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Risk factors for crash involvement in older motorcycle riders

Sy-Jou Chen[a,b], Chih-Yi Chen[b], Mau-Roung Lin[b,c,*]

[a] Department of Emergency Medicine, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan
[b] Institute of Injury Prevention and Control, College of Public Health, Taipei Medical University, Taipei, Taiwan
[c] Master Program in Long-Term Care, College of Nursing, Taipei Medical University, Taipei, Taiwan

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ABSTRACT

A prospective cohort study was conducted to identify risk and protective factors for crash involvement in older motorcyclists. Over a 1-year study period from August 2013 to July 2014, study participants were recruited from local community centers of five cities in Taiwan. People aged ≥60 years who rode a motorcycle at least once per week were eligible and were invited to participate in the study. Among 256 older riders who completed the baseline assessment and at least one of the four follow-up assessments, 79 (33.7%) experienced a motorcycle crash over the study period. Results of the proportional hazards model showed that after controlling for age, gender, and riding distance, older riders who had sustained hearing impairment (hazard ratio (HR) = 2.58; 95% confidence interval (CI), 1.30–5.15), rode a motorcycle at speeds of ≥41 km/h (HR = 2.31; 95% CI, 1.26–4.23), and had experienced a motorcycle crash in the past year (HR = 1.81; 95% CI, 1.06–3.09) were more likely to be involved in a crash, compared to their counterparts. Conversely, older riders who were obese (HR = 0.43; 95% CI, 0.22–0.82) were less likely to be involved in a crash than those with a normal weight, while longer functional reach distances (HR = 0.96; 95% CI, 0.93–0.99) and higher Tinetti balance scores (HR = 0.79; 95% CI, 0.69–0.91) were associated with a reduced risk of crash involvement. Among older people riding a motorcycle as their primary source of transportation, several factors associated with the occurrence of motorcycle crashes were identified. Restrictions and modifications of these risk factors may help design effective safety interventions for reducing crash and injury risks of this increasing riding population.

1. Introduction

Motorcyclists are about 26-times more likely per vehicle mile traveled to die and 5-times more likely to be injured in a crash, compared to passenger car occupants (NCSA, 2015). Among older people, motorcycle crashes have become an increasing public health concern, particularly in countries where the elderly are a rapidly growing proportion of the population with a trend toward an increasing age of motorcycle ownership (Mullin et al., 2000; Jackson and Mello, 2013; Oxley et al., 2013). In most countries of Southeast Asia, motorcycles are used as a primary source of transportation, and safety interventions for older motorcyclists in these countries are becoming particularly important and urgent; for instance, motorcyclists account for nearly 60% of road traffic fatalities in Taiwan, and one-third of motorcycle fatalities are those aged ≥60 years (NPA, 2016).

Older motorcycle riders are the most responsible riders among all age groups (Keall and Newstead, 2012; Oxley et al., 2013), since they are less likely to be cited for careless or reckless riding, exceeding the speed limit, or being in run-off-the-road collisions (Stutts et al., 2004). Nevertheless, riders aged ≥60 years are considered more likely to be at fault for a crash than are middle-aged (40–60 years) riders (Haque et al., 2009), and they are more vulnerable to serious injury and death after a crash partly due to pre-existing comorbidities and declines in physiological resilience (Richter et al., 2005; Talving et al., 2010; Jou et al., 2012; Fitzpatrick and O'Neill, 2017). Those findings underline the unique features of older motorcycle riders, and for effective safety interventions, there is a necessity to screen out unfit older riders at high risk for being involved in a crash.

While afore-mentioned studies of older motorcyclists were dedicated to injury patterns and severity or mortality risk, to our knowledge, no studies have focused on factors predicting the crash risk in this population. Accordingly, we conducted a prospective cohort study to identify risk and protective factors associated with crash involvement in older motorcycle riders.

* Corresponding author at: Institute of Injury Prevention and Control, Taipei Medical University, 250 Wu-Hsing Street, Taipei 11031, Taiwan.
E-mail address: mrlin@tmu.edu.tw (M.-R. Lin).

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2. Methods

2.1. Study participants

Over a 1-year study period from August 2013 to July 2014, study participants were recruited from local community centers in five cities situated in northern (Taipei), central (Miaoli and Taichung), and eastern (Hualien and Ilan) Taiwan. People aged ≥60 years who rode a motorcycle at least once per week were eligible and invited to participate in the study. We excluded persons who could not ambulate independently or had difficulty communicating.

Among 359 eligible persons, 315 participated in the baseline assessment, of which 256 completed at least one follow-up assessment. Written consent was obtained from each participant. The study protocol was reviewed and approved by the institutional review board of Taipei Medical University.

2.2. Data collection

The baseline assessment was conducted at local community centers. Through direct interviews and functional tests, research assistants collected information on sociodemographics, lifestyle behaviors, riding characteristics, medical conditions, and the functional health status. Assessment procedures and assessor attitudes were standardized through participation in a 4-h training course.

Sociodemographics and lifestyle behaviors consisted of age, gender, residential area, educational level, marital status, body weight and height, body-mass index (BMI), living arrangement, household income, regular exercise, current smoking, and alcohol consumption. The BMI was calculated by the individual's body weight (kg) divided by the square of height (m), and a BMI of $< 18.5\ kg/m^2$ was classified as underweight, 18.5–23.9 kg/m^2 as normal weight, 24–26.9 kg/m^2 as overweight, and $\geq 27\ kg/m^2$ as obese.

Riding characteristics consisted of riding experience, frequency of riding (days per week and minutes per day), kilometers ridden per month, the usual (most common) riding speed, and traffic violations and motorcycle crash experience in the past 3 years.

Information on medical conditions included hearing problems, the use of walking aids, the number of chronic diseases, and the number of medications used.

The functional health status involved activities of daily living (ADLs), visual acuity and visual field, cognitive function, handgrip strength, grooved pegboard test, and balance and gait function. ADLs were measured using the Older Adults' Resources and Services (OARS) functional assessment. The OARS scale consists of seven basic ADLs, including self-feeding, self-dressing, grooming, walking, getting in/out of bed, bathing, and controlling the bladder; and seven instrumental ADLs, including using a telephone, transporting oneself, shopping, preparing meals, doing housework, taking medication, and managing one's money to assess physical dependence and independent living in the community (George and Fillenbaum, 1985).

Corrected visual acuity was measured using Rosenbaum cards, with a value of < 20/50 being characterized as poor vision (Horton and Jones, 1997). The visual field was measured using a confrontation test and an Amsler grid to respectively assess peripheral and central vision. The confrontation test was performed by asking a subject who was sitting opposite the examiner at a one-arm distance to cover one eye and stare at the examiner's nose; the examiner then covered his own respective eye and wagged an index finger out of the subject's visual field and slowly brought it back, and the subject signaled to the examiner when they noted the hand entering the field of vision (Trobe et al., 1981). The Amsler grid is a pattern of horizontal and vertical lines crossing each other to form squares. The subject was asked to focus his/her gaze on the dot in the center of the grid at a distance of 30 cm away. Notes were made as to the distance when the subject perceived any distortions of the lines as the grid was slowly moved toward the subject (Amsler, 1953).

Cognitive function was assessed using the Mini-Mental State Examination (MMSE) and trail-making test (TMT). The MMSE test is a 30-point scale to measure general cognition, including orientation to time and place, attention and calculation, immediate recall, short-term memory, language, repetition, and complex commands. A score of < 24 was defined as cognitive impairment (Folstein et al., 1975; Guo et al., 1988). The TMT consists of two parts. In part A, subjects sequentially connect 25 circled Arabic numbers on a sheet of paper. In part B, subjects sequentially connect 25 circled alternatively Arabic and Chinese numbers (Lu and Bigler, 2002; Tombaugh, 2004). The amount of time it takes to complete each task was measured.

Handgrip strength was assessed using a hand-held dynamometer to measure the maximum isometric force of the grip in kilograms. Both hands were assessed, with two measurements per hand. The average of the two measurements was used. The grooved pegboard test, consisting of 25 holes with randomly positioned slots which were to be filled with pegs, assessed the visual-motor coordination of the upper limbs, with less time to complete the task indicating better manual dexterity (Ruff and Parker, 1993).

Balance and gait was assessed using the timed up and go (TUG), functional reach (FR), and Tinetti's performance-oriented mobility assessment. In the TUG test, subjects were asked to stand up from a standard chair with a seat height of between 40 and 50 cm, walk a 3-m distance at a normal pace, turn, walk back to the chair, and sit down (Podsiadlo and Richardson, 1991). Timing was measured in seconds, with a shorter time taken indicating better balance ability. In the FR test, a subject was positioned next to a wall with one arm raised 90°, fingers extended, and a yardstick was mounted on the wall at shoulder height. The distance in centimeters that a subject was able to reach forward from an initial upright posture to the maximal anterior leaning posture without moving or lifting the feet was measured by visual observation of the position of the third fingertip against the mounted yardstick (Duncan et al., 1990). Distances of two trials were averaged as the FR score, with a greater distance indicating better balance ability. As one part of the performance-oriented mobility assessment (Tinetti, 1986), the Tinetti balance (TB) test consists of 13 maneuvers such as sitting balance, sit to stand, immediate standing balance (first 3–5 s), standing balance, balance with the eyes closed, turning 360°, nudging the sternum, turning the neck, unilateral stance, extending the back, bending down and picking up an object, and sitting down. Each maneuver was graded as two points (normal), one point (adaptive), or zero points (abnormal). The TB score ranges 0–26, with a higher score indicating better balance ability. In the other part of the performance-oriented mobility assessment, the Tinetti gait (TG) test consists of the nine components of initiation of gait, step height and length, step symmetry and continuity, path deviation, trunk stability, walking stance, and turning while walking. Each component was scored as 1 (normal) or 0 (abnormal). The TG score ranges 0–9, with a higher score indicating better mobility.

2.3. Follow-up assessment

All study subjects were followed up by telephone every 3 months over the 1-year study period. Information about the occurrence of motorcycle crashes, frequency of riding (riding days in the past week and riding minutes per riding day), and riding distance in the past 3 months (kilometers) was obtained. A motorcycle crash was defined as an event of a single- or multiple-vehicle collision, resulting in any damage to the motorcycle or an injury to the rider or any other road users.

2.4. Statistical analysis

Distributions of sociodemographics and lifestyle behaviors, riding characteristics, medical conditions, and functional health status at the baseline assessment were compared between riders with a crash and