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Original Article

Physiotherapy Section

Cardiorespiratory Fitness and Quality of Life among Handloom Workers of Sualkuchi, Assam: A Cross-sectional Study

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ABSTRACT

Introduction: Cardiorespiratory Fitness (CRF) measures how efficiently the heart, lungs, and muscles supply oxygen during exercise. Quality of Life (QoL) encompasses an individual's perceived well-being and satisfaction across multiple domains, including physical, psychological, social, and environmental aspects. Handloom workers are exposed to various occupational health hazards due to the nature of their work, which often leads to altered postural mechanisms, musculoskeletal injuries, respiratory problems, etc. However, there has been limited research specifically addressing the CRF and overall QoL of handloom workers in Assam. This knowledge may aid in better healthcare resource allocation in the future based on their specific health needs.

Aim: The aim of the study is to analyse the CRF and understanding of the health challenges faced by handloom workers due to their occupational condition and how it is affecting the QoL of Handloom Workers of Sualkuchi, Assam, India.

Materials and Methods: The present cross-sectional study was conducted from January 2024 to June 2024 at Sualkuchi, Assam, India, where 74 handloom workers were assessed for CRF by the Modified Harvard Step Test. WHOQoL-BREF (World Health Organization Quality of Life - BREF (or Brief) assessment) was used to interpret the QoL across four domains: physical fitness, psychological well-being, relationships in society, and the effect of the environment. The Wilcoxon rank-sum test was used for the analysis of CRF and QoL. Correlational analysis was done between Physical Fitness Index (PFI) and Body Mass Index (BMI) using Spearman's rank test, $p<0.05$ is considered significant.

Results: The mean age of the participants was 36.5(±4.4) and the duration they worked for was 7(±7), respectively. The BMI of 91% of participants was in the normal range, and only 9.5% were overweight. Modified Harvard Step Test indicated that a significant number of handloom workers had a low PFI. In terms of QoL, the handloom workers rate their social relationships the highest among the quality-of-life domains, while psychological well-being is the lowest-rated domain.

Conclusion: The present study underscores significant occupational health concerns among handloom workers, particularly in terms of CRF. Addressing these issues requires a multi-faceted approach, involving improvements in workplace conditions, health interventions, and psychological support.

Keywords: Health status, Modified Harvard step test, Physical fitness index, VO_2max, WHOQoL-BREF

INTRODUCTION

Sualkuchi (Silk City), located on the northern bank of the mighty Brahmaputra River, approximately 35 km northwest of the capital of Assam, where 92% of workers are engaged in handloom activities ingrained in the old Assamese culture and heritage, reflecting the significant role they play in the local economy and cultural identity [1]. Each house in the village has 'taat-xaal', which is a hand-operated throw-shuttle loom built using bamboo and wood that creates rhythmic 'click-clack' sound audible from the streets and helps in Weaving Mekhela Sador, Gamosa, Riha, and other traditional textiles. Weaving is a way of living and is not just a tradition and every effort is put with love for the work [2].

The handloom sector is the second largest employment sector is well known for its rich heritage, plays a vital role in generating the economy of the country. The loom known locally as taat-xaal is not merely a tool of production but a symbol of cultural identity, livelihood, and community pride. Generations of weavers have preserved this weaving technique, prioritising authenticity and heritage over mechanisation. This deep cultural attachment to traditional methods also means that weaving practices have remained unchanged, exposing workers to prolonged hours in static postures, repetitive movements of the hand to move the shuttles, operation of the pedals, which demands repeated leg movements, low-light environments, and poorly ventilated spaces, putting the workers at various health hazards. Also, the close-packed rooms have poor ventilation, which limits freedom of movement and exposes them to dust pollution [3]. Few studies have explored the health hazards experienced by the workers, which revealed issues such as arthritis, difficulty in breathing, weak eyesight, low blood pressure, and these problems escalate due to the prolonged hours of work, exposure to harmful chemicals, poor aeration and inadequate workplace conditions [1,3]. Cardiovascular diseases are responsible for one-third of the deaths globally [4]. According to the American Heart Association (AHA), decreased physical activity is one of the major risk factors in the development of coronary artery disease. Evidence also indicates that CRF plays a major role in reducing mortality and preventing incidents of stroke, myocardial infarction, and controlling hypertension also has shown a potential role in cancer prevention [5]. Physical fitness as defined by American College of Sports Medicine, means maintaining a state of well-being that includes the capability to participate in sports, tasks related to work, and daily functional activities which is obtained by balanced diet, engaging in moderate to vigorous physical activity, ensuring an adequate amount of rest, and adhering to a structured exercise program. It also reflects the ability to overcome unexpected physical challenges. A physically fit individual can complete the tasks efficiently without excessive fatigue and recovers quickly [6].

The CRF assesses how efficiently the cardiovascular and respiratory systems deliver oxygen to the skeletal muscles during prolonged physical exercise and is a strong indicator of the overall health, illness, risk of heart disease and mortality. Importantly, lack of physical activity and poor physical conditioning are modifiable risk factors that can be controlled [7]. Step Tests are commonly utilized assessments for determining VO_2max which is an indicator of CRF.

Oxygen consumption in Step tests is typically calculated using an equation [4]. The Harvard Step Test developed by Brouha L et al., is a sub-maximal stress test that measures aerobic fitness and predicts VO_2max [8]. The PFI using the Modified Harvard Step Test is a widely used and calculated to assess cardiovascular fitness and endurance. After the exercise, the individual's heart rate is recorded at various intervals during the recovery period, usually at 1, 2, and 3-minute post-exercise. This index indicates how efficiently the cardiovascular system recovers after exercise, with higher PFI scores indicating better cardiovascular fitness [7]. QoL is defined by the World Health Organisation as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns". Key components of QoL typically include personal health (physical, mental, and spiritual), social relationships, education, working environment, financial resources, safety, freedom of decision-making, sense of belonging, security and surroundings [9].

Although studies from various states in India [1,3,10] have documented occupational health hazards among handloom workers including musculoskeletal disorders, visual strain, and respiratory issues-there is a lack of research specifically focusing on the unique context of Assamese weaving communities. In Sualkuchi, where the *taat-xaal* loom and traditional weaving techniques have been preserved for generations, work conditions differ notably from other states due to the use of non-mechanised looms, prolonged static postures, dimly lit indoor settings, and continuous year-round production of intricate silk fabrics. These culturally rooted practices, while integral to preserving heritage, may also increase the risk of physical strain and reduced cardiopulmonary capacity [1]. Consequently, there is a critical need to assess the CRF and QoL of Sualkuchi's handloom workers to develop interventions that protect health without compromising cultural integrity, The present study aimed to assess the CRF and QoL of Handloom Workers of Sualkuchi, Assam and the correlation of CRF with the demographic findings.

MATERIALS AND METHODS

A cross-sectional study was conducted at The Assam Royal Global University, Sualkuchi, Assam, India, from January 2024 to June 2024. Institutional Ethical Committee (IEC) approval was obtained with Reg No. (RGU/IECHR/MPT/2024/07). Written informed consent was obtained from all participants before inclusion in the study.

Inclusion criteria: Both males and females aged between 30-45 years who could read Assamese, Hindi or English were included in the Study.

Exclusion criteria: Subjects diagnosed with any cardiovascular disease, undiagnosed symptoms of chest pain and breathlessness, with severe hypertension, fever or any other illness, fractures or any severe injury, recent major surgeries and mental impairment leading to an inability to exercise adequately were excluded.

Sample size calculation: Total sample size was calculated by using the formula given below:

$$n=\frac{(Z\frac{\alpha}{2})^2\ p(1-p)}{d^2}$$

Where,

n is the required sample size

d is the Absolute error or precision.

$\frac{\alpha}{2}$ is the critical value of the normal distribution at $\frac{\alpha}{2}$.

p is the expected proportion of low CRF

For 95% confidence level, $Z\frac{\alpha}{2}$ is 1.96. As no published CRF estimate was available for hand-loom population therefore, we assumed a prevalence of low CRF=5% with d=0.05 and Z=1.96, the minimum sample size was 73. Allowing for 10% non-response, the final target sample size was 80.

Study Procedure

A convenience sampling method was employed to recruit participants because of its ease of access and the study's time constraints. Demographic data, including age, gender, duration of work, and BMI, were recorded for all subjects. Participants were familiarised with the Modified Harvard Step Test before the procedure and received instructions on how to prepare for it. A step test was conducted, and data were collected. Before starting the test, subjects rested for five minutes, after which their resting pulse rate was measured [8]. During the test, participants stepped up and down on a platform 30 cm high in a rhythmic manner for five minutes or until they reached exhaustion, guided by a metronome. Immediately after exertion, they were asked to sit down, and their pulse was counted between 1 to 1.5 minutes, 2 to 2.5 minutes, and 3 to 3.5 minutes. At the end of the protocol, the test score was calculated using the PFI [7]. The PFI score is determined by the following equation:

PFI=100×(duration of the test) / (2×(Pulse 1+Pulse 2+Pulse 3))

PFI scoring: >90 indicates excellent, 80-89 is good, 65-79 is average, 55-64 is low, and less than 55 signifies poor fitness [11,12].

Finally, participants completed the WHOQoL-BREF questionnaire [13], which evaluates four domains of QoL: Physical Health, Psychological health, Social relationships, and Environment. They rate their QoL on a scale from 1 to 5, selecting the number that best describes their experience. The final score ranges from 0 to 100, with 0 representing the lowest QoL.

STATISTICAL ANALYSIS

The collected data were scored, tabulated, and analysed using SPSS version 27. The Shapiro-Wilk test was performed to assess the normality of the data. Since the data followed a non-normal distribution, the non-parametric Wilcoxon rank-sum test was used for analysis. Spearman's rank test was used to measure the correlation between PFI and BMI. Statistical significance was set at $p<0.05$.

RESULTS

Of 80 screened subjects, six were excluded (fever: 2; severe back pain: 2; non-adherence: 2). The final sample comprised 74 handloom workers.

The cohort was predominantly female 54 (73%), with a mean age of 36.5 years (SD 4.4). Median work duration was five years (range 0-30). The BMI of 90.5% of participants was in the normal range, and only 9.5% were overweight. PFI shows 33 (45%) participants have poor CRF, out of which 19 (25.67%) subjects could not even complete the test, and 41(55%) fall in the low average [Table/Fig-1].

Characteristics	Values (N=74)
Age (in years)	
Mean (±SD)	36.5 (±4.4)
Median (range)	36.0 (30.0-47.0)
Gender	
Female	54 (73%)
Male	20 (27%)
Duration of work (years)	
Mean (±SD)	7 (±7)
Median (Range)	5 (0-30)
BMI level	
Normal	67 (90.5%)
Overweight	7 (9.5%)
PFI level	
Low average	41 (55%)
Poor	33 (45%)

[Table/Fig-1]: Baseline characteristics (Demographics, BMI, PFI).

WHOQoL-BREF scores indicated moderate overall QoL (73 (±6)). Among domains, social relationships scored highest (81 (±9), while psychological health scored lowest (69±9), highlighting psychosocial vulnerability [Table/Fig-2].

Quality of Life (QoL)	Values (N=74)
WHOQoL-BREF	
Mean (±SD)	73 (±6)
Median (range)	73 (59-90)
Physical	
Mean (±SD)	73 (±10)
Median (range)	71 (54-100)
Psychological	
Mean (±SD)	69 (±9)
Median (range)	67 (46-92)
Social relationship	
Mean (±SD)	81 (±9)
Median (range)	83 (50-100)
Environmental	
Mean (±SD)	71 (±6)
Median (range)	72 (53-88)

[Table/Fig-2]: WHOQoL-BREF Domains (Quality of Life scores).

CRF showed strong positive correlations with physical (r=0.73, p<0.001) and psychological well-being (r=0.71, p<0.001). Moderate correlations were observed with environmental (r=0.68, p<0.001) and social domains (r=0.61, p<0.001). BMI demonstrated no meaningful association (r=0.1, NS) [Table/Fig-3].

Spearman's Correlation		
WHOQoL-BREF	**Cardiorespiratory Fitness (CRF)**	**p-value**
Physical	r=0.732***	<0.001
Psychological	r=0.713***	<0.001
Social Relationship	r=0.608***	<0.001
Environment	r=0.680***	<0.001
BMI (kg/m^2)	r=0.1	>0.05

[Table/Fig-3]: Correlational analysis of components of Quality of Life (QoL) with Cardiorespiratory Fitness (CRF).
Spearman's correlation coefficient, p-value <0.05- considered significant

Longer work duration was significantly correlated with lower physical fitness (p-value=0.032), while age and BMI showed no meaningful relationship with fitness or QoL [Table/Fig-4].

Demographic Characteristics	Physical Fitness Index (PFI) and Quality of Life (QoL)	r	95% CI	p-value
Age (in years)	PFI	-0.24	(-0.45, -0.01)	0.347
Age (in years)	WHOQoL-BREF	0.09	(-0.14, 0.31)	0.999
Duration of work (years)	PFI	-0.34	(-0.53, -0.12)	0.032*
Duration of work (years)	WHOQoL-BREF	0.2	(-0.03, 0.41)	0.731
BMI (kg/m^2)	PFI	-0.11	(-0.33, 0.12)	0.999
BMI (kg/m^2)	WHOQoL-BREF	0.12	(-0.11, 0.34)	0.999

[Table/Fig-4]: Correlational analysis of demographic characteristics with PFI and Quality of Life (QoL).
(***) p<0.001(highly significant), (*) significant, NS: non-significant

DISCUSSION

In the present study, none of the participants achieved average or above-average CRF; 45% were classified as poor and 55% as low average, with one-quarter unable to complete the test. Although 91% had a normal BMI, fitness levels remained poor, underscoring that BMI does not adequately reflect muscle mass or cardiorespiratory efficiency. This discrepancy likely stems from low physical activity, poor body composition despite normal BMI, and a lack of exercise training [11].

Occupational factors appear central to these findings. Handloom weaving involves prolonged sitting, repetitive limb movements, restricted workspace, awkward postures, and poor ventilation, all of which may impair lung expansion and contribute to reduced fitness. Dust and lint exposure further compromise respiratory health, consistent with reports of musculoskeletal and pulmonary problems in textile workers [13] and impaired lung function in mining populations exposed to dust [14]. Even sedentary occupations show similar risks from prolonged sitting and insufficient activity [15]. Thus, the type and quality of workplace activity, combined with environmental exposures, may influence fitness outcomes more than absolute energy expenditure.

QoL scores were moderately high overall, with social relationships rated highest and psychological health lowest. This apparent paradox, poor fitness but relatively high QoL, can be explained by the multidimensional nature of QoL. As QoL is self-reported, individuals may perceive well-being through strong social and cultural support systems despite low physical performance [16]. In Assam, weaving is embedded in community traditions and collective identity, fostering resilience and mutual support [1,17,18]. This cultural context likely buffers the negative effects of occupational strain, explaining the strength of the social domain.

Correlation analyses confirmed strong positive associations between CRF and QoL domains (physical, psychological, environmental, social; all p<0.001). Although absolute fitness was poor, within-group variation showed that relatively better fitness aligned with higher perceived QoL. Psychological scores, however, remained lowest, reflecting financial instability, occupational strain, and limited mental health literacy, consistent with prior studies in vulnerable worker populations [3,19]. Demographic correlates showed that longer work duration was significantly associated with lower fitness, while age and BMI had no meaningful relationship with either fitness or QoL.

Limitation(s)

The present study has several limitations. The cross-sectional design precludes establishing causal relationships between occupational exposures and health outcomes. Data were collected from a single geographic area, which may limit generalisability. The absence of a control group restricts the ability to compare findings with other occupational groups. Furthermore, some potentially influential factors, such as income variability, Socioeconomic status, work–life balance, and mental health history, were not measured, and the study relied on self-reported data through the WHOQoL-BREF, which may be subject to recall bias, potentially affecting accuracy. Future studies should aim to include larger and more diverse samples, incorporate comparison groups, and use longitudinal designs to track changes over time

CONCLUSION(S)

Handloom workers demonstrated uniformly poor CRF despite most of them having normal BMI, highlighting that BMI is not a reliable indicator of physical fitness. QoL scores were moderately high, with social relationships strongest and psychological health weakest, reflecting cultural resilience despite occupational strain. Fitness correlated positively with multiple QoL domains, while longer work duration was significantly linked to reduced fitness. These findings emphasise the need for ergonomic improvements, physical activity promotion, and psychological support in this workforce.

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