

Research Article

A Prospective Evaluation of Modified Hand Injury Severity Score in Predicting Hand Function and Return to Work in Thresher Machine Hand Injuries

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Abstract: Background: Agriculture-related is a cause of complex occupational injuries, particularly in settings where mechanical equipment such as thresher machines are used. Prediction of functionality status is necessary for patients' counselling.

Objective: To evaluate the role of the modified hand injury severity score (mHISS) in predicting return to work following an injury from a thresher machine. The study also aimed to predict hand function in this cohort of patients.

Materials and Methods: A prospective longitudinal study was conducted at the Department of Plastic Surgery at Ruth Pfau Civil Hospital during 8th November 2024 to 25th February 2026 (Ref. No. IRB-3677DUHS/Approval/2024/343, dated: 6th November 2024). We used mHISS score to assess hand injury severity. Patients were assessed for their hand function (TAM) prior to returning to work. The outcomes were evaluated at the sixth month follow-up.

Results: Data from 110 patients were analyzed, whose mean age was 35.0 ± 9.8 years. Median mHISS score was 35. The majority returned to work within 6 months (84.5%) with a median time of 50 days and TAM was 185. The mHISS was significantly associated with return to work (HR=0.98, 95% CI: 0.97-0.98) and TAM ($\beta=-0.88$, 95% CI: -0.99 --0.77).

Conclusion: mHISS is a strong predictor of return to work, not only as it relates to time to return to work, but also relates to hand function at six months after the initial injury, as increasing mHISS indicating an extended time to return to work and a deterioration in hand function.

Keywords: Agricultural injury, Hand function, Hand trauma, Occupational injuries, Predictive scoring system.

INTRODUCTION

The hand is the second most active body part after the foot. The hand also sustains higher levels of stress/high-impact than any other body part, which increases the potential for injury. The properties of the skin on the hand enhance its ability to withstand (protect against) environmental, chemical, and physical hazards [1]. Occupational accidents have repeatedly been identified as a primary cause of employment absenteeism, and also as a worldwide public health issue [2, 3]. Upper extremities are the most frequent area injured through occupational incidents, and they are a major contributor to functional impairments. Hand injuries are one of the most common sources of impairment in young workers. All hand injuries are associated with some degree of permanent disability, which

results in decreased efficiency of activity both during the day and at work [4, 5].

The agriculture industry is one of the world's most dangerous industries with considerable numbers of accidents and occupational diseases [6]. In the agriculture industry, hand and upper extremity injuries are common, disabling injuries that represent a substantial occupational hazard for workers in the industry. Farm injuries can occur to workers of all ages, and they are associated with significant treatment costs and use of healthcare resources [7, 8].

Hands are the most important tools we use to do many things we do in our day to day lives and at work. Because of this, any injury to a person's hands can affect their entire life and prevent them from working for a long time. Due to the effect of hand injuries on all aspects of body and mind used for performing many types of movement,

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including work-type movements, it will take an individual about one full year to adjust after such an injury. During that time, he or she may not be able to participate fully at work for a period of time and may never return [9]. The process of returning-to-work (RTW) following a hand injury is complex because there are many different strategies available that may require support from numerous healthcare providers and other participants [10, 11]. Some studies have shown that time to RTW is positively associated with the site of injury, a person's age, the type of work performed, and the need for any further surgical intervention [2]. The literature contains evidence regarding the positive relationship between time to RTW [12], the site of hand injury [13], and the severity of injury [12, 14].

It could be advantageous to predict early on in the course of treatment which patients will not return to previous job. Early identification of patients that could benefit from retraining for new skills can help to decrease the financial burden caused by an injury and provide psychological support as they adjust to their expected level of permanent impairment. In 1996 Campbell and Kay developed the first hand injury severity score (HISS) to compare like injuries of the hand [15].

The original purpose of the HISS was to provide an objective and standardized method for measuring the severity of hand injuries as it relates to the involvement of anatomical structures (e.g., skin, skeletal system, motor system and neurovascular system). Due to several limitations in the original HISS, including but not limited to complexity and limited use among certain injury types, the modified hand injury severity score (mHISS) was developed. The mHISS was intended to improve the utility of the HISS by providing more comprehensive information about the nature of the injury and better predict the functional outcome and return to work of injured individuals. The mHISS has improved clinical utility by providing a more consistent and reproducible mechanism to categorize the severity of an injury and predict the clinical outcome, particularly in situations where different injury types are common [14, 15].

As per some recent reports, the figure for the number of cases of agricultural-related occupational injury per 100 workers is as high as 35 [16]. A recent survey carried out in Pakistan discovered that injuries due to thresher machines constituted 39% of agricultural injuries with an amputation rate of 38% for males [17]. The mHISS tool has never been employed in the local population. It is of great importance to examine how this tool may help

in predicting hand function and return to work at this specific group of patients. Therefore, the objective of the present study is to determine whether there is a relationship between thresher-related hand injury and returning home, and to evaluate the ability of the mHISS to predict return-to-work. The secondary aim was to predict hand function in this cohort of patients.

MATERIALS AND METHODS

This is a prospective longitudinal study that was undertaken at the Department of Plastic Surgery at Ruth Pfau Civil Hospital in Karachi over the period of 8th November 2024 to 25th February 2026, after receiving formal approval from the Institutional Review Board on the institutional letterhead bearing number IRB-3677DUHS/Approval/2024/343, dated: 6th November 2024. All patients who presented with an acute hand (or forearm) injury from a threshing machine in the emergency department and were 18 years of age or older and any gender were included in this study. Patients with diagnoses of mental illness or other cognitive impairments were excluded from this study, as were patients with any other traumatic injury to the hand in addition to the thresher machine injury, patients with a history of arthritis or gout, as well as those who had a past history of either a neck or shoulder condition that limited function of the hand or had a pathology of the hand, were also excluded.

An investigation had formerly determined that 81% of patients were able to go back to their previous employment after an accident [14]. Using a 95% CI with a 8% margin of error, the required sample size is 93 as estimated using online available calculator OpenEpi. However, for better results we studied 110 patients. Patients were recruited consecutively according to inclusion criteria with their written informed consent. In case if patient was unconscious, permission was sought from the caregiver.

All patients seen in the emergency department for hand injuries were first evaluated by the attending emergency physician who notified the case to hand trauma team. The history was then obtained by the attending emergency physician. Where a patient had sustained a hand injury from operating a "thresher", the patient was enrolled into the study. The following data were collected; demographics (patient's age, sex, education, work experience, formal training) and injury characteristics (injury location, injury type, dominant hand affected, mHISS score, range of motion, returned to work status at 6-month follow-up).

There are 4 components that comprise the Modified Hand Injury Severity Score (mHISS); they include the integumentary, skeletal, motor, and neuromuscular components (collectively, ISMN). Each ISMN component has both an absolute score and a weight based on their degree of functional use for the ray in question. Further, if an ISMN component has a complication (e.g., an infected wound; compound fractures; crush injuries; or avulsion injuries), the overall score of that ISMN component will be multiplied by 2. Finally, the aggregate of all ISMN component scores constitutes the overall mHISS. As described in Campbell and Kay's publication, the mHISS score will be categorized as follows: minor (mHISS < 20); moderate (mHISS 21-50); severe (mHISS 51-100), or major (mHISS > 101) (14). The assessment of functional outcome of the affected finger was done using Total Active Movement (TAM). TAM assessment includes measuring active motion range of the certain metacarpophalangeal (MCP), proximal interphalangeal (PIP), distal interphalangeal (DIP) joints of the affected finger in the position of wrist in neutral and pronation. For the case with the thumb, it was evaluated at the involved MCP and interphalangeal (IP) joint. The measurements were taken at each joint using finger goniometer. TAM was calculated by the total of the active angles of flexion of relevant joints minus the extension deficits. The results of TAM were expressed in degrees (°). Return to work (RTW) was classified as a patient returning to their past employment after at least 28 days without sick leave. The time from surgery until return to work was recorded in days.

After surgery, patients came back for an initial postoperative follow-up appointment 1 week later, then again 2 weeks postoperatively, and then once a month until healing of the wound and/or recovery were complete. If patients developed complications (e.g., discharge), they were instructed to come back for an appointment prior to the next scheduled appointment. Patients with minor injuries that did not require long-term follow-up were given instructions for home care and requested to return for an evaluation as clinically indicated. Patients were provided with the purpose of this study and asked to inform the researchers when they returned to work. In addition, all patients enrolled in the study were scheduled for an out-patient visit to evaluate their hand function. Additionally, when appropriate, clinicians conducted follow-up telephone calls to determine whether or not additional post-operative care was needed for each patient.

STATISTICAL ANALYSIS

The collected data were analyzed using SPSS version 27.0. For categorical variables, frequency and percentage were computed. For continuous variables the mean $\pm$ standard deviation or median and interquartile range was reported as appropriate. The normality of the numerical data was assessed using the Shapiro-Wilk test. The patients' return to work status was compared by different injury types at the 6-month time point using the Chi-square test. The time taken for the patient to resume work and the TAM were compared using the Kruskal-Wallis test. Post-hoc differences were tested using Man-Whitney U test with Bonferroni correction. Cox regression was applied to determine association of return to work with mHISS score. A linear regression analysis was performed to determine whether and to what extent the mHISS served as a predictor of time to return to work and the TAM. P-value < 0.05 was deemed as statistically significant.

RESULTS

A total of 110 patients were studied with mean age of 35.0 ± 9.8 years. Majority of them were males (82.7%) and working more than 5 years. Few of them attended professional work training (15.5%). The commonest injury site was finger (55%) with tendon nerve injury being the most frequent (33.6%). Mostly injuries occurred in dominant hand (85.5%). Median mHISS score was 35 (IQR=10-81.3). Around quarter of them had minor injuries (25.5%). Nearly one-third patients had moderate injuries (33.6%) whereas approximately one-fifth of patients had severe (21%) and major injuries (20%). Table 1 displays frequency distribution of sociodemographic and hand injury features of patients.

Table 1. Summary of Sociodemographic and Hand Injury Features of patients.

Variables	Frequency	Percentage%
Age Groups		
18-20 years	11	10.0%
21-29 years	25	22.7%
30-39 years	39	35.5%
40-49 years	27	24.5%
50 years and above	8	7.3%
Gender		
Male	91	82.7%
Female	19	17.3%

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Attended Professional Training		
Yes	17	15.5%
No	93	84.5%
Work Experience		
<5 years	22	20.0%
≥5 years	88	80.0%
Injury Site		
Finger	55	50%
Thumb	17	15.5%
Wrist	10	9.1%
Dorsum	12	10.9%
Mid palmer	10	9.1%
Forearm	6	5.5%
Injury Type		
Skin laceration	16	14.5%
Contusion	12	10.9%
Tendon nerve injury	37	33.6%
Traumatic amputation	12	10.9%
Avulsion	10	9.1%
Crush injury	17	15.5%
Fracture	6	5.5%
Dominant Hand Injury		
Yes	94	85.5%
No	16	14.5%
mHISS Categories		
Minor	28	25.5%
Moderate	37	33.6%
Severe	23	20.9%
Major	22	20.0%

Majority of patients returned to their work (84.5%) within first six months with median time of 50 (IQR=13-69) days. At sixth month follow-up the median TAM was 185 (IQR=160-240). Table 2 represented comparison of frequency of returned to work, time to return to work and average range of motion among different injury types. Proportion of RTW score significantly higher in patients with minor injuries like skin laceration and contusion whereas less number of patients with major injuries including traumatic amputation (58.3%) and avulsion (60%) returned to their work with six months. Time to return to work was significantly different among the injury types. The pos-hoc analysis revealed significant difference of time taken by skin laceration and contusion group with time taken by patients with other injury types. TAM was also significantly different among all the injury

types with significantly lower ranges for patients having traumatic amputation and avulsion as analyzed on post-hoc analysis.

Table 2. Comparison of Return to Work, Time to Return to Work and Total Active Range of Motion (TAM) among different Hand Injury Types.

Hand injury type	Return to work n(%)	Time to Return to Work Median (IQR)	TAM Median (IQR)
Skin laceration	16(100)	9 (7-14)	250 (248-252)
Contusion	12(100)	6.5 (5.3-8.7)	245 (242-247.3)
Tendon nerve injury	31(83.8)	56 (47-68)	195 (182.3-200)
Traumatic amputation	7(58.3)	150 (130-170)	90 (72.3-107.5)
Avulsion	6(60)	105 (93.7-122.5)	100 (95-106.3)
Crush injury	15(88.2)	60 (52-68)	170 (165-177.5)
Fracture	6(100)	41 (33.7-46.3)	160 (153.7-166.3)
p-value	*0.008	*<0.001	*<0.001

*Significant at p<0.05.

After adjusting for age and gender, mHISS score was significantly associated to return to work with increasing score was associated to a lower hazard of returning of work indicating one unit increase in mHISS score was associated to 2% decrease in the rate of return to work (HR=0.98, 95% CI: 0.97-0.98, p<0.001). An increasing mHISS score was associated with 0.88 units decrease in total active motion range (-0.88, 95% CI: -0.99 – -0.77, p<0.001) (Table 3).

Table 3. Multivariable association of mHISS with Returned to Work, Time to Return to Work and Range of Motion at Six Months.

Variables	Return to Work		Total Active Motion Range	
	HR (95% CI)	p-value	β (95% CI)	p-value
Age (years)	0.92 (0.89 – 0.95)	0.207	0.929 (-1.47 – -0.38)	*0.001
Gender (male)	1.35 (0.78 – 2.35)	0.502	6.42 (4.82- 17.65)	0.260

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mHISS score	0.98 (0.97 – 0.98)	*<0.001	-0.88 (-0.99 – -0.77)	*<0.001
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CI: Confidence interval, *Significant at $p < 0.05$.

DISCUSSION

This study demonstrated that 84.5% of those who had an accidental hand injury returned to work (RTW) within 6 months and the median number of days it took to RTW was 50. This indicates that in the group of people with high-risk jobs related to agriculture, this group returned to work at a relatively high rate, relatively quickly after they were injured. Moreover, this findings also suggested that increasing level of mHISS was associated with decreasing odds of RTW, increase in time to return and decreased hand function.

Numerically, our RTW and median time frames were very close to literature published internationally in cohorts with similar experiences of hand injuries in an occupational setting [14,18]. For instance, in 111 cases of occupational hand injuries in Turkey (heavy labour was predominantly agricultural), reported that the average time that elapsed until their RTW was 58.6 days which is similar to this study. RTW times were longer in patients with fractures, higher mHISS scores, had surgery and/or received physiotherapy. Another similar study demonstrated that the average RTW duration for patients with injuries of mild to moderate severity was 30 days, while the average duration for patients with severe injuries was 118 days with the period of time to RTW for patients with major injuries was 760 days or longer ($p < 0.0001$) [18]. In another other, the number of RTWs among a cohort of patients having hand and forearm injuries was approximately 79.7% with the average duration for these patients to return was 90 days. Approximately 60% of patients with major injuries RTW, and had an average length of more than one year to RTW [14].

Studies conducted in the past have further supported our findings of o determining return to employment link to mHISS. A prospective study measuring the severity of hand injuries indicated that mHISS was the only significant predictor of both return to employment and the length of time taken to return, regardless of age, occupation or hand dominance etc. The patients who returned to work had a significantly lower mean mHISS score than patients who did not return to work (55.8 vs 151.5) [14]. Cankurt Ayar N, *et al.* [19], conducted a study evaluating the use of mHISS to identify patients who returned to

work, which indicated that mHISS had a strong predictive ability for identifying with longer RTW. The use of mHISS demonstrated a strong association of the presence of a higher score in 94 patients suffering an injury to the hand, wrist, or forearm with increased levels of disability and a longer time to return to work (up to approximately 266 days post injury for major injuries) [20].

Several studies have shown similar findings to what has been presented above. One study followed 32 patients who suffered from traumatic injuries to their hand and the nerves inside of the hand for one year. The results from this study showed a strong correlation between higher mHISS scores and the time taken to return to work (average ~70 days), hand function scores and pinch strength (data available at 12-month follow-up) [21]. Another study conducted in Nigeria reviewing 49 patients who were treated with surgical reconstruction for upper limb injuries also found a statistically significant association between higher mHISS scores and increased time until returning to work (average of 14.3 ± 10.5 weeks), as well as a male-to-female difference and injury as related (by regression analysis) to time until return to work [22].

For hand function, this found that increasing mHISS levels were associated to decreasing range of TAM. In support of this finding, previous studies have shown that a person's ability to functionally recover is related to their level of injury. All follow-up studies showed significant positive correlations between total mHISS score, PRWHE, DASH, and HAQ scores. As a result, patients reporting higher injury severity based on mHISS score tend to be functionally worsened with higher DASH scores [23]. Additionally, level of injury severity is associated to hand function and pinch strength [24]. While most studies report similar correlations, there have been some mixed results, including a cross-sectional study showing weak or no correlation between injury severity (HISS) and DASH scores ($r_s = 0.1$) [25].

STRENGTHS

The strengths entail the prospective longitudinal design, standard injury severity measurement, and clinically pertinent outcomes. The use of standard injury severity measure (mHISS) and clinical outcomes such as elapsed time to return to work and hand function improves the clinical relevance of the study. Cox proportional hazards regression was an appropriate statistical method to take into account the time of return to work and censored observations. In addition, the study emphasizes relevant

occupational health issue presented in a population where evidence regarding the issue of functional recovery is limited.

LIMITATIONS

The study suffers with few limitation as it was performed in a single center with a limited sample size limiting the generalizability of findings to other settings in Pakistan. In addition, there are a number of social, occupational, and workplace factors that were not fully captured that may play a significant role in impacting returns to work time.

CONCLUSION

The present study found a significant role of mHISS in predicting return to work, time to return to work and hand function at sixth month follow-up with increasing mHISS levels indicating serious injuries taking longer to return to work and compromised hand function.

ABBREVIATIONS

HISS: Hand injury severity score.

mHISS: Modified hand injury severity score.

RTW: Return-to-work.

TAM: Total active motion.

AUTHORS' CONTRIBUTIONS

Hiba Khan: Conceptualization, study design, methodology, data analysis and interpretation, drafting the manuscript, critical review and revision of the manuscript, and final approval of the version to be published.

Faisal Akhlaq Ali Khan: Study design, critical review and revision of the manuscript, and final approval of the version to be published.

Asma Ishtiaq, Saba Asif, and Waqas Sami: Methodology, data analysis and interpretation, drafting the manuscript, and final approval of the version to be published.

Ali Ekram: Methodology, data analysis and interpretation, and drafting the manuscript.

All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Declared none.

ETHICAL DECLARATIONS

Data Availability

The data supporting the findings of this study are included in the article. Further inquiries regarding the data may be directed to the corresponding author, subject to applicable ethical, privacy, and institutional requirements.

Ethical Approval

This prospective longitudinal study was conducted at the Department of Plastic Surgery, Ruth Pfau Civil Hospital, Karachi, Pakistan, from 8th November 2024 to 25th February 2026, following approval from the Institutional Review Board. Ethical approval was granted under Reference No. IRB-3677DUHS/Approval/2024/343, dated 6th November 2024.

Consent to Participate

Written informed consent was obtained from all patients before their participation in the study.

Consent for Publication

Written informed consent for publication was obtained from patients whose individual information, clinical details, images, or other potentially identifiable material are included in this article, where applicable.

Declaration of Competing Interest

The authors declare that they have no known financial or non-financial competing interests that could have influenced the work reported in this study.

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Use of AI-Assisted Technology

The authors used Google Gemini, an artificial intelligence (AI)-assisted language tool, to assist with improving the language, grammar, readability, and formatting of the manuscript. AI was not used for data collection, data analysis, interpretation of results, or generation of scientific conclusions. All AI-assisted output was critically reviewed, revised, and approved by the authors, who take full responsibility for the accuracy, integrity, originality, and final content of the manuscript.

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