The Journal of Prevention of Alzheimer's Disease 13 (2026) 100606

Contents lists available at ScienceDirect

The Journal of Prevention of Alzheimer's Disease

journal homepage: www.elsevier.com/locate/tjpad

Original Article

# Mapping the nature, type, and association network of safety incidents among individuals with cognitive impairment in China: a large-scale multicenter cross-sectional study

Ying Zhou [a,b,1], Guoping Peng [c,1], Zhengluan Liao [d], Huayan Liu [e], Jun Liu [f], Wang Liao [f], Qiumin Qu [g], Jingping Shi [h], Jieli Geng [a], Nan Zhi [a], Wenwei Cao [a], Yaying Song [a], Yang Zhang [i], Xiaohong Wang [j], Lin Wang [b], Yuan Zhu [k], Yan Zhou [a], Huali Wang [l], Yongan Sun [m], Rujing Ren [n], Hengge Xie [o,2], Gang Wang [a,*], representing ADC

[a] Department of Neurology, Renji Hospital, Shanghai Jiao Tong University, School of Medicine, Shanghai 200127, China
[b] School of Nursing, Shanghai Jiao Tong University, School of Medicine, Shanghai 200025, China
[c] Department of Neurology, The First Affiliated Hospital, Zhejiang University School of Medicine, Hangzhou, Zhejiang 310003, China
[d] Department of Psychiatry, Zhejiang Provincial People's Hospital, Hangzhou Medical College, Hangzhou 310014, China
[e] Department of Neurology, First Affiliated Hospital, China Medical University, Shenyang 110001, China
[f] Department of Neurology, The Second Affiliated Hospital, Institute of Neuroscience, Key Laboratory of Neurogenetics and Channelopathies of Guangdong Province and the Ministry of Education of China, Guangzhou Medical University, Guangzhou 510260, China
[g] Department of Neurology, The First Affiliated Hospital of Xi'an Jiaotong University, Shanxi 710061, China
[h] Department of Neurology, Affiliated Nanjing Brain Hospital, Nanjing Medical University, 210029, Nanjing, China
[i] Yuyuan Community Health Service Center, Huangpu District, Shanghai 200010, China
[j] Shanghai Jinshan Zhongren Geriatric Nursing Hospital, Shanghai 201501, China
[k] Department of Nursing, Ruijin Hospital, Shanghai Jiaotong University, School of Medicine, Shanghai, 200025, China
[l] Dementia Care and Research Center, Peking University Institute of Mental Health (Sixth Hospital), National Clinical Research Center for Mental Disorders, NHC Key Laboratory for Mental Disorders, Beijing 100191, China
[m] Department of Neurology, Peking University First Hospital, Beijing 100044, China
[n] Department of Neurology and Institute of Neurology, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200025, China
[o] Department of Neurology, The Second Medical Center, National Clinical Research Center for Geriatric Disease, Chinese PLA General Hospital, Beijing 100853, China

ARTICLE INFO

*Keywords:*
Cognitive impairment
Safety incidents
Network analysis

ABSTRACT

*Background:* Patient safety critically influences both quality of life and disease progression in older adults with cognitive impairment, yet large-scale multicenter data remain scarce. This study aims to systematically analyze the types of safety incidents experienced by patients with Alzheimer's disease and related cognitive impairments, and explore the network associations of different safety incidents.

*Methods:* Initiated by the Alzheimer's Disease China (ADC), this survey recruited 1057 older individuals with Alzheimer's and related cognitive impairments, along with their families, across 31 provinces, autonomous regions, and municipalities. The safety incidents evaluated in this study included falls, getting lost, medication errors, verbal aggression, physical aggression, household fire, aspiration, and choking. Incidence rates for overall and specific safety incidents were calculated. Correlation analyses and network analysis were performed to examine relationships between safety incidents.

*Results:* A high proportion (73.5%) of participants reported at least one safety incident in the past year, with over one-third (36.0%) experiencing three or more concurrent incidents. Medication errors (55.9%) and verbal

* Corresponding author at: Department of Neurology, Renji Hospital, Shanghai Jiao Tong University, Shanghai School of Medicine 200127, China.
*E-mail addresses:* zhouying@shsmu.edu.cn (Y. Zhou), guopingpeng@sohu.com (G. Peng), liaozhengluan@163.com (Z. Liao), liuhy@cmu1h.com (H. Liu), liujun@gzhmu.edu.cn (J. Liu), liaowang@gzhmu.edu.cn (W. Liao), quqiumin@xjtufh.edu.cn (Q. Qu), shijingping@jsph.org.cn (J. Shi), gengjieli@renji.com (J. Geng), zhinan@renji.com (N. Zhi), viviancao15@163.com (W. Cao), songyaying@renji.com (Y. Song), yylhzy1201@126.com (Y. Zhang), 908753524@qq.com (X. Wang), wanglsd@shsmu.edu.cn (L. Wang), zy21290@rjh.com.cn (Y. Zhu), jdhljxzl@163.com (Y. Zhou), pkuh@pku.edu.cn (H. Wang), doctorren2001@126.com, sya@bjmu.edu.cn (Y. Sun), doctorren2001@126.com (R. Ren), xiehengge@163.com (H. Xie), wanggang@renji.com (G. Wang).
[1] Joint first authors
[2] Joint Corresponding authors.

https://doi.org/10.1016/j.tjpad.2026.100606
Received 20 February 2026; Received in revised form 2 May 2026; Accepted 14 May 2026
Available online 29 May 2026

aggression (39.6%) were most frequent, followed by falls (32.5%) and physical aggression (22.7%). Incidence rates varied significantly by cognitive impairment stage, care setting, and geographic region. Network analysis highlighted medication errors and getting lost as central nodes bridging other incidents.
*Conclusions:* This study reveals an alarmingly high incidence of safety incidents among cognitively impaired patients, affecting their physical, psychological, and familial well-being. A collaborative, multidisciplinary effort involving healthcare professionals, family caregivers, fire and police emergency responders, and public health policymakers is essential to develop individualized safety strategies aligned with patient needs and contextual considerations.

## 1. Introduction

Cognitive impairment, particularly Alzheimer's disease (AD) and related dementia, poses a significant and growing challenge to global public health [1]. In China, an estimated 17 million people live with AD and other dementias, slightly above the global average, and this number continues to rise with age [2]. Beyond the cognitive and functional decline, safety incidents emerge as a critical factor that not only cause direct physical injury but also exacerbate caregiver strain, increase hospitalization rates, and may accelerate cognitive and functional deterioration [3]. Consequently, safety is intrinsically linked to health outcomes and must be elevated to a strategic public health priority.

The World Health Organization (WHO) defines patient safety as "the absence of preventable harm to a patient and reduction of risk of unnecessary harm in health care" [4]. For cognitively impaired individuals, safety incidents are common and can lead to physical harm, psychological distress, and even premature death [5]. Typical safety incidents include falls, getting lost, medication errors, and aggressive behaviors [6,7]. These occurrences also impose heavy burdens on caregivers and healthcare systems, frequently precipitating institutionalization and generating substantial costs [7]. Thus, effective safety management is both an ethical imperative and a socioeconomic necessity.

Although prior research has reported high prevalence rates of individual safety incidents such as falls and getting lost [8], most studies have focused on single incidents or lacked large-scale, national-level data [7]. Recent epidemiological evidence reveals alarmingly high rates of safety incidents among older adults with cognitive impairment. A systematic review found that this population experiences twice the incidence of falls compared to cognitively intact peers, with community-dwelling individuals with MCI showing prevalence rates of 53.0–63.0% [9]. Medication safety is another critical concern, with 46.5% of dementia patients receiving at least one inappropriate medication [10]. Other critical threats include getting lost, with an estimated 0.5% of dementia patients reported missing each year, predominantly from home settings. Choking also poses a major risk, affecting 17.3% of cognitively impaired older adults [11,12]. Behavioral and psychological symptoms are also prevalent, with agitation and aggression affecting between 5% and 88.0% of patients [13]. The Fire and Rescue Service in England has also documented the heightened fire risk for this population, detailing classic cases of fire incidents linked to dementia [14]. While these studies collectively confirm the heightened safety vulnerability of cognitively impaired individuals, significant knowledge gaps remain. Existing literature lacks a comprehensive understanding of how the overall safety profile varies by region, care setting, and disease stage. Moreover, focusing on a single type of safety incident fails to capture the associative patterns among multiple safety incidents. Network analysis has become a powerful tool in psychological science for mapping complex multivariate relationships and visualizing interconnections among variables [15]. In recent years, network analysis has been successfully applied to explore comorbidity or symptom networks, biomolecular mechanisms, and health-related risk factors [15]. To our knowledge, only one study has used network analysis for root-cause identification in construction accident management [16]. No studies have yet has adopted a holistic perspective to elucidate complex associations among diverse safety incidents in individuals with cognitive impairment.

In 2020, WHO reinforced its commitment to patient safety through technical reports and guidelines on incident reporting and learning systems [17]. These documents notes that while reporting mechanisms have been implemented across multiple tiers such as healthcare facilities, organizational and national programs; many remain narrowly focused on specific clinical safety areas such as blood transfusion. Establishing robust patient safety incident reporting and learning systems is critical to improving healthcare quality and safety, particularly for vulnerable populations like individuals with cognitive impairment. However, no dedicated safety reporting system currently exists that is specifically designed for this population.

Here, this study aims to map the safety landscape for Alzheimer's disease and related dementias (ADRD) in China by examining the incidence of both overall and specific safety incidents among individuals with cognitive impairment, analyzing the differences in safety incidents across different disease stages, geographic regions, and care setting, as well as exploring network associations among different incident types. These findings will develop tailored safety management strategies to mitigate risks, potentially slow cognitive decline, and enhance quality of life for this population.

## 2. Methods

### 2.1. Study design

A large-scale multicenter cross-sectional safety survey was conducted by Alzheimer's Disease China (ADC), the official Chinese member of Alzheimer's Disease International. The survey covered the 31 provinces, autonomous regions, and municipalities across the country, representing 99.6% of the country's total landmass according to the latest official geographic statistics.

### 2.2. Participants

Eligible participants were patients with subjective or objective cognitive impairment or their primary caregivers, who met the following criteria: (1) detailed knowledge of the patient's safety incidents; (2) a patient diagnosis of subjective cognitive decline (SCD) or other cognitive impairment by a neurologist; (3) capacity to respond to survey questions; and (4) provision of informed consent. Participants were excluded if they or their caregivers were unable to provide reliable survey responses due to severe cognitive, psychiatric, or physical conditions.

Although SCD, by definition, lacks objective clinical evidence of cognitive impairment, it represents the earliest symptomatic stage of cognitive decline and may already be accompanied by increased vulnerability to safety incidents (e.g., medication error). Inclusion of this group enabled examination of safety profiles across the continuum from preclinical cognitive decline to dementia.

Potential participants were identified from the registry of individuals enrolled in ADC collaborating memory clinics and community-based cohorts who had undergone formal cognitive evaluation or received a diagnosis. This sampling strategy accounts for the relatively high prevalence of cognitive impairment observed in our sample, as participants

were drawn from populations already engaged in neurological assessment rather than from the general community.

Based on an estimated prevalence of cognitive impairment of 21.5%, a margin of error of 3%, and a 95% confidence level, the minimum required sample size was 721 participants. After accounting for an anticipated 20% nonresponse or attrition rate, the target sample size was set at 866 [18].

### 2.3. Measurements

Demographic and clinical data were collected from patients or their primary caregivers, encompassing age, gender, education, care settings (i.e., home, hospital, nursing home), geographic region, and comorbidities. To ensure diagnostic accuracy, neurologists affiliated with the participating Alzheimer's Disease Center network or collaborating memory clinics were invited to review available medical records and, where applicable, confirm standardized cognitive diagnoses such as subjective cognitive decline (SCD), mild cognitive impairment (MCI), and specific dementia types (e.g., AD). Clinicians also provided relevant diagnostic details and treatment information, including results of apolipoprotein E (APOE) genotyping, pharmacological therapies, and lifestyle interventions.

According to the safety assessment checklist provided by Alzheimer's Association [19], this study focused on eight core safety domains tailored to older adults with cognitive impairment, including falls, getting lost, medication errors, verbal aggression, physical aggression, household fire, aspiration, and choking. All safety incidents were assessed for the 12-month period prior to survey administration.

Falls were assessed using a validated two-item questionnaire designed to investigate participants' fall incidents. Participants reported whether they or patient had ever fallen in the past year, and affirmative responders further specified incident frequency. For statistical analyses, annual fall occurrence was dichotomized as a binary (yes/no) variable [20].

Getting lost was evaluated using a two-item questionnaire. Participants reported the occurrence of any getting-lost incidents within 12 months, with positive responses followed by frequency reporting. Getting lost was coded as a binary variable (yes/no) for the past year [21, 22].

Medication errors included missed doses, incorrect medications, refusal to take medications, and hiding medications [23]. Frequency of each type over the past year was categorized as: never, rarely ($\leq$3 times/year), occasionally (1–2 times/month), frequently (1–2 times/week), or often ($>$ twice/week). Each item was coded 0 for "never"and 1 for any occurrence, and a combined binary variable was generated to indicate the presence of any medication error.

Verbal aggression was assessed using a single-item questionnaire from the Neuropsychiatric Inventory (NPI), a widely recognized scale for measuring neuropsychiatric symptoms [24]. Participants were asked whether they had experienced these behaviors and to rate their frequency in the past year. A similar single-item questionnaire was used to assess physical aggression among patients with cognitive impairment in the past year.

Household fire were determined by a single binary item enquiring whether participants had experienced any fire-related safety problems within their living spaces over the past year [14].

Aspiration and choking were both defined as clinically critical safety incidents. Aspiration was confirmed based on participant-verified of respiratory aspiration over the 12-month recall period and coded dichotomously (yes/no) [25,26]. Similarly, choking incidents were screened via binary self- and caregiver-reported responses regarding 12-month incident occurrence [12].

All eight safety domains were uniformly converted into dichotomous variables representing incident occurrence within the standardized 12-month retrospective timeframe. The total number of individual safety incidents was quantified by summing distinct types of safety incidents for each participant. Comprehensive details regarding the measurement sources, standardized assessment protocols, coding criteria, and inclusion for subsequent network analysis across all safety incidents are provided in see Supplementary Material File A Table A1.

### 2.4. Participant recruitment, data collection and management

Participant recruitment and data collection were conducted concurrently from July to September 2025 to ensure assessments reflected comparable temporal conditions and minimize potential bias on reported safety incidents.

Based on the objectives of this study, we developed an online survey questionnaire that includes patients' basic information and safety incidents (see Supplementary Material File B). In line with the Alzheimer's Association Safety Assessment Checklist [19], responses concerning patients' safety incidents were provided either by the patients themselves or by their primary caregivers, depending on who possessed the most detailed knowledge of the past-year incidents. This approach was adopted to maximize participation and data completeness, given that individuals with cognitive impairment may experience recall difficulties or impaired awareness of certain incidents. Recognizing that caregiver reports are likely to be more reliable for retrospective and context-specific safety incidents, we prioritized enrollment of the primary long-term caregiver when feasible.

Participants were recruited from a population largely consistent with our previously published ADC study, employing comparable inclusion criteria and caregiver-reporting methods [18]. A pilot assessment was conducted to evaluate the feasibility and clarity of the questionnaire. The pilot phase revealed several practical issues. Findings indicated that patients with objective cognitive impairment (particularly MCI and dementia) were generally unable to accurately recall past safety incidents, and thus the questionnaire was predominantly completed by their primary caregiver. For older adults with SCD, the questionnaire was either self-completed or filled out by a caregiver.

Detailed instructions and an informed consent form were included with the questionnaire. A time limit was also established, questionnaires completed in less than 5 min were excluded from analysis. Consecutive questions with identical responses were also excluded. Initially, 1115 eligible participants were enrolled; after excluding cases with incomplete or inconsistent data, the final analytic sample comprised 1057 individuals with cognitive impairment. A flow diagram of participant is presented in Supplementary Material File C Figure A1.

All data were securely stored on a password-protected, encrypted server managed by the research team. Unique participant identifiers were used to anonymize data, and all personal information was handled in compliance with the Declaration of Helsinki and local data protection regulations. Regular backups were performed to prevent data loss.

### 2.5. Statistical analysis

Statistical analyses were performed using SPSS 26.0 and R 3.4. Descriptive statistics are presented as mean$\pm$standard deviation or median (interquartile range) for continuous variables, and as frequency (%) for categorical variables. Group comparisons employed independent *t*-tests for normally distributed continuous data and chi-square tests for categorical data.

Network analysis was used to explore associations among the total number of safety incidents, specific safety incidents, and stages of cognitive impairment. Each type of safety incident was defined as a node, while pairwise statistical associations between distinct safety incidents were defined as edges [15]. Given that all included safety incidents were dichotomous variables, tetrachoric correlation matrices were computed to accurately estimate pairwise latent associations, avoiding statistical bias derived from conventional Pearson correlation for binary data. The graphical least absolute shrinkage and selection operator (LASSO) regularization algorithm with extended Bayesian

information criterion was applied to construct sparse, parsimonious partial correlation networks, which filtered spurious weak correlations and retained only direct, independent associations between safety incident nodes.

Three commonly adopted centrality indices were calculated to quantify the relative importance of each node within the overall safety network: strength (the sum of absolute partial correlations connecting one node to all other nodes, reflecting overall association magnitude), betweenness (the frequency of a node lying on the shortest path between other node pairs, identifying critical bridging incidents), and closeness (the inverse sum of shortest paths linking a target node to all other nodes, representing risk propagation efficiency) [27]. All centrality metrics were normalized for standardized visual comparison. In network visualization, green edges indicate positive associations representing concurrent co-occurrence of distinct safety incidents, red edges indicate negative associations representing mutually restrictive relationships between incidents, and edge thickness corresponds to the magnitude of pairwise association strength.

To evaluate network reproducibility and robustness, a case-dropping bootstrap approach (2000 bootstrap resamples) was performed to test the stability of edge weights and centrality indices. The correlation stability coefficient (CS-coefficient) was calculated, with a CS-coefficient above 0.25 regarded as acceptable stability and above 0.5 indicating excellent robustness. Nodes with high betweenness centrality were recognized as key bridging safety incidents that facilitate the co-occurrence and transmission of other adverse safety events [27,28]. Notably, all network analyses in this study were cross-sectional, descriptive, and exploratory, which only illustrated concurrent co-occurrence patterns and correlational relationships among safety incidents, rather than establishing causal ordering, longitudinal disease trajectories, or definite intervention effects.

### 2.6 Ethics approval and consent to participate

The study was approved by the Human Ethics Research Committee of Renji Hospital, Shanghai Jiao Tong University School of Medicine (LY2025–293-A). Informed consent was obtained from all participants prior to the commencement of the study.

## 3. Results

### 3.1. Characteristics of participants' demographic information

The demographic and clinical characteristic of the patients with cognitive impairment are summarized in Table 1. A total of 1057 patients with cognitive impairment were enrolled, comprising 195 (18.4%) with SCD, 194 (18.4%) with MCI, and 668 (63.2%) with AD dementia. Patient-reported responses accounted for 6.6% ($n$ = 70), while caregivers completed 93.4% ($n$ = 987). The majority (76.9%) of the patients were over 70 years old, and 679 (64.2%) were women. Most patients (61.9%, $n$ = 654) resided with family members. Geographically, 51.3% ($n$ = 542) were from eastern China, followed by northeastern (14.2%, $n$ = 150) regions.

Among all participants, 107 (10.1%) underwent APOE gene polymorphism testing. In accordance with the amyloid-tau-neurodegeneration (ATN) biomarker framework, 41.0% of the total sample ($n$ = 434) fulfilled the diagnostic criteria for AD, while 63.2% received a clinical diagnosis of AD dementia based on standardized clinical guidelines.

**Table 1**
Demographic and clinical characteristics of the participants.

| Variables | Total ($n$ = 1057) | Without safety incidents ($n$ = 280) | With safety incidents ($n$ = 777) | $\chi^2/t$ | $P$ |
|---|---|---|---|---|---|
| Age | | | | 41.756 | <0.001*** |
| 60–69 years old | 244(23.1%) | 36(12.9%) | 208(26.8%) | | |
| 70–79 years old | 402(38.0%) | 93(33.2%) | 309(39.7%) | | |
| ≥80 years old | 411(38.9%) | 151(53.9%) | 260(33.5%) | | |
| Gender | | | | 2.621 | 0.105 |
| Male | 378(35.8%) | 89(31.8%) | 289(37.2%) | | |
| Female | 679(64.2%) | 191(68.2%) | 488(62.8%) | | |
| Education level | | | | 21.112 | <0.001*** |
| Junior school and below | 221(20.9%) | 47(16.8%) | 174(22.4%) | | |
| High school | 568(53.7%) | 183(65.3%) | 385(49.5%) | | |
| College above | 268(25.4%) | 50(17.9%) | 218(28.1%) | | |
| Living pattern | | | | 241.312 | <0.001*** |
| With family members | 654(61.9%) | 65(23.2%) | 589(75.8%) | | |
| Alone or institutionalization | 403(38.1%) | 215(76.8%) | 188(24.2%) | | |
| Activity of Daily Living | 37.90±14.74 | 43.13±15.18 | 36.02±14.11 | 7.085 | <0.001*** |
| Basical ADL | 13.80±7.11 | 17.74±6.99 | 12.38±6.60 | 11.472 | <0.001*** |
| Instrumental ADL | 24.10±8.47 | 25.39±8.53 | 23.64±8.41 | 2.975 | 0.003** |
| Lifestyle or medication treatment | | | | 114.398 | <0.001*** |
| Yes | 893(84.5%) | 181(64.6%) | 712(91.6%) | | |
| No | 164(15.5%) | 99(35.4%) | 65(8.4%) | | |
| Comorbidity | | | | 9.749 | 0.002** |
| No | 527(49.9%) | 162(57.9%) | 365(47.0%) | | |
| Yes | 530(50.1%) | 118(42.1%) | 412(53.0%) | | |
| Region | | | | 174.023 | <0.001*** |
| Eastern | 542(51.3%) | 238(85.0%) | 304(39.1%) | | |
| Northern | 83(7.9%) | 9(3.2%) | 74(9.5%) | | |
| Northeastern | 150(14.2%) | 13(4.6%) | 137(17.6%) | | |
| Central | 124(11.7%) | 10(3.6%) | 114(14.7%) | | |
| Northwestern | 88(8.3%) | 5(1.8%) | 83(10.7%) | | |
| Southwestern | 70(6.6%) | 5(1.8%) | 65(8.4%) | | |
| ApoE apolipoprotein | | | | 17.278 | 0.001** |
| Untested | 950(89.9%) | 269(96.1%) | 681(87.6%) | | |
| 1 (ε4/ε4) | 60(5.7%) | 6(2.1%) | 54(7.0%) | | |
| 2 (ε2/ε4, ε3/ε4) | 25(2.3%) | 1(0.4%) | 24(3.1%) | | |
| 3 (ε2/ε2, ε2/ε3 or ε3/ε3) | 22(2.1%) | 4(1.4%) | 18(2.3%) | | |

Note: Table values are mean ± SD or N (%). P values based on $t$-test or chi-squared test. Abbreviations: APOE, apolipoprotein E; ADL, Activity of Daily Living. ***$P$ < 0.001, **$P$ < 0.01, *$P$ < 0.05.

Regarding interventions, 130 patients (12.3%) received lifestyle interventions, 712 (67.4%) were prescribed pharmacological treatment, and 51 (4.8%) received both modalities. In addition, 114 patients (10.8%) were treated with the amyloid-β (Aβ) monoclonal antibody lecanemab.

### 3.2. The nature of safety incidents among patients with cognitive impairment

Over two-thirds ($n = 777$, 73.5%) of patients experienced at least one safety incident in the past year, with more than one-third ($n = 381$, 36.0%) facing three or more concurrent safety incident types.

In terms of demographic and clinical characteristics, we observed no differences in gender related to safety incidents among patients with cognitive impairment ($P > 0.05$). However, significant differences were found in age, education level, duration of cognitive impairment diagnosis, living pattern, activities of daily living, lifestyle or medication treatments, comorbidities, geographic regions, and ApoE status in relation to safety incidents among these patients ($P < 0.01$).

### 3.3. The types of safety incidents among patients with cognitive impairment

Fig. 1 illustrates the incidence of specific safety incidents among patients with cognitive impairment. Notably, over half (55.9%) of patients reported medication errors, including missed doses (49.7%), medication refusal (24.6%), incorrect medication intake (18.4%), concealment of medication (14.5%). The majority of patients (66.4%) had a history of getting lost, with 18.4% occurring in the past year. Additionally, 46.7% experienced falls, with 32.5% occurring within the last year. Furthermore, 6.8% of patients experienced aspiration while 11.2% patient experienced choking. Moreover, verbal aggression (39.6%) and physical aggression (22.7%) were frequently reported by patients with cognitive impairment. Lastly, 12.7% faced household fire-related incidents due to unsafe practices.

### 3.4. Comparison of safety incidents across different stages of cognitive impairment

As summarized in Table A2 (see Supplementary Material File A), safety incidents differed significantly across these stages. Specifically, significant differences were observed in medication errors ($\chi^2 = 100.711$, $P < 0.001$), getting lost ($\chi^2 = 81.941$, $P < 0.001$), physical aggression ($\chi^2 = 60.340$, $P < 0.001$), household fire ($\chi^2 = 42.914$, $P < 0.001$), verbal aggression ($\chi^2 = 40.229$, $P < 0.001$), falls ($\chi^2 = 21.488$, $P < 0.001$), and aspiration ($\chi^2 = 16.865$, $P = 0.002$) across cognitive impairment stages while no differences were detected in choking ($\chi^2 = 4.449$, $P > 0.05$).

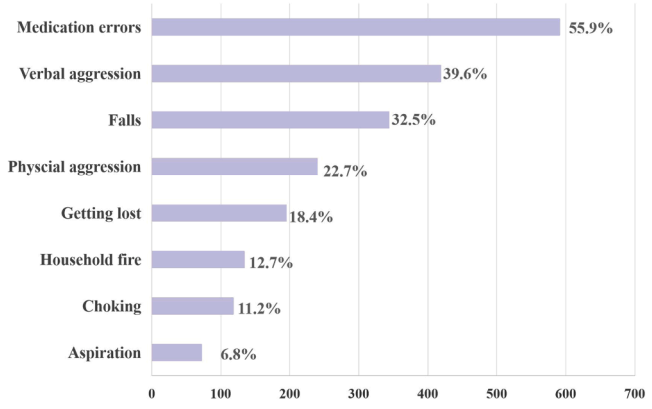


**Fig. 1.** The incidence of safety incidents among individuals with cognitive impairment.

Fig. 2A presents the significant difference of specific safety incidents among participants stratified by stage of cognitive impairment. Aspiration increased progressively with disease severity. Whereas, medication errors, getting lost, verbal aggression, showed an initial rise from earlier stages, reached their peak in moderate dementia, and then declined in severe dementia. For household fire, the highest incidence was observed in older individuals with MCI.

### 3.5. Comparison of safety incidents across different care settings

As shown in Table A3 (see Supplementary Material File A), significant differences in safety incident rates were observed across various care settings over the past year ($P < 0.001$). Nursing homes reported the lowest rates of falls (7.2%) and medication errors (14.8%). In contrast, hospitals exhibited the highest incidence of aspiration (32.1%) and choking (25.0%). The home environment had the highest rate of medication errors at 73.3%, along with a substantially higher risk of individuals getting lost (25.8%) compared to other clinical settings. Household fire incidents were more pronounced in the home settings, with an incidence of 17.6%. When comparing homes and hospitals, behavioral symptoms were more prevalent in facilities, with elderly care institutions showing the highest rates of verbal aggression (55.7%) and physical aggression (38.6%).

Fig. 2B also illustrates the significant difference of specific safety incidents among participants across different care settings. Older adults with cognitive impairment living outside nursing homes were more vulnerable to most types of safety incidents than those residing in nursing home.

### 3.6. Comparison of safety incidents across different geographic regions

Table A4 (see Supplementary Material File A) presents the incidence of safety incidents by different geographic regions, revealing significant differences. Compared to other regions, central China reported the highest rates of safety incidents (91.9%). Eastern China reported the lowest rates for safety incident indicators such as medication errors (40.8%), falls (20.7%), and getting lost (11.3%). In contrast, central China has the highest rate of aspiration incidents at 8.9%, while northeastern China (20.7%) reported elevated rates of choking. Additionally, northeastern China had the highest rates of verbal aggression with a rate of 59.3%, followed closely by northwestern China at 51.1%. The regions with the highest rates of physical aggression were also northeastern (36.0%), central (27.4%) and northwestern China (27.3%). Furthermore, northeastern China has the highest incidence of household fire accidents, accounting for 34.7%, followed by central China (16.1%) and northwestern region (15.9%).

### 3.7. Correlation and network analysis of safety incidents among patients with cognitive impairment

Fig. 3 illustrates the correlations between safety incidents in patients with cognitive impairment. The overall safety incidents were strongly associated with falls ($r = 0.581$, $P < 0.01$), medication errors ($r = 0.551$, $P < 0.01$), verbal aggression ($r = 0.677$, $P < 0.01$), and physical aggression ($r = 0.599$, $P < 0.01$). Falls, aspiration, choking, medication errors, getting lost, and aggressive behaviors (both verbal and physical) all showed significant positive correlations ($P < 0.01$). Notably, aspiration exhibited the strongest correlation with choking ($r = 0.524$, $P < 0.01$). Additionally, verbal aggression was positively associated with physical aggression ($r = 0.558$, $P < 0.01$). In contrast, fire safety issues demonstrated weaker correlations with other safety incidents ($r = 0.092$–$0.197$, $P < 0.01$).

Fig. 4 presents the network analysis of various safety incidents among older adults with cognitive impairment. Distinct interconnected safety incident cluster was identified across the overall safety network,

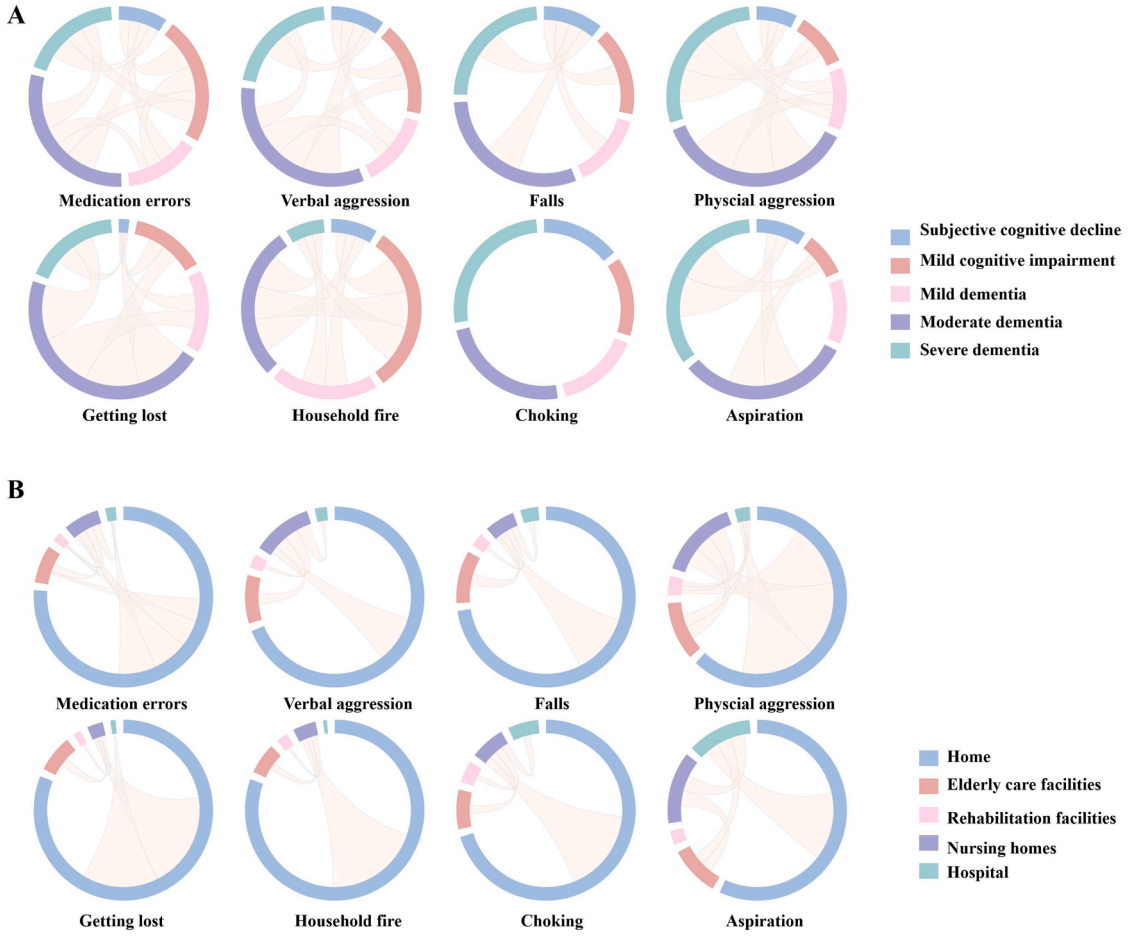


**Fig. 2.** Comparison of safety incidents across different stages of cognitive impairment and different care settings Data are presented as percentage. Differences between groups were considered significant at P < 0.05.

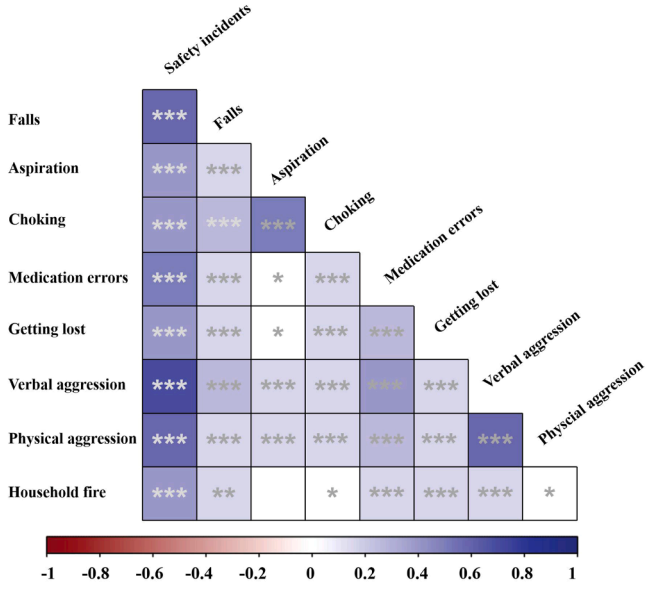


**Fig. 3.** Correlations of safety incidents among individuals with cognitive impairment. Red color indicates negative associations, blue indicate positive associations. Pearson correlation efficient, two side 95%, *$P$<0.05, *$P$<0.01, ***$P$<0.001 .

with verbal and physical aggression exhibiting the strongest pairwise

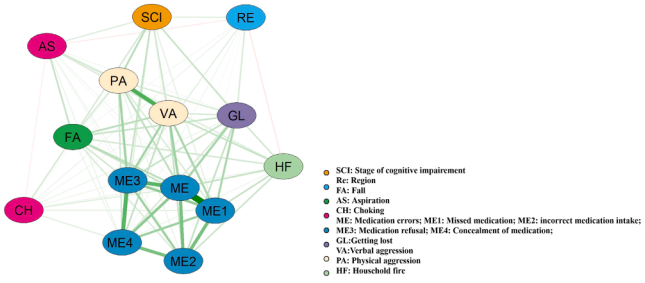


**Fig. 4.** Network analysis of safety incidents among individuals with cognitive impairment.

correlation among all incident pairs. Quantitative centrality analyses further showed that medication errors, household fire, and verbal aggression yielded higher strength and closeness centrality values compared with other safety incidents. Betweenness centrality quantification confirmed medication errors and getting lost as the primary cross-domain bridging nodes within the network. These two safety incidents connected neuropsychiatric behavioral clusters, and physical safety incidents including choking and aspiration (see Supplementary Material File C Figure A2). Subgroup analysis of medication errors further examined four specific subtypes: missed medication, incorrect medication intake, medication refusal, and concealed medication. All medication error subtypes presented stable mutual interconnections within the network.

## 4. Discussion

To our knowledge, this is the first large-scale multicenter cross-sectional study to systematically assess the overall safety status of cognitively impaired patients in China, and one of the first at both Asian and global levels. The findings reveal an alarmingly high incidence of safety incidents, with over two-thirds of patients experiencing at least one in the past year. The study examined a broad spectrum of issues-from common problems like falls and getting lost to often-overlooked areas such as household fire and medication errors. These results provide a critical evidence base for healthcare professionals, family caregivers, fire and police emergency responders, and public health policymakers to develop targeted safety strategies for this vulnerable population.

This study identifies medication errors as the most prevalent safety incident among cognitively impaired patients, a finding consistent with established research [23]. Omission errors were the most common type. These errors arise from a complex interplay of factors, with polypharmacy-over 50% of participants were prescribed three or more medications-being a primary driver [23,29]. Both our data and recent qualitative interviews reveal that management strategies evolve with disease progression [30]. Patients with MCI or mild dementia often employ compensatory strategies to maintain autonomy, while caregivers assume full responsibility for those with moderate dementia. Promisingly, our study found that 56.8% of caregivers provide medication management support, and over a third of patients or caregivers utilize intelligent aids like smart pillboxes. This underscores the need for collaborative, personalized medication management plans that respect patient autonomy in early disease stages while strategically leveraging technology to safeguard treatment efficacy.

This study further identified several key safety incidents with distinct risk profiles. The incidence of verbal aggression (39.6%) was lower than a prior large-scale report (44.6%) [31], a difference potentially explained by our study's predominance of mild to moderate dementia. Rates of physical aggression aligned with existing research [32], confirming that these behaviors occur across the cognitive impairment spectrum and generally increase with severity. Similarly, the observed incidence of falls and getting lost was consistent with earlier findings [33]. These incidents are frequent concerns, driven by factors such as frailty, declining functional ability, and polypharmacy. Notably, choking and aspiration emerged as critical incidents, yet often overlooked, particularly for individuals with dysphagia. Impaired swallowing reflexes can lead to silent aspiration, which lacks obvious symptoms like coughing but may result in life-threatening aspiration pneumonia [34].These findings underscore that patient safety is a multidimensional construct spanning physical, psychological, and social domains. Effective safety systems must therefore systematically identify, prioritize, and analyze these diverse risks [17].

Our analysis identified varying associations between demographic characteristics and safety incidents among cognitively impaired patients. While no gender-based disparities were observed, consistent with prior studies that adjusted for age and comorbidities [8]. Several other factors showed significant predictors. Age was a critical determinant, with older patients facing higher risks, a finding consistent with global data on frailty and polypharmacy complications in advanced age [35]. Our findings revealed that participants with a junior high school education or below, as well as those with a college degree or above, experience lower safety incidents than their high-school-educated counterparts. The former group's reduced risk stems from limited cognitive reserve but is mitigated by close caregiver supervision [36, 37]. The latter benefits from higher health literacy and better access to protective resources. In contrast, individuals with a high school education have moderate cognitive reserve yet tend to live more independently and rely less on formal care, leaving them more vulnerable to accidents when cognitive decline occurs. Furthermore, disease duration, comorbidity, and ApoEε4 carrier status significantly influenced risk, reflecting progressive functional and neuropsychiatric decline [38]. Collectively, these findings highlight the necessity of personalized risk stratification that integrates sociodemographic, clinical, and genetic markers to optimize prevention strategies.

The present study identified that significant differences in the prevalence of safety incidents across the spectrum of cognitive impairment. The prevalence of some incidents-including choking and aspiration, was higher in participants with more advanced cognitive impairment. Conversely, the prevalence of other safety incidents, such as medication errors and fall, follow a rise-and-fall pattern, peaking before declining in later stages. This divergence is likely tied to patients' evolving functional abilities and caregiver oversight. In the early stages, individuals often retain independence, which exposes them to certain self-management risks. As dementia advances and daily living capabilities decline, comprehensive caregiver intervention reduces exposure to these incidents, thereby lowering their incidence [39]. However, further decline in severe dementia introduces or worsens vulnerabilities, leading to elevated aspiration, choking, and other risks despite greater supervision. These findings underscore the need for stage-specific safety strategies that both early residual risks and distinct late-stage challenges.

This study demonstrates that safety incident profiles among cognitively impaired patients is highly dependent on the care setting, necessitating tailored strategies. (1) Home settings were characterized by a high incidence of medication errors (73.3%), falls (40.6%), and household fire (17.6%), primarily due to unsupervised management, environmental hazards, and caregiver knowledge gaps [40,41]. Interventions should prioritize caregiver education, medication management tools (e.g., smart pillboxes), and home safety assessments. (2) Hospital settings revealed significant risks for aspiration (32.1%) and choking (25.0%). These risks often exacerbated by acute illness severity, medication side effects, and inadequate swallowing supervision amidst clinical priorities. Prevention requires standardized swallowing assessments and staff training in safe feeding techniques. (3) Nursing homes presented a different profile, with low rates of falls (7.2%) and medication errors (14.8%), likely due to structured protocols and professional staffing [30]. However, elderly care facilities reported high rates of verbal (55.7%) and physical (38.6%) aggression, potentially linked to overcrowding and inadequate personalized care [31]. Strategies should enhance behavioral management through staff training and environmental modifications, while maintaining effective physical safety protocols.

This study reveals significant regional disparities in the incidence of safety incidents among cognitively impaired individuals in China. Central China reported the highest overall rate of safety incidents (91.9%), with notably high levels of physical aggression (27.4%), and household fire (16.1%). In contrast, eastern China-characterized by greater economic development-demonstrated the lowest rates of key incidents, including falls (20.7%), and getting lost (11.3%). Northeastern China led in choking incidents (20.7%) and reported highest rates of verbal aggression (59.3%). These geographic patterns are closely tied to local conditions. The discrepancy could be attributed to factors such as local dietary habits, traditional practices, and healthcare access limitations. These disparities underscore the need for region-specific strategies, including caregiver education focused on local risks, infrastructure improvements (e.g., subsidizing home safety modifications in resource-limited areas), and safety protocols adapted to socio-cultural practices.

Network analysis identified medication errors and getting lost as central, highly interconnected nodes within the safety incident network. Medication errors showed strong interconnectivity, indicating a shared vulnerability in management systems where targeted interventions (e.g., medication reconciliation, caregiver training) could yield broad benefits [23]. Similarly, getting lost often act as sentinel events, precipitating functional decline and worsened behavioral symptoms [11]. A distinct behavioral cluster linked physical and verbal aggression, suggesting cycles triggered by unmet needs or communication difficulties [42]. Notably, observable correlational links between this behavioral cluster

and medication-related incidents further underline the necessity of integrated multi-domain safety management strategies. Targeting these central nodes offers an efficient risk-reduction strategy. For instance, multifaceted fall prevention programs combining environmental modifications with medication reviews can produce systemic benefits [30]. Collectively, these exploratory network findings visualize complex synchronous co-occurrence patterns of diverse safety incidents, clarify intrinsic correlations across multidimensional safety incidents, and provide preliminary empirical evidence for optimized integrated safety management for older adults with cognitive impairment.

This study yields substantial practical implications for healthcare professionals, family caregivers, frontline emergency responders, and public health policymakers and administrators. (1) For healthcare professionals, our findings highlight high-risk safety incidents and critical bridging incident types across different cognitive stages, which can guide standardized stage-based safety screening, targeted risk evaluation, and individualized preventive intervention in routine cognitive care. (2) For family caregivers, the identified safety incident types and interactive mechanisms enable personalized home safety management, continuous risk monitoring, and proactive precautionary training to reduce avoidable adverse safety incidents. (3) For frontline emergency personnel, including fire and police officers, the categorized safety incidents and stage-specific incident characteristics provide empirical evidence to support rapid risk judgment, standardized emergency disposal, and targeted on-site rescue responses for cognitively impaired older adults involved in safety incidents. (4) For policymakers and public health administrators, the notable regional and setting-based disparities in safety incident prevalence emphasize the necessity of optimizing regional geriatric healthcare resource allocation, developing unified safety management guidelines for older adults with cognitive impairment, and implementing systematic caregiver education and supportive service programs. Therefore, collaborative, multi-stakeholder efforts are warranted to comprehensively safeguard the safety of older adults across the entire spectrum of cognitive impairment.

This study has several limitations. First, the cross-sectional design only captures single-time-point observational data. Accordingly, the constructed safety network solely reflects correlational, synchronous co-occurrence of safety incidents rather than causal relationships, directional risk pathways, or longitudinal safety changes alongside cognitive decline, highlighting the need for longitudinal validation. Second, the study relied heavily on caregiver proxy reports (93.4%) rather than patient self-reports, which may introduce recall bias and potential misclassification. Heterogeneity in respondents across SCD, MCI, and dementia subgroups may also reduce comparability across groups. Future studies are encouraged to incorporate objective monitoring tools (e.g., wearable devices, smart sensors) to reduce subjective retrospective reporting bias. Third, driving safety was excluded due to the study's predominant use of public transportation and travel restrictions for those over 70. Future multinational studies should include driving metrics where relevant. Fourth, non-probability sampling from memory clinics and Alzheimer's Disease Center registries may restrict the generalizability of findings to broader community populations. Finally, multiple unmeasured confounders, including healthcare accessibility, caregiver burden, and socioeconomic factors, were not adjusted for, and subgroup analyses remained unadjusted. Future studies with population-based sampling, longitudinal designs, multivariable adjusted models, and objective outcome measures are warranted to validate and extend our findings.

## 5. Conclusions

This study reveals the alarmingly high incidence of safety incidents among patients with cognitive impairment, encompassing physical, psychological, and familial aspects. Safety incidents were identified in more than one-fifth of cases, including medication errors, verbal aggression, falls, and physical aggression. The research further identifies significant disparities in incidence rates based on care settings, geographic regions, and disease stages, underscoring the critical influence of physiological, environmental, and socioeconomic factors on patient safety. Network analysis identified medication errors and falls as central bridging nodes, linking multiple co-occurring incidents within the safety profile. Targeted, stage-specific, context-tailored preventive strategies, alongside collaborative multidisciplinary and multi-stakeholder efforts including healthcare professionals, family caregivers, fire and police emergency responders, and public health policymakers are imperative to alleviate cascading safety risks, standardize safety management protocols, and ultimately improve patient safety and quality of life among older adults with cognitive impairment.

## Fundings (Funding sources)

This work was supported by the following funding sources: Brain Science and Brian-Like Intelligence Technology of the Minstry of Science and Technology of China (2021ZD0201804), National Natural Science Foundation of China (Grant No. 72504178), Shanghai Science and Technology Plan Project Funding (Grant No. 24YF2722500), Fundamental Research Funds for the Central Universities (Grant No. YG2025QNA01), Shanghai Jiao Tong University School of Medicine: Nursing Development Program (SJTUHLXK2024), Shanghai Jiao Tong University Humanities and Social Sciences Youth Training Program (Grant No. 2025QN035, "Nursing + X" Interdisciplinary Project (Grant No. HLXKGDD2024), Science and Technology Innovation Humanities and Social Sciences Project (Grant No. WK2404), and High-Level Local University Development Initiative, Shanghai Jiao Tong University School of Nursing: Excellent Medical Innovation Talent Training Project (Grant No. HLDC24-02).

## Declaration of the use of generative AI and AI-assisted technologies in scientific writing and in figures, images and artwork

The authors declare that no generative AI or AI-assisted technologies were used in the preparation of the manuscript, scientific writing, or the creation/editing of any figures, images, or artwork in this work.

## Data statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## CRediT authorship contribution statement

**Ying Zhou:** Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Guoping Peng:** Visualization, Supervision, Methodology, Investigation, Data curation. **Zhengluan Liao:** Project administration, Investigation, Formal analysis, Data curation. **Huayan Liu:** Project administration, Investigation, Data curation. **Jun Liu:** Resources, Project administration, Investigation, Data curation. **Wang Liao:** Resources, Project administration, Investigation, Data curation. **Qiumin Qu:** Resources, Project administration, Investigation, Data curation. **Jingping Shi:** Resources, Investigation, Data curation. **Jieli Geng:** Investigation, Data curation. **Nan Zhi:** Investigation, Data curation. **Wenwei Cao:** Investigation, Data curation. **Yaying Song:** Investigation, Conceptualization. **Yang Zhang:** Investigation, Data curation. **Xiaohong Wang:** Investigation, Data curation. **Lin Wang:** Investigation, Data curation. **Yuan Zhu:** Investigation, Data curation. **Yan Zhou:** Investigation, Data curation. **Huali Wang:** Investigation, Data curation. **Yongan Sun:** Investigation, Data curation. **Rujing Ren:** Investigation, Data curation. **Hengge Xie:** Writing – review & editing, Supervision,

Project administration, Methodology. **Gang Wang:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

We thank Mrs. Chunling Gu from Shanghai Jinmei Elderly Care, Mr. Bin Tang from Shanghai Jianai Charity, and Mrs. Li Hong form Lezhi Organizations for helping organize the survey.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjpad.2026.100606.

## References

[1] Alzheimer's Association. 2025 Alzheimer's disease facts and figures. Alzheimers Dement 2025;21(4):e70235. https://doi.org/10.1002/alz.70235.
[2] Zhi N, Ren R, Qi J, Liu X, Yun Z, Lin S, et al. The China alzheimer report 2025. Gen Psychiatr 2025;38(4):e102020. https://doi.org/10.1136/gpsych-2024-102020.
[3] Livingston G, Huntley J, Liu KY, Costafreda SG, Selbæk G, Alladi S, et al. Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission. Lancet 2024;404(10452):572–628. https://doi.org/10.1016/S0140-6736(24)01296-0.
[4] World Health Organization. (2024), Global patient safety report 2024. https://www.who.int/publications/i/item/9789240095458. Accessed February 20, 2026.
[5] Bangerter L, Zabala G, Werner NE, Kim YK, Adams K, Fong A, et al. A multi-hospital analysis of clinician-reported safety events in people living with dementia: contributing factors and system recommendations. Jt Comm J Qual Patient Saf 2025;51(11):711–8. https://doi.org/10.1016/j.jcjq.2025.07.010.
[6] Scott J, Sykes K, Waring J, Spencer M, Young-Murphy L, Mason C, et al. Systematic review of types of safety incidents and the processes and systems used for safety incident reporting in care homes. J Adv Nurs 2025;81(1):69–115. https://doi.org/10.1111/jan.16264.
[7] Chalmer R. Safety considerations in older adults with cognitive impairment including dementia. A comprehensive guide to safety and aging. 1st edi. CRC Press; 2023.
[8] Tyson BT, Pham MT, Brown NT, Mayer TR. Patient safety considerations in the rehabilitation of the individual with cognitive impairment. Phys Med Rehabil Clin N Am 2012;23(2):315–34. https://doi.org/10.1016/j.pmr.2012.02.007.
[9] Chantanachai T, Sturnieks DL, Lord SR, Payne N, Webster L, Taylor ME. Risk factors for falls in older people with cognitive impairment living in the community: systematic review and meta-analysis. Ageing Res Rev 2021;71(11):101452. https://doi.org/10.1016/j.arr.2021.101452.
[10] Qin QNX, Ming LC, Abd Wahab MS, Tan CS, Yuda A, Hermansyah A. Drug-related problems among older people with dementia: a systematic review. Res Soc Adm Pharm 2023;19(6):873–81. https://doi.org/10.1016/j.sapharm.2023.02.015.
[11] Bantry White E, Montgomery P, Dementia. Walking outdoors and getting lost: incidence, risk factors and consequences from dementia-related police missing-person reports. Aging Ment Health 2015;19(3):224–30. https://doi.org/10.1080/13607863.2014.924091.
[12] Manduchi B, Walshe M, Burke É, Carroll R, McCallion P, McCarron M. Prevalence and risk factors of choking in older adults with intellectual disability: results from a national cross-sectional study. J Intellect Dev Disabil 2021;46(2):126–37. https://doi.org/10.3109/13668250.2020.1763278.
[13] Anatchkova M, Brooks A, Swett L, Hartry A, Duffy RA, Baker RA, et al. Agitation in patients with dementia: a systematic review of epidemiology and association with severity and course. Int Psychogeriatr 2019;31(9):1305–18. https://doi.org/10.1017/S1041610218001898.
[14] James T, Clark A. Fire risk and safety for people living with dementia at home: a narrative review of international literature and case study of fire and rescue services in England. Dementia 2025;24(5):977–95. https://doi.org/10.1177/14713012251320251.
[15] Borsboom D, Deserno MK, Rhemtulla M, Epskamp S, Fried EI, McNally RJ, et al. Network analysis of multivariate data in psychological science. Nat Rev Methods Primers 2021;1(1):58–76. https://doi.org/10.1038/s43586-021-00055-w.
[16] Kumi L, Jeong J, Jeong J, Son J, Mun H. Network-based safety risk analysis and interactive dashboard for root cause identification in construction accident management. Reliab Eng Syst Saf 2025;256(4):110814. https://doi.org/10.1016/j.ress.2025.110814.
[17] World Health Organization. Patient safety incident reporting and learning systems: technical report and guidance. https://www.who.int/publications/i/item/9789240010338; 2020. Accessed February 20, 2026.
[18] Bian D, Liang F, You Y, Li X, Hu H, Wang H, et al. Evaluating dietary quality and dietary inflammatory potential in cognitive impairment patients in China. Alzheimers Dement 2025;21(6):e70345. https://doi.org/10.1002/alz.70345.
[19] Alzheimer's Association. Safety assessment checklist & guide. https://www.alz.org/getmedia/836b0211-fc03-4984-8e74-2efd88260830/hc-23002_cpt-safety-assessment_march2023.pdf; 2023. Accessed February 20, 2026.
[20] Solie CJ, Swanson MB, Harland K, Blum C, Kin K, Mohr N. Two-item fall screening tool identifies older adults at increased risk of falling after emergency department visit. West J Emerg Med 2020;21(5):1275. https://doi.org/10.5811/westjem.2020.5.46991.
[21] White EB, Montgomery P. A review of "wandering" instruments for people with dementia who get lost. Res Soc Work Pr 2014;24(4):400–13. https://doi.org/10.1177/1049731513514116.
[22] Chiu YC, Algase D, Liang J, Liu HC, Lin KN. Conceptualization and measurement of getting lost behavior in persons with early dementia. Int J Geriatr Psychiatry 2005;20(8):760–8. https://doi.org/10.1002/gps.1356.
[23] De Vito AN, Emrani S, Hallowell E, Goldstein A, Davis JD, Margolis SA. Medication management error types: associations with mild cognitive impairment subtype. Clin Neuropsychol 2024;38(8):1931–46. https://doi.org/10.1080/13854046.2024.2339560.
[24] Cummings J. The neuropsychiatric inventory: development and applications. J Geriatr Psychiatry Neurol 2020;33(2):73–84. https://doi.org/10.1177/0891988719882102.
[25] Arslan SS, Demir N, Kılınç HE, Karaduman AA. The ability of the eating assessment tool-10 to detect aspiration in patients with neurological disorders. J Neurogastroenterol Motil 2017;23(4):550–4. https://doi.org/10.5056/jnm16165.
[26] Romano M, Schultz T, Tai A. The diagnostic test accuracy of clinical swallow assessment for oropharyngeal aspiration: a systematic review. JBI Libr Syst Rev 2012;10(56 Suppl):1–16. https://doi.org/10.11124/01938924-201210561-00002.
[27] Jones PJ, Ma R, McNally RJ. Bridge centrality: a network approach to understanding comorbidity. Multivar Behav Res 2021;56(2):353–67. https://doi.org/10.1080/00273171.2019.1614898.
[28] Hevey D. Network analysis: a brief overview and tutorial. Health Psychol Behav Med 2018;6(1):301–28. https://doi.org/10.1080/21642850.2018.1521283.
[29] Havelikar U, Sonawane HK, Khandare RS, Parewal K, Shaikh SA, Chaudhari N, et al. Optimizing patient care: an inclusive review of polypharmacy and the vital role of pharmacists in mitigation. Intell Hosp 2025;1(1):100006. https://doi.org/10.1016/j.inhs.2025.100006.
[30] O'Conor R, Russell AM, Pack A, Oladejo D, Filec S, Rogalski E, et al. Managing medications among individuals with mild cognitive impairment and dementia: patient-caregiver perspectives. J Am Geriatr Soc 2024;72(10):3011–21. https://doi.org/10.1111/jgs.19065.
[31] Sano M, Cummings J, Auer S, Bergh S, Fischer CE, Gerritsen D, et al. Agitation in cognitive disorders: progress in the international psychogeriatric association consensus clinical and research definition. Int Psychogeriatr 2024;36(4):238–50. https://doi.org/10.1017/S1041610222001041.
[32] Veldwijk-Rouwenhorst AE, Zuidema SU, Smalbrugge M, Bor H, Wetzels R, Gerritsen DL, et al. Very frequent physical aggression and vocalizations in nursing home residents with dementia. Aging Ment Health 2021;25(8):1442–51. https://doi.org/10.1080/13607863.2020.1786799.
[33] Farup PG, Hestad K, Engedal K. Falls in persons with cognitive impairment—incidence and characteristics of the fallers. Geriatrics 2024;9(6):168. https://doi.org/10.3390/geriatrics9060168.
[34] Xu J, Meng R, Yan J, Zheng W, Wu Y, Chen Q. Bidirectional impact of dementia and aspiration pneumonia on cognitive decline in older adults: a retrospective cohort analysis. Geriatr Gerontol Int 2025;25(11):1481–7. https://doi.org/10.1111/ggi.70176.
[35] Yu X, Qian Y, Zhang Y, Chen Y, Wang M. Association between polypharmacy and cognitive impairment in older adults: a systematic review and meta-analysis. Geriatr Nurs 2024;59(9–10):330–7. https://doi.org/10.1016/j.gerinurse.2024.07.005.
[36] Marselli G, Favieri F, Forte G, Corbo I, Agostini F, Guarino A, et al. The protective role of cognitive reserve: an empirical study in mild cognitive impairment. BMC Psyol 2024;12(1):334. https://doi.org/10.1186/s40359-024-01831-5.
[37] Reppermund S. The interplay between depressive symptoms, cognitive function, activities of daily living and cognitive reserve in older adults. Int Psychogeriatr 2021;33(8):759–61. https://doi.org/10.1017/S1041610221000508.
[38] Li M, Wang Y, Kazis L, Weng J, Xia W. Comorbidities and apolipoprotein E genotypes of patients with mild cognitive impairment in transition to Alzheimer's disease. J Alzheimers Dis Rep 2025;9:25424823251353209. https://doi.org/10.1177/25424823251353209.
[39] Ghasempourabadi M, Yang E, Burke M, Jones B, Phelps B, Bansal N. Correlations between kitchen safety measures, functional independence, and caregiving burden for older adults living with mild cognitive impairment. Arch Phys Med Rehab 2024;105(4):e86. https://doi.org/10.1016/j.apmr.2024.02.242.
[40] Wang DY, Wong ELY, Cheung AWL, Tam ZPY, Tang KS, Yeoh EK. Implementing the information system for older adult patients post-discharge self-management: a

qualitative study. Age Ageing 2024;53(7):afae136. https://doi.org/10.1093/ageing/afae136.

[41] Franchini A, Barake B, Galasso C, Moreyra Garlock ME, Mulligan J, Quiel S, et al. Integrating fire safety into bridge design is essential for resilient infrastructure. Nat Commun 2024;15(1):6629. https://doi.org/10.1038/s41467-024-49593-3.

[42] Schwertner E, Pereira JB, Xu H, Secnik J, Winblad B, Eriksdotter M, et al. Behavioral and psychological symptoms of dementia in different dementia disorders: a large-scale study of 10,000 individuals. J Alzheimers Dis 2022;87(3):1307–18. https://doi.org/10.3233/JAD-215198.