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RESEARCH

# MORTALITY AFTER TRAFFIC ACCIDENTS OF ELDERLY AGE GROUPS DEFINED BY WORLD HEALTH ORGANIZATION CATEGORIZATION

## ABSTRACT

***Introduction:*** Elderly patients have increased mortality compared with younger patients after experiencing trauma.Although different categories of geriatric age groups exist in medical literature, the World Health Organization categorizes geriatric people as older (from 65 to 79 years old) and oldest-old (≥80 years old). The aim of this study was to compare injury severity, mortality with hospitalization, intensive care unit, andsurgery rates with hospitalization time of younger patients with those of elderly people and within 2 geriatric age groups admitted to the emergency department after traffic accidents.

***Materials and Method:*** Patients admitted to a teaching hospital emergency department after traffic accidents between January 1, 2012 and December 31, 2013 were enrolled in this retrospective study. Age groups were defined as young, older and oldest-old. Injury severity was assessed with the Abbreviated Injury Scale (AIS) for 6 body regions and the Injury Severity Score (ISS). p<0.05 was considered statistically significant.

***Results:*** In total2687 patients were included in the study;196 (6.7%) patients were classified as older and 59 (2.0%) patients were classified as oldest-old. Mortality (6.3% vs. 0.7%, p<0.001) with hospitalization (23.1 vs. 12.3%%, p<0.001), ICU admission (7.1% vs. 2.3%%, p<0.001), and surgery rates (11.8% vs. 6.0%%, p<0.001) with hospitalization time (1.1 vs. 2.8 days) were higher in elderly patients than in young patients but were similar between the 2 geriatric age groups.

***Conclusion:*** Elderly patients experience more severe trauma after traffic accidents young patients; however, no difference was observed between the 2 geriatric age groups defined by World Health Organization.

***Key Words:*** Trauma, Geriatrics; Injury.

ARAŞTIRMA

# DÜNYA SAĞLIK ÖRGÜTÜ SINIFLANDIRILMASINA GÖRE TANIMLANAN YAŞLI YAŞ GRUPLARININ TRAFİK KAZALARI SONRASI MORTALİTENİN DEĞERLENDİRİLMESİ

## ÖZ

***Giriş:*** Travma, geriatrik yaş gruplarında en sık ölüm nedeni olmasa da, genç hastalarla karşılaştırıldığında geriatrik hastalarda mortalite daha fazladır. Tıbbi literatürde farklı geriatrik yaş sınıflamaları olup Dünya Sağlık Örgütü (DSÖ), yaşlı hastaları genç-yaşlı (65-79 yaş) ve yaşlı-yaşlı (80 yaş ve üzeri) olarak gruplandırmaktadır. Bu çalışmanın amacı acil servise trafik kazası sonrası gelen genç ve yaşlı hastalar ile her iki geriatrik yaş grubu arasında yaralanma şiddeti, mortalite ile hastaneye yatış, yoğun bakım yatış ve operasyon oranlarını karşılaştırmaktır.

***Gereç ve Yöntem:*** Bu retrospektif çalışmaya acil tıp kliniğine 1 Ocak 2012 ile 31 Aralık 2013 tarihleri arasında trafik kazası ile başvuran hastalar alındı. Yaş grupları genç, genç-yaşlı ve yaşlı-yaşlı olarak tanımlandı. Yaralanma şiddeti 6 vücut bölgesinde hesaplanan Abbreviated Injury Scale (AIS) ve Injury Severity Score (ISS) ile değerlendirildi. p<0.05 değeri istatistiksel olarak anlamlı kabul edildi.

***Bulgular:*** Çalışmaya 2687 hasta alındı ve 196 (6.7%) hasta genç-yaşlı ve 59 (2.0%) hasta yaşlı-yaşlı olarak sınıflandırıldı. Genç hastalarla karşılaştırıldığında geriatrik hastalarda mortalite (6.3% vs 0.7%, p<0.001), hastane yatış (23.1 vs 12.3%%, p<0.001), yoğun bakım yatış (7.1% vs 2.3%%, p<0.001) ve operasyon oranı (11.8% vs 6.0%%, p<0.001) daha fazla olmasına rağmen rağmen her iki geriatrik yaş grupları arasında bir fark saptanmadı.

***Sonuç:*** Genç hastalarla karşılaştırıldığında geriatrik hastalarda trafik kazası sonrası daha ciddi travma geçirmesine rağmen Dünya Sağlık Örgütü tarafından tanımlanan 2 geriatrik yaş grubunda bir fark saptanmamıştır.

***Anahtar Sözcükler:*** Travma; Geriatri; Yaralanma.

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## Introduction

Trauma in the elderly is a growing problem of health systems due to an increased life-span. Similar to a general trend in the world, Turkey has an increasing elderly population; although the geriatric population currently accounts for 7.7% of the total population, the number is expected to rise to 10.7% in 2023 (1). Advancements in treating chronic conditions have not only led to increased mobility of elderly people, but also lead to a predisposition to injuries. Although a more common cause of trauma in young patients, traffic accidents remain a significant cause of trauma-related injuries in elderly people (2-5).

Elderly patients suffer a higher morbidity and mortality after trauma than younger patients because of age, preexisting medical conditions, mechanisms of injury, and increased rate of complications (6, 7). As young age is generally described as younger than 65 years, several age groupings exist in public health and trauma-related medical literature for defining older patients. One categorization is based on sub-grouping patients as young-old (65-74 years old), middle-old (75-84 years old), and oldest-old (≥85 years old). Several studies conducted in the past in other areas of medical literature used this grouping, although a standard does not exist (8). The World Health Organization (WHO) categorizes older people as those aged 65 to 79 years and oldest-old as aged 80 years and older when describing geriatric age groups (9). Although geriatric trauma patients older than 75 years of age have increased mortality, a relationship between trauma severity and geriatric age groups has not been studied in the medical literature.

The aim of this study was to compare the severity of trauma after traffic accidents of young and older patients within 2 geriatric sub-groups in terms of anatomic trauma scores and mortality as well as hospitalization, intensive care unit (ICU) admission and surgery rates.

We hypothesize that although young people have better outcomes after trauma, elderly patient sub-groups (older people vs. oldest-old) have similar outcomes after traffic accidents because of different physiological responses to trauma. An explanation of this result may be a result of the heterogeneity of medical conditions, the impact of trauma on the patient and varied responses to traumatic injuries.

## Materials and Methods

Patients admitted to Izmir Training and Research Hospital Emergency Medicine Clinic following traffic accidents between January 1, 2012 and December 31, 2013 were enrolled in this retrospective cross-sectional study. Patients' clinical, laboratory, and radiology reports with forensic reports were obtained from patient charts and hospital electronic records system. Patients with insufficient data, patients aged ≤18 years, patients who discharged themselves, and patients who were transferred to our hospital after stabilization or transferred to another hospital after stabilization due to unavailable beds were excluded in the study. Traumatic cardiac arrests on arrival without further diagnostic study or autopsy were also excluded. Any patient with a score of 0 was also excluded. Demographic characteristics included accident types (motor vehicle, motorcycle, or pedestrian accident), gender, and age.

Trauma severity is assessed by the generally approved Abbreviated Injury Scale (AIS), which divides the body into 6 regions (head–neck, face, thorax, abdomen–pelvic organs, extremities–pelvis, and external), and severity of injury is graded from 0 to 6 (none to maximal (untreatable, results in death)). Scores of 3 or more are considered serious injury. The Injury Severity Score (ISS), derived from AIS, is calculated by the sum of squares of the three most severely injured body regions and ranges from 1 to 75. Major trauma is defined as an ISS score of 15 or more.The primary outcome is the mortality (during ED or ward/ICU) stay, and the secondary outcome is hospitalization and ICU admission rate and surgery need with hospitalization time.

Patients aged 18–64 years were considered young, while patients aged 65 years and older were considered elder. Although a scientific consensus of sub-grouping elderly patients does not presently exist, we chose the WHO categorization of geriatric populations into 2groups, patients aged 65 to 79 years as older and patients aged 80 years and older as oldest-old. We performed statistical analysis of trauma severity between young and elderly patients and within the 2 sub-groups of geriatric patients (older vs. oldest-old) using AIS scores for 6 regions of the body and ISS as well as hospitalization, surgery and ICU stay rate, hospitalization time and mortality.

This study was approved by the institutional ethics committee, which in turn is approved by the Ministry of Health of the Turkish Republic. Statistical analysis was performed using SPSS 20.0 for Windows (SPSS, Chicago, IL, USA). Normality of distribution was assessed with Kolmogorov–Smirnov testand Q–Q plots. For comparison of groups, the Kruskal–Wallis test was used for analysis of non-parametric continuous variables and Chi-square test for categorical values. Comparisons of categorical values were assessed with Chi-square test or Fisher's exact test when variable count was <5. $p<0.05$ was considered statistically significant.

## Results

During the study period, 4093 traffic accident victims were admitted to the emergency department, and after exc-

**Table 1—** Demographic Characteristics of the Patients

| Characteristics | Data (n=2942) |
|---|---|
| Age (years) | |
| Mean, years | 37.9 (18–90); sd=16.3 |
| Young (18–64 years) | 2687 (91.3%) |
| Older (65–74 years) | 196 (6.7%) |
| Oldest-old (85 and more) | 59 (2.0%) |
| Gender | |
| Male/Female | 2129 (72.4%) / 813 (27.6%) |
| Traffic accident type | |
| Motor vehicle passenger | 1280 (43.5%) |
| Pedestrian struck | 1212 (41.2%) |
| Motorcycle/bicycle | 450 (15.3%) |
| ISS | |
| Minor (1–15) | 2858 (97.1%) |
| Major (≥16) | 84 (2.9%) |

lusion criteria were applied, 2942 patients were included in the study. In total, 2129 (72.4%) of patients were male and the mean age was 37.9 (SD 16.3). In total, 2687 (91.3%) of patients were classified as young, 196 (6.7%) were classified as older and 59 (2.0%) were classified as oldest-old. The most common form of accident was motor vehicle passenger, followed by pedestrian struck and motorcycle/bicycle accident. After calculating ISS scores, 84 (2.9%) patients were found to have major trauma (Table 1).

When trauma severity was assessed by AIS for each of the 6 body regions using the Mann–WhitneyU test, trauma severity of face, abdomen, and external injuries was similar between young and elder people (≥65 years old) (p=0.12, 0.93 and 0.88, respectively) (Table 2). However, elderly people had more severe traumatic injuries of head-neck, thorax, and pelvis–extremities injuries and had higher ISS scores than young patients (p=0.03, <0.001, 0.02, and <0.001, respectively). When we analyzed trauma severity between the 2 geriatric sub-groups (older vs.oldest-old), oldest-old people had higher AIS scores for the abdomen region, whereas AIS scores for the remaining 5 regions and ISS scores were similar (p=0.47 for head–neck, p=0.39 for face, p=0.24 for thorax, p=0.04 for abdomen, p=0.75 for pelvis–extremities, p=0.58 for external, and p=0.53 for AIS).

A Mann–Whitney-U test indicated that hospitalization times of elderly patients were longer than those of young patients (Mdn=1632.2 vs.1456.3, U=301625.5, p<0.001). When another analysis was performed for geriatric age groups, the test did not show a significant difference between the 2 groups (Mdn=125.7 vs. 131.2, U=7614.0, p=0.43).

The primary outcome was assessed by Chi-square test, and results showed that mortality was significantly higher in elderly patients than in young patients (6.3% vs. 0.7%, p<0.001) (Table 3). Older patients were 8.93 (95%CI, 4.57–17.46) times more likely to die following a traffic acci-

**Table 2—** Comparison of Trauma Severity in terms of AIS and ISS Between Young and Elder Patients and within Two Geriatric Sub-groups.

| Trauma Regions and severity | Young vs. elder (n=2942) | Older vs. oldest-old (n=255) |
|---|---|---|
| Head–neck AIS | 1463.5 vs. 1555.8, U=364.1, p=0.03 | 126.5 vs. 132.9, U=6073, p=0.47 |
| Face AIS | 1466.6 vs. 1523.3, U=355.8, p=0.12 | 129.5 vs. 122.9, U= 5480.0, p=0.39 |
| Thorax AIS | 1457.6 vs. 1617.5, U=379.8, p=<0.001 | 130.2 vs. 120.8,U= 5357.5, p=0.24 |
| Abdomen–pelvic organs AIS | 1471.7 vs. 1469.5, U=342.1, p=0.93 | 125.9 vs. 135.1, U= 6202.0, p=0.04 |
| Pelvis–extremities AIS | 1461.2 vs. 1579.8, U=370.2, p=0.02 | 125.0 vs. 138.1, U= 6377.0, p=0.75 |
| External AIS | 1471.4 vs. 1472.3, U=342.8, p=0.88 | 128.2 vs. 127.5, U= 5752.5, p=0.58 |
| ISS | 1440.5 vs. 1798.5, U=426.0, p=<0.001 | 126.5 vs. 133.0, U= 6079.0, p=0.53 |

Note: First values are medians, with respective U and p values.

**Table 3—** Comparison of Hospitalization, ICU Admission and Surgery Rate, Hospitalization Time and Mortality Between Young and Elder Patients and within Two Geriatric Sub-groups.

| | Young vs. Elder (n=2942) | Older vs. Oldest-old (n=255) |
|---|---|---|
| Mortality | 20 (0.7%) vs. 16 (6.3%), $\chi^2$=58.93, p<0.001 | 12 (6.1%) vs. 4 (6.8%), $\chi^2$=3.29, p=0.77 |
| Hospitalization rate | 331 (12.3%) vs. 59 (23.1%), $\chi^2$=23.71, p<0.001 | 40 (20.4%) vs. 19 (32.2%), $\chi^2$=3.55, p=0.06 |
| ICU admission | 61 (2.3%) vs. 18 (7.1%), $\chi^2$=20.44, p<0.001 | 11 (5.6%) vs.7 (11.9%), $\chi^2$=2.70, p=0.10 |
| Surgery | 160 (6.0%) vs. 30 (11.8%) $\chi^2$=13.01, p<0.001 | 20 (10.2%) vs. 10 (16.9%), $\chi^2$=1.99, p=0.16 |

Note: First values are number of patients with percentage in brackets, with respective Chi-square and p values.

dent than young patients. Assessment of the mortality rate between the 2 geriatric sub-groups using Fisher's exact test revealed no statistical difference between the two groups (6.1% vs. 6.8%, p=0.77).

Secondary outcome, hospitalization, ICU admission, and surgery rates were also assessed by Chi-square test, showing that elderly patients had higher hospitalization (23.1 vs. 12.3%), ICU admission (7.1% vs. 2.3%), and surgery rates (11.8% vs. 6.0%) than young patients (p<0.001 for all tests). Older patients were 2.14 (95%CI, 1.57–2.93) times more likely to be hospitalized, 3.27 (95%CI, 1.90–5.62) times more likely to be admitted to the ICU and 2.10 (95% CI, 1.39–3.18) times more likely to undergo surgery than young patients. Comparison of secondary outcomes within the two sub-groups of elderly patients indicated no statistical difference between the three (p=0.06, 0.10, and 0.16, respectively).

## Discussion

This retrospective study demonstrated that although elderly patients have higher mortality with admission to hospital, ICU and surgery rates than young patients, the subgroups of the geriatric population (older patients aged 65–79 years and oldest-old patients aged 80 years and older) affected by trauma have similar mortality and prognosis after traffic accidents. These results are in contrast with previous studies conducted both in late 90s and 2000s (6,7,10,12).

A possible explanation of findings in previous studies can result from the selection criteria of study populations. Database studies use patients admitted to hospital following trauma and fail to include young and elderly patients discharged from ED after treatment or transferred to intermediate care who are not included in analysis (12). Also registries such as National Trauma Data Bank or statewide trauma registries don't include the mortality after hospital discharge but evidence has shown elderly trauma victims experience mortality after hospital discharge (13).

Grouping elder people in age categories is a challenging task, both epidemiologically and clinically. WHO addressed that age is a major factor for categorization but contributing medical, socio-economic, cultural, and country-specific characteristics also influence categorization. Old age accompanied by poverty and chronic debilitating medical conditions with limited or no access to medical health care challenges the chronological definition of old age when patients in their mid-50s, with limited or no healthcare, have an abnormal response to trauma compared with patients with more chronic health conditions, who have access to proper medical care.

Mechanisms of trauma are different in elderly patients compared to younger patients, where falls account for three-quarters of all traumas followed by motor vehicle collisions (6). Also incidence of penetrating trauma is higher in younger patients. Pre-existing medical conditions, higher mortality after serious trauma (defined as ISS>15) lead to more complicated outcome following trauma in the elderly group. One study found that 73% of elderly patients with traumatic brain injury have pre-existing medical conditions compared to %28 of non-elderly patients (11). Pre-existing medical conditions, including liver and chronic renal insufficiency, chronic obstructive pulmonary disease and steroid use were found to increase the risk of mortality and morbidity in the geriatric population (14). Also using of medications, such as ß-blockers or calcium channel blockers, may mask abnormal physiological signs of shock and can be misleading in the management of trauma patients (14,16).

Insufficiency of bony structures to protect external trauma to the central nervous system and thoracic organs as well as fragile pelvic and extremity bones contribute to higher regional and overall injury severity for the head, thoracic, and pelvic–extremity regions of elderly trauma victims, but a difference did not exist between geriatric age classifications as defined by the WHO (6, 9). In addition, an increased vulnerability of brain vessels and concomitant use of anti-aggregants with anti-coagulants use lead to higher risk of severe traumatic brain injury, which is a major contributor to trauma (6). Failure of protection of the thoracic cage by the ribs because of decreased bone intensity and muscle wasting increased with ageincreases the vulnerability of thoracic organs to trauma. A similar finding was found in another study, in which head–neck and extremity traumas were significantly higher in elderly patients (6,15).

Advanced age is a well-known contributor to mortality and injury severity of trauma patients. Several studies have divided elderly patients into different age groups and have found mixed results. An older study of Kuhne et al. found trauma victims older than 65 years had higher mortality rates, and patients older than 55 years had higher rates of complications independent of trauma severity (16). A recent study based on a database of trauma victims concluded patients older than 70 to 74 years old had greater mortality compared to younger patients (12). Current recommendation of American College of Surgeons for transferring of trauma victims older than 55 years old to trauma center is derived from the Finelli's study using Major Trauma Outcome Study in 1989 (17). This age-related risk was thought to be influenced by the increased prevalence of co-morbid medical conditions after the

age of 55 (6,7). On the other hand, Eastern Association for the Surgery of Trauma fails to give an age based threshold for triage of elderly patients for triage to trauma center and state that age is a continuous value and categorizing age groups as dichotomous value is not reliable due to insufficient data in previous studies (18).

A recent meta-analysis sought to determine the exact age at which mortality increases but was unsuccessful because of the heterogeneity of medical conditions and insufficient evidence (10). The authors concluded that patients older than 75 years who experienced trauma had higher mortality rates than patients younger than 75 years,but they were unable to identify a difference between age groups of 75 to 84 years and older than 85 years.

This study demonstrated that after traffic accidents, injury severity and mortality of geriatric age groups, as defined by WHO, are not statistically different from one another, but susceptibility to trauma of elderly people is clearly increased compared with that in young people. Physicians must recognize that elderly trauma patients are more likely to have more severe injuries, mortality, surgery, hospitalization, and ICU admission rateswith hospitalization time than young patients despite their presence in any geriatric age range, and more effort is essential to successfully diagnose concomitant injuries and treat these patients effectively.

### Conflict of Interest

Authors declare that there are no conflicts of interest.

## References

1. Elderly Statistics 2013. Turkish Statistical Institute. [Internet] Available at: http://www.tuik.gov.tr/IcerikGetir.do?istab_id=265. Accessed on July 19, 2015.
2. Allard R. Excess mortality from traffic accidents among elderly pedestrians living in the inner city. Am J Public Health 1982;72:853-4. (PMID:7091484).
3. Perdue PW, Watts DD, Kaufmann CR, Trask AL. Differences in mortality between elderly and younger adult trauma patients: geriatric status increases risk of delayed death. J Trauma 1998;45:805-10. (PMID:9783625).
4. McCoy GF, Johnston RA, Duthie RB. Injury to the elderly in road traffic accidents. J Trauma 1989;29:494-7. (PMID:2709457).
5. Richter M, Pape HC, Otte D, Krettek C. The current status of road user injuries among the elderly in Germany: a medical and technical accident analysis. J Trauma 2005;58:591-5. (PMID:15761356).
6. Bonne S, Schuerer DJ. Trauma in the older adult: epidemiology and evolving geriatric trauma principles. Clin Geriatr Med 2013;29:137-50. (PMID:23177604).
7. Callaway DW, Wolfe R. Geriatric trauma. Emerg Med Clin North Am 2007;25:837-60. (PMID:17826220).
8. Zizza CA, Ellison KJ, Wernette CM. Total water intakes of community-living middle-old and oldest-old adults. J Gerontol A BiolSci Med Sci 2009;64:481-6. (PMID:19213852).
9. World Health Organization. Men Ageing and Health. Geneva: WHO; 1999. p 10. [Internet] Available from: http://whqlibdoc.who.int/hq/2001/ WHO_NMH_NPH_01.2.pdf. Accessed:July 13, 2014.
10. Hashmi A, Ibrahim-Zada I, Rhee P, et al. Predictors of mortality in geriatric trauma patients: a systematic review and meta-analysis. J Trauma Acute Care Surg 2014;76:894-901. (PMID:24553567).
11. Mosenthal AC, Livingston DH, Lavery RF et al. The effect of age on functionaloutcome in mild traumatic brain injury: 6-month report of a prospective multicenter trial. J Trauma 2004;56:1042–8. (PMID:15179244).
12. Caterino JM, Valasek T, Werman HA. Identification of an age cutoff for increased mortality in patients with elderly trauma. Am J Emerg Med 2010;28:151-8. (PMID:20159383).
13. Mullins RJ, Mann NC, Hedges JR, et al. Adequacy of hospital discharge status as a measure of outcome among injured patients. JAMA 1998;279:1727-31. (PMID:9624026).
14. Grossman MD, Miller D, Scaff DW, Arcona S. When is an elder old? Effect of preexisting conditions on mortality in geriatric trauma. J Trauma 2002;52:242-6. (PMID:11834982).
15. Brand S, Otte D, Mueller CW, et al. Injury patterns of seniors in traffic accidents: a technical and medical analysis. World J Orthop 2012 Sep 18;3:151-5. (PMID:23173111).
16. Kuhne CA, Ruchholtz S, Kaiser GM, Nast-Kolb D. Working Group on Multiple Trauma of the German Society of Trauma. Mortality in severely injured elderly trauma patients-when does age become a risk factor? World J Surg 2005;29:1476-82. (PMID:16228923).
17. Finelli FC, Jonsson J, Champion HR, et al. A case control study for major trauma in geriatric patients. J Trauma 1989;29:541-8. (PMID:2724372).
18. Triage of Geriatric Trauma. Eastern Association for the Surgery of Trauma. [Internet] Available at: http://www.east.org/tpg/geriatric.pdf. Accessed on July 19,2014.