)- Post (Kg)	6.91	6.45	2.24	2.58
Strength IR (Left)- Pre (Kg)	4.98	3.97	2.86	3.05
Strength IR (Left)- Post (Kg)	7.23	6.66	2.67	3.54
CCFT (Pressure 1 mmHg- Pre)	22.31	22.00	1.33	2.00
CCFT (Pressure 1 mmHg- Post)	23.85	24.00	1.46	2.00
CCFT (Pressure 2 mmHg- Pre)	23.04	23.00	1.45	2.00
CCFT (Pressure 2 mmHg- Post)	24.19	24.00	1.61	1.00
CCFT (Pressure 3 mmHg- Pre)	23.48	23.00	1.36	3.00
CCFT (Pressure 3 mmHg- Post)	24.56	25.00	1.30	1.00
CCFT average pressure (mmHg)- Pre	24.06	24.00	1.06	1.67
CCFT average pressure (mmHg)- Post	24.03	24.00	1.04	1.67
CCFT pressure variation (mmHg)- Pre	2.57	2.00	1.59	1.00
CCFT pressure variation (mmHg)- Post	1.87	2.00	1.10	1.25

[Table/Fig-4]: Descriptive statistics of demographic and outcome variables at baseline and post intervention (n=210).
ER: External rotation; IR: Internal rotation; CCFT: Cranio cervical flexion test

As the data were non normally distributed, non parametric tests were used. Postintervention, there was a significant reduction in SPADI and NDI scores, along with significant improvement in shoulder muscle strength (all p-value <0.001) [Table/Fig-4,5]. Deep cervical flexor performance assessed using the CCFT showed significant post intervention improvements at pressure levels 1, 2, and 3 mmHg (all p-value <0.001). CCFT pressure variation reduced significantly post intervention (p-value <0.001), indicating improved cervical motor control. The change in CCFT average pressure was minimal (Pre: 24.06 mmHg; Post: 24.03 mmHg) and, despite reaching borderline statistical significance (p-value=0.050), did not indicate a clinically meaningful improvement in deep cervical flexor performance [Table/Fig-5].

A higher proportion of participants demonstrated Subtle Abnormalities (SA) across most movements, particularly in right shoulder abduction (128, 61.0%) and left shoulder flexion (118, 56.2%). Normal scapular motion (N) was comparatively lower, indicating a considerable prevalence of scapular dyskinesis among the study population. Overall, both unilateral and combined assessments suggest that scapular dysfunction was more common than normal movement patterns [Table/Fig-6].

DISCUSSION

The study demonstrated a high prevalence of WMSDs, with the shoulder being the most affected region (91.4%), followed by the

Variables	Z	Asymp. Sig. (2-tailed)
SPADI (Post-test) - SPADI (Pretest)	12.569	<0.001
NDI (Post-test) - NDI (Pretest)	12.495	<0.001
Strength ER (Right)- Post (Kg) - Strength ER (Right)- Pre (Kg)	12.565	<0.001
Strength IR (Right)- Post (Kg) - Strength IR (Right)- Pre (Kg)	12.327	<0.001
Strength ER (Left)- Post (Kg) - Strength ER (Left)- Pre (Kg)	12.519	<0.001
Strength IR (Left)- Post (Kg) - Strength IR (Left)- Pre (Kg)	12.206	<0.001
CCFT (Pressure 1 mmHg- Post) - CCFT (Pressure 1 mmHg- Pre)	10.403	<0.001
CCFT (Pressure 2 mmHg- Post) - CCFT (Pressure 2 mmHg- Pre)	7.639	<0.001
CCFT (Pressure 3 mmHg- Post) - CCFT (Pressure 3 mmHg- Pre)	8.262	<0.001
CCFT Average Pressure (mmHg)- Post - CCFT Average Pressure (mmHg)- Pre	1.956	0.050
CCFT Pressure Variation (mmHg)- Post - CCFT Pressure Variation (mmHg)- Pre	6.354	<0.001

[Table/Fig-5]: Pre-post comparison of pain, disability, strength, and CCFT outcomes using Wilcoxon Signed-Rank test (n=210).

Movement	Category	n (%)
Left shoulder flexion	N	62 (29.5)
	OA	30 (14.3)
	SA	118 (56.2)
Right shoulder flexion	N	64 (30.5)
	OA	43 (20.5)
	SA	103 (49.0)
Left shoulder abduction	N	91 (43.3)
	OA	30 (14.3)
	SA	89 (42.4)
Right shoulder abduction	N	39 (18.6)
	OA	43 (20.5)
	SA	128 (61.0)
Combined left	N	91 (43.3)
	OA	30 (14.3)
	SA	89 (42.4)
Combined right	N	75 (35.7)
	OA	43 (20.5)
	SA	92 (43.8)

[Table/Fig-6]: Scapular Dyskinesis Test (SDT) findings.
Note: N: Normal; OA: Obvious abnormality; SA: Subtle abnormality

neck (72.9%). Overall, musculoskeletal symptoms were commonly reported across multiple body regions, indicating a substantial occupational burden among toy makers. This occupational group is exposed to repetitive upper-limb movements and prolonged static postures, which are recognised risk factors for MSDs, particularly affecting the cervico-scapular region.

The socio-demographic and occupational profile revealed a predominantly middle-aged workforce with prolonged daily work exposure, which is consistent with previous findings in manual and craft-based occupations [6-15]. Studies in similar sectors such as textile work, wood carving, and furniture industries have reported that repetitive upper-limb activities and sustained postures significantly increase the risk of MSDs [6-15]. Bovenzi M et al., demonstrated a higher prevalence of upper limb disorders among workers engaged in repetitive hand-intensive tasks, which was comparable to the occupational demands of toy makers in the present study [27]. Thus, the current findings are concurrent with existing literature regarding occupational exposure and associated risk factors.

The prevalence of musculoskeletal symptoms was highest in the shoulder and neck regions, followed by the lower back and knees. These findings were in agreement with previous studies among handicraft workers, where the shoulder and neck have been identified as the most affected regions due to repetitive arm movements and sustained postural loading [28,29]. Similar patterns have been reported among textile workers, sculptors, and other artisans [6-15] indicating that the cervico-scapular complex bears the greatest biomechanical load in such occupations. Therefore, the present study supports existing evidence highlighting the vulnerability of the upper body in repetitive, precision-based work.

With respect to intervention outcomes, the study demonstrated significant improvements in SPADI, NDI, and shoulder muscle strength following the stabilisation program. These findings are consistent with previous research supporting the effectiveness of therapeutic exercise. A study by Santello G et al., reported that structured shoulder exercise programs significantly improved pain and function among workers with shoulder disorders [18]. Similarly, home-based exercise interventions have been shown to reduce SPADI scores and improve functional outcomes over time [19].

Further, studies on scapular stabilisation have demonstrated improvements in scapular kinematics, particularly enhanced external rotation and improved scapular control during arm elevation, contributing to reduced pain and improved function [19,20]. Randomised controlled trial comparing neck exercises alone with combined neck and scapular stabilisation have reported superior outcomes in the combined intervention group, including reductions in pain, improved posture, and increased cervical range of motion [19,20]. These findings were in concurrence with the present study, where a combined cervico-scapular approach resulted in significant improvements across all outcome measures.

The improvements observed in muscle strength and functional outcomes in this study can be explained by enhanced neuromuscular control and improved scapulohumeral rhythm. Improved scapular stabiliser strength is associated with better scapular positioning, which may help reduce mechanical strain on cervical structures during repetitive upper-limb activity. Concurrently, activation of deep cervical flexors enhances cervical stability and reduces compensatory muscle overactivity. This synergistic effect of combined neck and scapular stabilisation is supported by previous literature and explains the significant reductions in pain and disability observed in the present study [19,20].

An important contribution of this study lies in its integrated approach, combining both prevalence assessment and intervention within a single occupational group. While earlier studies have predominantly focused either on epidemiological aspects or intervention outcomes, the present study bridges this gap by addressing both [17-20]. Additionally, the hybrid mode of intervention, incorporating both supervised and telerehabilitation sessions enhances its practical applicability in informal-sector settings where access to continuous therapy may be limited.

The findings of this study are largely consistent with existing literature, demonstrating a high prevalence of WMSDs among handicraft workers, particularly affecting the cervico-scapular region. The significant improvements observed following neck and scapular stabilisation exercises support their effectiveness as a targeted intervention. The study also contributes novel evidence by applying a combined and context-specific rehabilitation approach in an underserved occupational group, highlighting its potential for broader application in similar settings.

Limitation(s)

The quasi-experimental design without a control group limits causal inference. Convenience sampling from a specific geographic area may affect generalisability. The short duration of follow-up limits the understanding of long-term sustainability of outcomes. Furthermore, ergonomic factors and workplace modifications were not included, which could have further influenced the results.

Future studies should consider randomised controlled designs with larger and more diverse populations to strengthen the evidence base. Long-term follow-up is recommended to assess sustainability of outcomes. Incorporating ergonomic interventions alongside exercise programs may provide a more comprehensive approach to managing WMSDs.

CONCLUSION(S)

The present study demonstrated a high prevalence of WMSDs among Channapatna toy makers, with the shoulder and neck being the most commonly affected regions due to repetitive upper-limb activity and sustained occupational postures. The findings highlight the substantial biomechanical demands placed on the cervico-scapular complex in this artisanal occupation. Following the intervention, the combined neck and scapular stabilisation exercise program resulted in significant improvements in pain, disability, shoulder muscle strength, and deep cervical flexor performance. These outcomes indicate that targeted cervico-scapular rehabilitation can effectively enhance both functional capacity and neuromuscular control in individuals exposed to repetitive occupational tasks.

The hybrid rehabilitation approach adopted in this study demonstrated practical feasibility in delivering structured exercise interventions within an informal-sector occupational setting where continuous supervised therapy may be difficult. Overall, the study provides valuable evidence supporting the role of integrated cervico-scapular stabilisation programs in reducing the burden of WMSDs and promoting occupational health among Channapatna toy makers.

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