**Interaction of age and sex on post-discharge quality-of-life in adult trauma patients in urban India – a cohort study**

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**Abstract**

*Background:*

Age and sex can affect with post-discharge outcomes and quality of life (QOL) in trauma patients. However, the interaction between age and sex on QOL in this cohort in low- and middle-income countries (LMIC) settings is poorly studied.

*Methods*:

This study is a cross-sectional study using data from an ongoing interrupted time series study of trauma patients from four tertiary-care hospital in urban India. QOL was assessed at 90-days post-admission using the EuroQol (EQ) 5D-3L that consists of 5 dimensions and the visual analog scale (VAS) to rate current health status. Multivariate linear regression and multivariate ordinal logistic regression was used to study the association of age and sex along with an interaction term with the EQ-5D VAS score the different domains of EQ-5D respectively.

*Results:*

The preliminary analysis was conducted on a sample of 658 participants that had a median age of 35 years (IQR:25.0-49.5) with 22 % being female. The findings show that overall females had a slightly higher mean EQ5D health status score (78.0) than males (77.4). We did not find statistically significant differences across all age groups and sex as well as no interaction effect between age and sex in the overall population. Pain and inability to perform usual activities were the main drivers of poor QOL with more 40 % reporting anxiety or depression. Old-aged females (60 years and above) and middle-aged men (33-59 years) reported the lowest health status, while middle-aged females had the odds of reporting problems across the functional domains.

*Conclusion:*

The reasons for age and gender differences in QOL and its domains should be explored in detail in future research. Healthcare providers should consider options for addressing the persistent pain and psychosocial needs among post-discharge trauma patients especially among females and older patients. More research is required to understand how age and sex, along with other socioeconomic indicators shape QOL in trauma patients in India.

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**Introduction**

Trauma contributes to one-tenth of the global disability-adjusted life-years (DALYs), with low-and middle-income countries (LMICs) bearing a disproportionate burden of the morbidity (1,2). To address this burden, it is important to understand the long-term outcomes of trauma and the different factors associated with these outcomes, especially in LMICs (3–5). This encompasses a range of socioeconomic outcomes including health-related quality of life (QOL) (6–9).

Age and sex are associated with post-discharge QOL among trauma patients. Elderly populations and females tend to have limited access to resources, reduced social capital, disparities in support, poor health-seeking behavior, and restricted education and employment opportunities (10–14). This can shape their post-discharge well-being and outcomes after trauma (15–18). Consequently, older age and being a female can make trauma patients more vulnerable to poorer post-discharge QOL (19–22). There is some evidence that in LMIC settings, older females may have higher morbidity compared to other demographic groups (23,24). Additionally, age and sex shape health outcomes, working not as an additive but a multiplicative interaction across different age groups and sex (25–27).

However, there is little research on the interaction between age and sex on QOL among post-discharge trauma patients in LMIC settings. Understanding the interaction between age and sex on QOL may provide insights for improving trauma management and developing support services in LMIC settings (28,29). The aim of this study is to assess the interaction of age and sex with post-discharge QOL among adult trauma patients using the context of urban India.

**Methods**

*Study Design*

This study is a cross-sectional analysis of data from an ongoing study—the Trauma Audit Filters Trial (TAFT) of trauma patients admitted at four tertiary-care hospital in urban India between November 2019 and January 2021.

*Setting*

India accounts for nearly 20% of global trauma burden (1). More than one-tenth of all the DALYs in India are due to trauma and it is among the top five causes of morbidity (30). The patients were enrolled from the on-going Trauma Audit Filters Trial (TAFT) in four participating tertiary-care hospitals in Indian cities (31). These were the Grant Medical College and Sir Jamshedjee Jeejeebhoy Hospital in Mumbai, Lok Nayak Hospital of Maulana Azad Medical College (MAMC) in Delhi, the Institute of Post-Graduate Medical Education and Research and Seth Sukhlal Karnani Memorial Hospital (SSKM) in Kolkata and St. John's Medical College, Bengaluru.

The first three are public hospitals that have nominal fees catering to patients from low-income sections of the population. The patients admitted in the public hospitals mainly belong to patients who come from low socioeconomic populations, who are unable to bear the costs of treatment in private healthcare facilities. They usually live in small, overcrowded, and poorly build urban settlements that have limited accessibility and use communal latrines. They are engaged in low-income jobs or daily-wage labour to support their families. The fourth is a charitable private hospital that caters to different income groups which includes both patients who pay the full cost for treatment and low-income patients who pay subsidized fees. The higher and middle-income population admitted in this facility have better housing, sanitation, and employment.

*Participants*

We included adult patients (aged 18 and above which is the legal age for adults in India) (32) presenting to the casualty department with a history of trauma—as per the V01-Y36, chapter XX of the International Classification of Disease version 10 (ICD-10) (33)--who are admitted and discharged alive.

*Variables*

Age and sex were the main variables for this study. As injury severity can affect post-discharge outcomes including QOL, we adjusted for severity using a local physiological injury severity model which was shown to have superior discrimination and calibration of predicting mortality in a similar cohort of trauma patients from urban India (Study III). The model included age, sex, systolic blood pressure (SBP), respiratory rate (RR), heart rate (HR), oxygen saturation (SPO2), and Glasgow Coma Scale (GCS).

*Outcomes*

Health-related quality-of-life outcome was measured using the EQ-5D Tool (34). EQ-5D is a standardized measure of quality of life using five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension in the tool has three levels: no problems, some problems, and extreme problems. Additionally, there is a visual analog scale (VAS) for patients to rate their current health status from 0 to 100, with 100 being the best health state. The patients were followed up at 3-months after being admitted to the study sites, via telephone, to record the EQ5D scores. EQ-5D tool can be administered over the telephone and has translations available in multiple Indian languages (34).

*Table 1: Description of study variables and outcomes*

|  |  |
| --- | --- |
| Name | Description |
| *Variables* | |
| Age | Participant's age rounded up to closest whole year |
| Sex | Participant 's sex:  *Female*  *Male* |
| Physiological Injury Severity Model | On arrival to the hospital:  *Systolic blood pressure (SBP)*  *Respiratory rate (RR),*  *Heart rate (HR),*  *Oxygen saturation (SPO2),*  *Glasgow Coma Scale (GCS)* |
| *Outcomes* | |
| Quality of Life | The participant's reply to the EQ-5D questionnaire at 3 months after arrival at the study site:  -Visual analog scale (VAS)  -Five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression |

*Data Source*

Data was collected by one dedicated independent project officer in each of the hospitals. The project officer prospectively gather data on a standardized intake form for eight hours per day, five days a week, by directly observing the staff delivering trauma care. Vital signs such as systolic blood pressure and respiratory rate was recorded by the project officer independently. GCS was calculated based on inputs from the treating doctor and patient records. The project officer was rotated daily through each eight-hour shift in the morning, evening and night. Data for the variables was collected from patient records, or from the patient or patient representatives when they are at the hospital. Additionally, the project officer followed up the patient or the patient relatives at 3-months after discharge by telephone for information on the outcomes and any missed variables.

*Bias*

There could be bias in collection of data and recording of vital signs used to calculate injury severity. Adequate training of the project officers, periodic quality control of the data with external project officers and weekly online review meetings was done to reduce this bias.

*Statistical Methods*

In this study we divided study population into three groups: young adults-18-32 years, middle-aged adults-33-59 years, and old adults-60 years and above. We used multivariable linear regression to study the association of age and sex with the EQ-5D VAS score and multivariate ordinal logistic regression was used to measure the association with the different domains of EQ-5D which have multiple levels as responses. In order study the interaction between age and sex, we used the interaction term which was the product of age and sex (sex \* age groups) (26).

In order to account for the effects of multicollinearity we calculated the variance inflation factor (VIF) and we centered those variables having a value above 5 by subtracting the mean. We estimated 95% confidence intervals and denote associations with a p-value of less than 0.05 as statistically significant (35). The statistical software R was used for all statistical analyses (36).

*Study Size*

Previous studies indicate that 10 to 50 events per variable (EVP) is adequate to obtain stable estimates for logistic regression in multivariate analysis (37,38). This is for an outcome having 50% prevalence. In this study based on preliminary analysis, around 50% of the participants reported some problems across each of the domains of EQ5D. If we aim for an EVP of least 20, we need at least 40 subjects for each predictor. Given that our model includes around 8 free parameters (Table 1), we need a minimum sample size of 320. Additionally, for multinomial logistic regression the EVP is ratio of the smallest number of observations in the multinomial outcome categories divided by the number of free parameters and should be at least 10 (39). With 8 free parameters, requiring at least 80 events per category i.e., 160 subjects. For example, the EQ5D domains of mobility has three outcomes: "No problems in walking about", "Some problems in walking about", "Confined to bed". Therefore, there should be at least 80 subjects in each of the three categories. In case of there are inadequate subjects in these three outcomes categories, the categories would be combined into two "Having no problems" and "Having any problems". For linear regression there should be at least 2 subjects per variable (38). Therefore, the EQ5D health state analysis would require a minimum sample of 16.

*Ethics*

Ethical clearance for the data collection was obtained from the four participating hospitals for the on-going TAFT project (Regionala etikprövningsnämnden i Stockholm, Dnr 2017/2:6.Institutional Ethics Committee, Maulana Azad Medical College and Associated Hospital, New Delhi, India: F.1/IEC/MAMC/(57/02/2017/No.113) dated: 19.07.2017; F.1/IEC/MAMC/(72/07/2019/No.29) dated: 03.03.2020; IPGME&R Research Oversight Committee (Institutional Ethics Committee), Institute of Post-Graduate Medical Education and Seth Sukhlal Karnani Memorial Hospital (IPGMER & SSKM), Kolkata, India: Inst/IEC/2017/396 dated: 21.08.2017 Institutional Ethics Committee, Grant Government Medical College & Sir JJ Group of Hospitals, Mumbai, India: IEC/Pharm/CT/111/A/2017, dated 22.08.2017; Institutional Ethics Committee, St. John's Medical College & Hospital, Bengaluru, India: IEC/1/671/2017 (IEC Study Ref No. 160/2017) dated: 24.08.2017; IEC/1/973/2021 dated: 20.09.2021). Waiver of informed consent was granted for collection of clinical data which was routinely collected for the patients, as they were all admitted after trauma, often arriving in an altered level of consciousness and in severe physical and psychological distress.

*Data management*

Each center was assigned a center identification number and each patient a locally unique study identification number. Project officers first entered data on paper without any personal identification data. The project officers then transferred this data to an electronic format using a dedicated data entry application. The electronic data did not include any direct identifiers such as name, hospital record number, and telephone numbers. The only way to link an electronic record to a paper intake form was by combining the record's hospital and study identification numbers. Paper forms were kept locally at each center for the duration required by locally applicable laws and regulations, or at least five years, whichever is longest. The adequacy of their storage was the responsibility of the principal investigator at each center. Care was taken to ensure that at no time where they stored with less than reasonable care.

**Results**

Out of a total of 2427 trauma patients enrolled, 1769 were excluded for missing data or those who had died within 90-days. The final cohort of 631 participants included in this study had a median age of 36 years (IQR: 26.0-50.0) with 20 % of participants being female. The most common mechanisms of injury were road traffic injuries (56.4 %). Almost all of the injuries were blunt (97.3 %) and majority of the participants were transferred (83.7 %) to the study hospitals. The all cause 30-day mortality was 25.3 %. The median injury severity score was xxx. Details of the study population is given in Table 2.

*Table 2: Description of study sample characteristics*

|  |  |  |
| --- | --- | --- |
| *Variable* |  | *Numbers* |
| Age in years (median [IQR]) |  | 35.0 [25.0, 49.5] |
| Sex (%) | Female | 22.7 |
| *Distribution across sex and age categories* | | |
| Female | 18-32 years | 52 |
| 33-59 years | 65 |
| 60 years and above | 26 |
| Male | 18-32 years | 244 |
| 33-59 years | 197 |
| 60 years and above | 47 |
| Mechanism of injury (%) | Road traffic injuries | 56.3 |
| Falls | 23.8 |
| Assault | 6.0 |
| Railway injuries | 1.1 |
| Other | 12.9 |
| Type of injury (%) | Blunt | 97.3 |
| Penetrating | 2.7 |
| Mode of transport (%) | Ambulance | 67.0 |
| Police van | 2.1 |
| Private Vehicles | 29.5 |
| On Foot | 0.6 |
| Transferred (%) | Transferred | 83.7 |
| SBP (median [IQR]) |  | 122.0 [112.0, 132.5] |
| RR (median [IQR]) |  | 22.0 [19.0, 22.0] |
| HR (median [IQR]) |  | 84.0 [78.0, 89.0] |
| SPO2 (median [IQR]) |  | 98.0 [97.0, 98.0] |
| GCS (median [IQR]) |  | 15.0 [15.0, 15.0] |
| 30-day mortality (%) \* | Dead | 25.3 |

SBP = systolic blood pressure, RR = respiratory rate, HR = heart rate, SPO2 = Oxygen saturation, GCS = Glasgow Comma Scale, ISS = Injury Severity Score, IQR = Interquartile range

\*Overall mortality rate of the dataset (2427)

*EQ-5D Scores*

The mean EQ5D health status score was 76.6 (SD = 20.5). Just over half the participants (54.8%) reported no problems with mobility while two-thirds reported no problems with self-care. While less than half the participants (43.0%) could carry on usual activities without any problems and only one-third of the patients (34.7%) reported no pain or discomfort after three-months of post-discharge. Around 40% of the participants reported experiencing some form of anxiety or depression. Again, the proportion of young males reporting any problems across all the five domains was the lowest while the proportion middle-aged females reported experiencing the problems across all the five domains was the highest. The overall EQ-5D scores are provided in Table 3.

*Table 3. Proportion of EQ-5D scores in the sample population*

|  |  |  |
| --- | --- | --- |
| EQ-5D Domain | Levels | Numbers |
| EQ5D Health Status (mean [SD]) |  | 76.6 [20.5] |
| EQ5D Mobility (%) | No Problems | 347 (55.0) |
|  | Some Problems | 207 (32.8) |
|  | Confined to bed | 77 (12.2) |
| EQ5D Self Care (%) | No Problems | 402 (63.7) |
|  | Some Problems | 175 (27.7) |
|  | Unable to wash or dress | 54 (8.6) |
| EQ5D Usual Activities (%) | No Problems | 268 (42.5) |
|  | Some Problems | 240 (38.0) |
|  | Unable to perform usual activities | 123 (19.5) |
| EQ5D Pain/Discomfort (%) | No Pain | 215 (34.1) |
|  | Moderate Pain | 388 (61.5) |
|  | Extreme Pain | 28 (4.4) |
| EQ5D Anxiety/Depression (%) | No Anxious/depressed | 371 (58.8) |
|  | Moderately Anxious/depressed | 192 (30.4) |
|  | Extremely Anxious/depressed | 68 (10.8) |

The Five domains of the EQ5D Score are: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. SD = Standard deviation

*EQ-5D in relation to gender and age*

*Health Status*

Overall females had a slightly higher mean EQ5D health status score (78) than males (77.4) After adjusting for severity, young males (18-32 years) had the highest health status score (80.5) followed by younger females (79.9) while older females (74.1) and middle-aged males (74.4) reported the lowest scores (Table 4).

*Table 4. Adjusted EQ-5D Health status across age and sex categories*

|  |  |  |
| --- | --- | --- |
| Gender and Age Categories (n) | EQ5D Score | |
| Mean | SE |
| Male 18-32 years (244) | 80.5 | 1.24 |
| Male 33-59 years (197) | 74.4 | 1.38 |
| Male 60 years and above (47) | 75.2 | 2.82 |
| Female 18-32 years (52) | 79.9 | 2.69 |
| Female 33-59 years (65) | 77.8 | 2.4 |
| Female 60 years and above (26) | 74.1 | 3.8 |

*Adjusted for injury severity*

*SE =Standard Error*

The linear regression of health status with the interaction effect of age and sex was not significant even after adjusting for injury etiology, vitals, and severity. The adjusted linear regression analysis of health status, keeping young males as the reference group, was statistically significant only for middle-aged males (Table 5).

*Table 5. Regression analysis summary of EQ-5D health status with interaction of age and sex and across different groups*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group** | **Coefficient** | **95% CI** | | **p-value** |
| Male 18-32 years | Reference | | | |
| Male 33-59 years | -6.09 | -9.74 | -2.44 | 0.00\* |
| Male 60 years and above | -5.22 | -11.27 | 0.82 | 0.09 |
| Female 18-32 years | -0.53 | -6.32 | 5.27 | 0.85 |
| Female 33-59 years | 3.99 | -3.95 | 11.93 | 0.32 |
| Female 60 years and above | -6.70 | -8.43 | -0.70 | 0.90 |

*Adjusted for injury severity*

*CI = Confidence Interval, \* statistically significant at 0.05*

*Mobility*

The adjusted logistic regression analysis in the mobility dimension keeping young males as the reference group, shows all groups had lower odds of reporting some mobility problems than young males except middle-aged females (Table 6). Only the odds for middle aged males were statistically significant.

*Self-care*

All groups had lower odds of reporting problems performing self-care activities than young males except middle-aged females (Table 6). The higher odds of middle-aged females reporting problems performing self-care activities than young males were statistically significant.

*Usual Activities*

Analysis in the usual activities dimension shows that all groups had lower odds of reporting problems performing usual activities than young males except middle-aged females (Table 6). Again, no group had odds that were statistically significant.

*Pain/Discomfort*

For pain/discomfort, all groups had lower odds of reporting having pain and discomfort than young males except middle-aged and old females and the odds in both these cohorts were statistically significant (Table 6).

*Anxiety/Depression*

Young females, middle-aged and old males had higher odds of reporting anxiety and depression than young males (Table 6). The odds of the young female cohort were statistically significant.

Thus, middle-aged females reported higher odds of reporting problems with across all domains except anxiety and depression. Older females had higher odds, almost three times, of reporting experiencing pain. Having higher odds of having anxiety and depression young females, middle-aged and old males. However, the cohorts reporting the lowest overall health status were older females and middle-aged males.

**Discussion**

This study examined the interaction of age and gender on QOL in trauma patients discharged from four tertiary-care hospital in urban India at 3-months after discharge. We did not find statistically significant differences across all age groups and sex as well as no interaction effect between age and sex in the overall population. The sub-group analysis, however showed differences in QOL between males and females across young (18-32 years), middle-aged (33-59), and older (60 years and above) groups. In each of the five EQ5D domains, odds of reporting problems varied between the groups. We found middle-aged males report lower overall QOL scores while middle aged females had the highest odds of reporting problems across almost all the QOL domains.

*Table 6. Adjusted odds ratio of reporting any problem in the EQ-5D domains across different groups*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Group** | **Mobility** | | | **Self-Care** | | | **Usual Activity** | | | **Pain/Discomfort** | | | **Anxiety/Depression** | | |
| *OR* | *95% CI* | | *OR* | *95% CI* | | *OR* | *95% CI* | | *OR* | *95% CI* | | *OR* | *95% CI* | |
| Male 18-32 years | *Reference group* | | | | | | | | | | | | | | |
| Male 33-59 years | 0.77\* | 0.51 | 1.15 | 0.72 | 0.39 | 1.36 | 0.70 | 0.38 | 1.29 | 0.53 | 0.28 | 1.00 | 1.66\* | 0.90 | 3.04 |
| Male 60 years and above | 0.66 | 0.5 | 1.0 | 0.69 | 0.46 | 1.02 | 0.71 | 0.48 | 1.04 | 0.52 | 0.35\* | 0.78 | 1.42 | 0.96 | 2.10 |
| Female 18-32 years | 0.79 | 0.4 | 1.4 | 0.52 | 0.28 | 0.99 | 0.67 | 0.35 | 1.27 | 0.31 | 0.14\* | 0.67 | 1.55 | 0.82 | 2.93 |
| Female 33-59 years | 1.48 | 0.61 | 3.39 | 1.11\* | 0.48 | 2.59 | 1.31 | 0.57 | 3.03 | 1.31 | 0.52\* | 3.28 | 0.58 | 0.25 | 1.33 |
| Female 60 years and above | 0.75 | 0.23 | 2.57 | 0.95 | 0.30 | 2.99 | 0.82 | 0.24 | 2.75 | 3.30 | 0.92 | 11.86 | 0.87 | 0.28 | 2.70 |

*Adjusted for age, gender, mechanism of injury, mode of transport, transfer status, heart rate, oxygen saturation, systolic blood pressure, respiratory rate, type of injury, and Glasgow Coma Scale*

*OR = odds ratio, CI = Confidence Interval, \* statistically significant at 0.05*

The mean EQ5D VAS score of 76.6 of trauma patients in this study is lower than the median general population norm for India of 80 (40). A recent study of a similar cohort of trauma patients from north India, reported index scores of around 90 at 3-months post-injury, higher than our findings (41). This could be because two of the three study sites of that study were secondary-care hospitals, which treat less severe trauma patients. The score is however, higher than other studies from Sweden and Australia which report scores between 48 to 66 for trauma patients at 3-months (42–44). Our results indicate that, even after 3-months since discharge, trauma patients still face some limitations to achieve full recovery for a long-time after trauma. Pain and inability to perform usual activities were the main drivers of poor QOL in our study, with nearly two-thirds of participants reporting some form of pain at 3-months. Our study population had a higher proportion of persons reporting problems across all the EQ-5D domains—except anxiety and depression—in comparison to the general Indian population norm (41). This is also consistent with other literature on similar injured cohorts in other settings (42,43).

In this study injured females reported slightly better overall QOL than males. But sub-group analysis by age, indicates that except, for middle-age group, females reported lower score than males. This is similar to the general population norm in India and the difference in the middle-age group could be due to the fact that middle-aged males are more severely injured than females in India (45). Evidence on this remains mixed with some studies reporting lower scores for females while other report lower scores for males (22,41,46,47). Studies that report females having better QOL scores than males also tend to have a smaller proportion of females in their study sample (48). More research on trauma patients from India and other LMICs is required to understand the gender differences in post-discharge QOL outcomes in these settings.

In this study, old-aged females had the lowest EQ-5D health status scores than the other groups, followed by middle-aged males (coefficients respectively of −6.70 (95% CI −8.43; −0.70) and −6.09 (95% CI -9.74; 0.82)). All groups reported lower QOL after 3-months following the injury than younger males. This is similar with findings from high-income settings where older trauma patients perform worse (43,46,49,50). The lower scores among injured older participants is related to existing comorbidities, frailty-related factors, and availability of social safety nets (51–53). Moreover, older females in India, have been shown to have limited access to healthcare, social support, and economic independence (24,54). The low reported health status scores of this cohort observed in this study could be a result of these vulnerabilities.

In this study more females reported pain, problems with performing usual activities, and barriers to self-care than their male counterparts in the middle and older age cohorts. These findings are in line with other studies from high-income settings showing that females report more problems in the pain, and usual activities domain than males (49). It was seen that young females and middle-aged and older males reported higher odds of having anxiety and depression than their opposite sex counterparts. This psychological morbidity seems to be the main driver of poor health status scores among these three demographic cohorts in our study. There is evidence of younger age and female sex being predictive of anxiety and depression after injury (49). The reasons for injured middle-aged and older males reporting higher odds for anxiety and depression is unclear and contrary to prevalence evidence from India (55). The reasons for this needs to be studied in-depth. Overall, the proportion of patients reporting psychological morbidity (41%) was almost twice as high as seen in previous studies (41,43). This underscores the need to account for psychological issues faced by trauma, often overlooked, as part of the long-term consequences of trauma (56).

This paper has attempted to study the interaction of age and sex on QOL in an urban Indian cohort of trauma patients. Though the data collected uses the biological term sex corresponding to “female” and “male” routinely used in hospital records in India, this would also largely overlap with the social construct of gender as “woman” and “man” respectively in this context. We believe that in this context gendering would have already occurred before hospitalization and data collection and the participants in this study would have answered from a gender-perspective as a “woman” or “man”. However, we acknowledge that this study does not explore non-binary gender identities and non-heterosexual persons.

Our study showed that while middle-aged women had the highest odds of reporting problems in the mobility, self-care, pain, and usual activities than other groups, they did not report lower overall health status. This could be because of the gendered norms influencing healthcare-seeking behavior among women in the Indian settings, where women may not consider their health status as requiring care despite having more health problems (24,57,58). This difference in reporting overall health status with respect to individual domains needs to investigated in future studies on trauma from urban India. Especially, focusing on functional morbidity problems in women and older populations.

The findings from our study indicate that males and females do not recover QOL at 3-months post trauma the same way across different age groups in the urban Indian context. The reasons for these differences should be explored in detail in future qualitative studies. Additionally, future research should focus on specific cohorts of trauma such as traumatic brain injury or spinal cord injuries and road traffic injuries or falls to study the differences in QOL outcomes and the reasons for the same. The findings of this study highlight that healthcare providers should consider options for addressing the persistent pain among post-discharge trauma patients. Moreover, it emphasizes the need for providing psychosocial care as part of trauma management to improve overall QOL among trauma patients. Additionally, given the differences between reporting overall health status and health-related problems faced, especially among women and older adults, healthcare providers could probe for these problems during post-discharge follow-ups visits.

However, these two biological variables are inadequate to understand how different social factors interact to affect QOL. There is a need to go beyond age and sex to explore interactions with other social dimensions such as income, class, caste, which determine how different age groups and sexes experience health outcomes due to marginalization, inequality, discrimination, health-seeking behavior, and access to healthcare services in the Indian context (59,60). This is important to provide a more nuanced understanding of the intersectional nature of these interactions within this cohort. This will help in identifying additional vulnerable groups who may require more attention by the healthcare system and develop policies to improve their health outcomes.

*Limitations*

Various socioeconomic factors interact with age and sex to affect QOL, including household income, education status, nature of occupation, and type of caregiving. Not including these variables has limited the study interaction of age and sex on QOL in trauma patients in this paper. Future research should study the interactions of these variables along with age and sex on QOL in trauma patients. This study does not include other sexes such as transpersons or persons with non-binary gender identities who tend to be more socioeconomically vulnerable in the Indian context.

Adjusting for injury severity based on just psychological parameters may not always be accurate (61). We decided to use it to adjust for severity based on a recent analysis we conducted which showed it better discrimination and calibration than local models (Study III). Conducting a telephonic interview could have affected the ability of participants to understand the questions and thereby the reported responses. We tried to follow the instructions on how to collect the information over the telephone as much as possible. This study only captures those who responded during the follow-up calls, leaving out drop-outs. Another limitation is that using QOL measured at a single point of time does not allow in observing changes in QOL across time between the different age and sex groups. Longitudinal studies from low resource settings would help in understanding patterns and changes over time.

**Conclusion**

Our study indicates that there are differences in how age and sex interact to affect post-discharge QOL among trauma patients in urban India. Older females report the lowest health status while middle-aged women reported the highest odds of functional morbidity. Psychological morbidity was reported most among middle-aged and older males as well as young females. Elevating pain and providing psychosocial care as part of follow-up in healthcare settings may improve QOL in trauma patients, especially among those demographics reporting higher odds of these morbidities. More research from different settings, longitudinal studies, and in-depth qualitative investigations are required to assess the nature, extent, and interaction of these and other socioeconomic variables in LMIC settings like India.

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