新北市政府114年度自行研究報告

研究報告名稱:
駕照新規和交通事故及致命傷害的關聯性 – 高齡駕駛

研究機關：新北市立聯合醫院

研究人員：詹征禕

研究期程：114.01.01-114.12.31

新北市政府 114 年度自行研究成果摘要表

計畫名稱	**駕照新規和交通事故及致命傷害的關聯性 – 高齡駕駛**
期程	**自 114 年 1 月 1 日至 114 年 12 月 31 日**
經費	**971,936 元**
緣起與目的	本研究旨在利用 2013 年 1 月至 2023 年 12 月台灣交通事故檔 (National Taiwan Traffic Crash Dataset)，探討這些駕照新規定對高齡駕駛的事故發生率和事故死亡率的影響。
方法與過程	本研究採用隨機效應 Poisson 回歸的中斷時間序列模型，利用台灣國家交通事故資料集，分析了 2013 年 1 月至 2023 年 12 月台灣 70 歲及以上老年摩托車騎士的經人口調整後的致命和非致命事故率。考慮到 COVID-19 疫情從 2019 年末開始，一直持續到 2020 年，事故數據分為立法前（2013 年 1 月 – 2016 年 6 月）、立法期間（2016 年 7 月 – 2018 年 6 月）和立法後（2018 年 7 月– 2023 年 12 月）。
研究發現及建議	研究結果顯示，在強制進行身體和認知評估的立法改革之後，75 歲及以上高齡機車騎士的事故率

	呈下降趨勢。然而，實際事故率的增幅高於立法前。結合過去 10 年的觀察數據（數據顯示 70-74 歲高齡騎士的事故率持續上升），這提示我們或許應該考慮將強制健康評估的範圍擴大到 75 歲以下的人群，這或許能夠提高台灣高齡騎士的安全。
備　　註	

1. 摘要

Background and objectives

Driving and riding support older adults' independence and wellbeing, but road safety concerns have led Taiwan to require mandatory health and cognitive assessments for drivers and riders aged 75 or above in July 2017. This study evaluates how these legislative changes affect fatalities, injuries, and crashes involving older motorcyclists. The analysis on car drivers was not performed due to the very small number of injuries involving older drivers.

Material and methods

An interrupted time series using random effects quasi-Poisson regression analyzed the population adjusted fatal and non-fatal crash rates using The Taiwan National Traffic Crash Dataset in older motorcycle riders 70 and older in Taiwan, from January 2013 to December 2023. Considering the COVID-19 pandemic which began in late 2019 and continued throughout 2020, the crash data were divided into pre-legislation (January 2013 - June 2016), legislation (July 2016 - June 2018), and post legislation (July 2018 –December 2023).

Results

The fatal crash rate (per 1,000,000 person) in older riders aged 70 to 74 decreased 16% after the legislation (IRR=0.84; 95%CI= 0.52, 1.36; p=0.47) while it increased in those aged 75 and older by 27% (IRR=1.27; 95%CI= 0.87, 1.84; p=0.21). On the other hand, the non-fatal crash rate increased significantly in riders aged 70 to 74 years old, as their population adjusted non-fatal crash rates increased by 1% (IRR=1.01; 95%CI=1.00, 1.02; p<0.0001). However, there is no change in the non-fatal crash rate in those aged 75 and more.

When adjusting for the crash rates in control group (riders aged 70 to 74), the fatal crash rates of riders aged 75 and more did not change after the legislation (point-change: IRR=3.21; 95CI%=0.82, 12.4; P=0.09. slope-change: IRR=0.98; 95%CI=0.95, 1.01; P=0.15). On the other hand, there is a significant increase in the non-fatal crash rates after the legislation in point-change by 59% (IRR=1.59; 95%CI=1.40, 1,80; P<0.0001) but a significant decrease in slope-change by 1% (IRR=0.99; 95%CI=0.98, 0.99; P<0.0001).

Conclusions

The findings suggest a decreasing trend in crashes among older

motorcycle riders aged 75 and more following the legislative changes mandating physical and cognition assessments. However, the increased point-change indicating the actual crash rate was higher than before legislation. Combined with the observational data over 10 years showing continuous increasing trends in crash rates among older riders 70-74 years of age, it may suggest considering extending the mandatory health assessment to those younger than 75 years old, which may improve the older rider safety in Taiwan.

Keywords: elderly motorcyclist, traffic injury, interrupter time series

2. 主旨及背景說明

The global trend of an increasing older population and extended lifespan are noteworthy[1-4], and for the increasing number of older individuals expected to live longer than before, a better quality of life is crucial. This can be achieved through multiple approaches, including increased physical activity and enhanced social interactions[5]. Driving and riding plays a critical role for older adults, as it enables participation in external social activities[6], which subsequently enhances their mental health and sense of empowerment, thereby supporting their aging journey[7]. On the other hand, giving up driving/rider is associated with increased mortality, depression, and cognitive decline[8-10].

The global trend of aging is also reflected in the increasing proportion of older licensed drivers[11]. In countries such as the United States, Sweden, and Taiwan, approximately 15% to 20% of licensed drivers are aged 65 or older[12-14], with projections of a 25% prevalence in most Organization for Economic Co-operation and Development (OECD) member countries by 2030[11]. Many older drivers drive frequently; for example, 16% older drivers in Germany are regular drivers[15].

3. 相關研究、文獻之檢討

Contrary to common belief, older drivers do not exhibit higher crash rates than middle-aged (35-54 years) or young (15-24 years) drivers when trip distance and driver numbers are considered[16-19]. However, they are overrepresented in fatal crashes, particularly those aged 70 and above[18,20]. Furthermore, older drivers are more likely to sustain more severe

post-crash injuries compared to non-older drivers[21,22]. These trends are particularly pronounced among older motorcyclists. In Taiwan, 75% of crashes involving elderly motorcyclists were fatal[14]. Similar patterns of increased
fatality risk for older motorcyclists have been observed in the United States and Thailand as well[23,24]. The recovery process for older crash victims is often complicated by pre-existing health conditions, leading to poorer outcomes[25].

There has been a notable decline in fatality rates among older drivers and riders over the past several decades, with recent trends indicating stabilization[17,26,27]. This reduction in fatality risk among older drivers has outpaced that of younger counterparts[27]. A variety of factors may contribute to this trend, including decreased functional disabilities and improved visual acuity within the aging population[28]. Moreover, advancements in vehicle safety design, such as side airbags, coupled with enhanced clinical and medical interventions, have likely contributed to increased survivability among older crash victims[26,29].

However, even relatively healthy older adults experience declines in physical and cognitive function, which can negatively impact driving ability. These changes can impair driving ability, manifested in difficulties such as diminished hazard perception, inadequate spatial judgment, and increased error rates.[18,30] The declining health-related functional abilities, and reduced riding performance, significantly elevated the crash risk among older drivers and riders[31,32].

To balance road safety concerns with the mobility needs of older adults, licensing authorities of many jurisdictions have implemented strategies such as mandatory health and cognitive assessments, more frequent license renewals, and restricted driving zones or time.[33-35] While the overall consensus is that these policies reduce crash rates among older drivers, the evidence is not entirely conclusive. Some studies have found a decrease in crash rates for older drivers after the policy implementation[34,36,37], others have found that these policies are particularly effective for certain subgroups of older drivers38 or no impact (such as policies such as in-person license renewals)[39]. Factors such as variations in the policies implemented, uncontrolled variables, and the complex nature of crash mechanism may all contribute to these inconsistent findings.

In July 2017, Taiwan implemented a new licensing policy targeting

drivers aged 75 and older. This policy mandated health and cognitive function assessments as part of the license renewal process, which was shortened to a two-year cycle. The aim was to evaluate the physical and cognitive capabilities of older drivers and ensure their suitability for continued driving. While car and motorcycle drivers aged 75 or older were required to undergo both physical and cognitive examinations, individuals with a medical certificate confirming the absence of mild-to-late stage Alzheimer's disease were exempted from the cognitive assessment.

4. 研究方法

Material and methods

This is a retrospective data project using an interrupted time series (ITS) approach to investigate changes in crash rates among Taiwan older motorcycle riders aged 70 years and older based on police crash records between 1 January 2013 and 31 December 2023.

National Taiwan Traffic Crash Dataset (the Crash Dataset)

All road traffic-related crashes were officially documented and recorded by law enforcement authorities, ensuring their inclusion in the comprehensive dataset. The ownership and maintenance of the entity in question are under the purview of the National Police Agency of Taiwan. Proficient law enforcement crash investigators were tasked with documenting and finalizing the comprehensive dataset encompassing car information, crash details, and victim records. The crash files encompass pertinent information regarding many characteristics of road traffic accidents, including the specific time and date of the incident, prevailing weather conditions at the time of the crash, as well as the type of road involved. The vehicle files encompass essential information pertaining to the attributes of the vehicle implicated in the crash, including the first point of impact, vehicle type, and maneuvers executed by the vehicle. In addition, the victim files contain data pertaining to various victim characteristics, including age, gender, severity of injury, license status, blood alcohol content (BAC) level, and utilization of restraints.

Fatal and non-fatal crashes

In this study, fatality of crashes was based on police records in the crash

dataset. Fatal crashes are defined when casualties sustain fatal injuries within 24 hours after road crashes, and non-fatal crashes are defined when casualties sustain injuries and survive for more than 24 hours after road crashes.

Study participants

Causality was determined based on police records. In the absence of explicit causality information, crashes involving side or rear impacts were excluded to retain incidents in which riders were more likely to be at fault. Only riders who were at-fault of the crashes were included in this study and grouped by age at crash: (70-74, 75 years old and older), based on the likely impact of legislation on changes in crash involvement. Riders aged 70-74 years were deemed least likely to be affected and were used as a control group to account for the impact of other systemic changes on crash involvement over time.

Data cleaning and processing

Data on road crashes between January 2013 and December 2023 involving elderly were extracted from the Crash Dataset. Cases with missing data in key variables such as fatality, and road user type were excluded. Figure 1 illustrates the data extraction processes for this study.

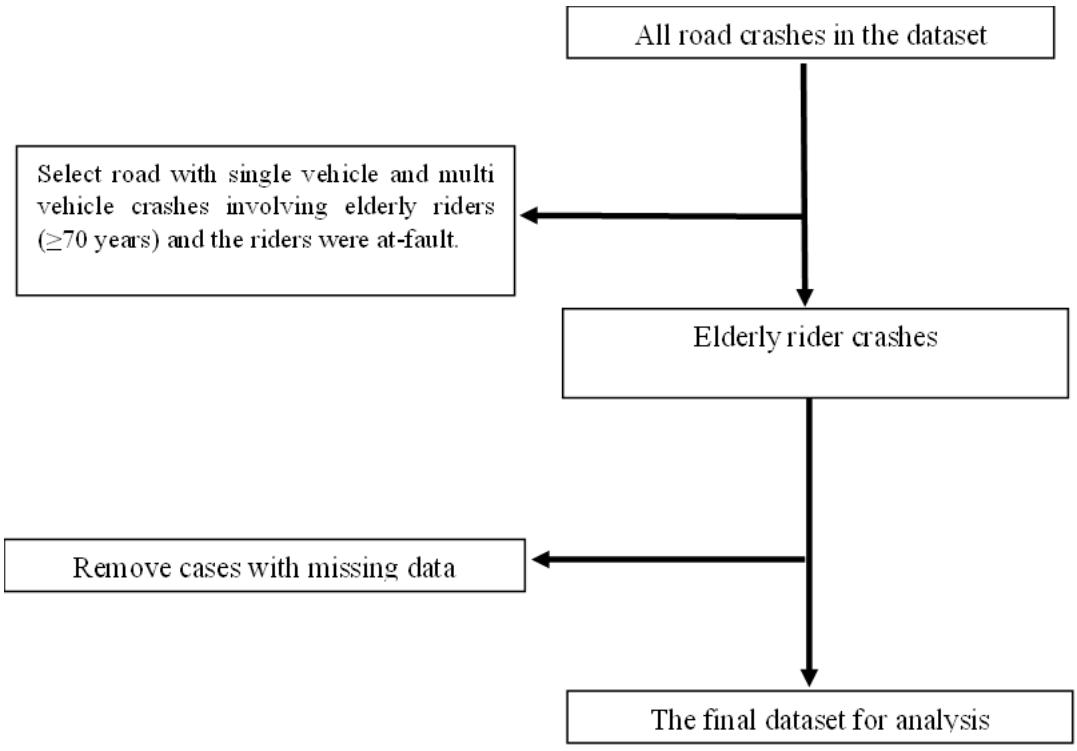

Figure 1. data extraction flowchart.

Statistical analysis

Monthly crash rates by age group (70-74 years old, and 75 and older) were calculated as the number of cases divided by annual age-specific estimated population.

For instance, the annual population of individuals aged 70-74 years served as the denominator in calculating crash rates for this age group. Actual and predicted rates in the pre-legislation period were plotted, and average rates were self-compared between pre- and post- legislative time period.

Indicator variables were used to specify the three time periods: pre-legislation (January 2013 - June 2016), legislation (July 2016 - June 2018), and post-legislation (July 2018 – June 2019, January 2021 December 2023). These periods reflect public discussions, and dissemination of information to the public about the intended change in legislation prior to the official implementation of the new legislation in Taiwan as well as the lock-down period during COVID-19 pandemic. A lag in the law's impact was expected due to the time needed for the public to fully understand and comply with the required new policies, as well as for police enforcement to become standard practice (a 6-month grace period was implemented).

A random effects quasi-Poisson model was used to model the monthly injury counts using the log population estimates as the offset by age group and the study time periods. An autoregressive error process of lag 1 (AR(1)) was used to account for any serial correlation, including autocorrelations. Comparisons were then made for the study age groups (75 years and older) in the post-legislation period to their pre-legislation trajectory and the comparison age group (70-74 years old), and these results were summarized as incidence rate ratios (IRR) and their 95% confidence intervals (95%CI). The analyses were conducted in R.

5.研究發現

Results

This study included 206,028 crash cases for older motorcyclists between the study period and accounted for 1,942 fatalities (Table 1). Among fatal crashes, the average age of riders was slightly higher (77.06 ± 5.18 years) compared to non-fatal cases (75.62 ± 4.85 years). The observational

trends of fatal and non-fatal crash rates were presented in supplementary Figure 1&2.

Table 1. Distribution of fatal and non-fatal crash between 2013 and 2023 across age group, gender, and year of crash in Taiwan.

Variable	Motorcycle riders	
	Fatal (n=1,942)	**Non-fatal** (n=204,086)
Age (Mean (± SD), Median (Q1, Q3))	77.06 ± 5.18 76 (73, 80)	75.62 ± 4.85 74 (72, 79)
Age (years), n (%)		
70-74	727 (37.4%)	102,464 (50.2%)
≥75	1,215 (62.6%)	101,622 (49.8%)
Gender, n (%)		
Male	1,453 (74.3%)	134,997 (66.1%)
Female	489 (25.2%)	69,089 (33.9%)
Year of crashes, n (%)		
2013	175 (9%)	12,307 (6%)
2014	156 (8%)	14,591 (7.1%)
2015	154 (7.9%)	14,493 (7.1%)
2016	148 (7.6%)	14,068 (6.9%)
2017	130 (6.7%)	14,779 (7.2%)
2018	169 (8.7%)	17,338 (7.5%)
2019	201 (10.4%)	19,164 (9.4%)
2020	223 (11.5%)	21,395 (10.5%)
2021	206 (10.6%)	22,557 (11.1%)
2022	201 (10.4%)	24,819 (12.2%)
2023	179 (9.2%)	28,575 (14%)

There are ninety data-points (monthly crash rate) analyzed using ITS for each age group. The fatal crash rate (per 1,000,000 person) in older riders aged 70 to 74 decreased 16% after the legislation (IRR=0.84; 95%CI= 0.52, 1.36; p=0.47) while it increased in those aged 75 and older by 27% (IRR=1.27; 95%CI= 0.87, 1.84; p=0.21). On the other hand, the non-fatal crash rate increased significantly in riders aged 70 to 74 years old, as their population adjusted non-fatal crash rates increased by 1% (IRR=1.01;

95%CI=1.00, 1.02; p<0.0001). However, there is no change in the non-fatal crash rate in those aged 75 and more (Table 2). The observations and predicted values based on pre-legislative modelling were plotted in Figure 2A & 2B for fatal crash rates, and Figure 3A &3B for non-fatal crash rates.

Table 2. Self-comparison of the motorcyclist's fatal and non-fatal crash rate (per 1,000,000 population) pre- and post- (without control group) using random effects quasi-Poisson model.

Age group	Rate: pre-	Rate: post	Point estimates	IRR (95% CI)	p-value
Fatal crash					
70-74	2.81	2.68	-0.17	0.84 (0.52, 1.36)	0.47
≥75	1.47	1.55	0.24	1.27 (0.87, 1.84)	0.21
Non-fatal crash					
70-74	294.75	457.74	0.01	1.01 (1.00-1.02)	<0.0001
≥75	133.58	144.40	-0.0002	1.00 (0.99-1.01)	0.93

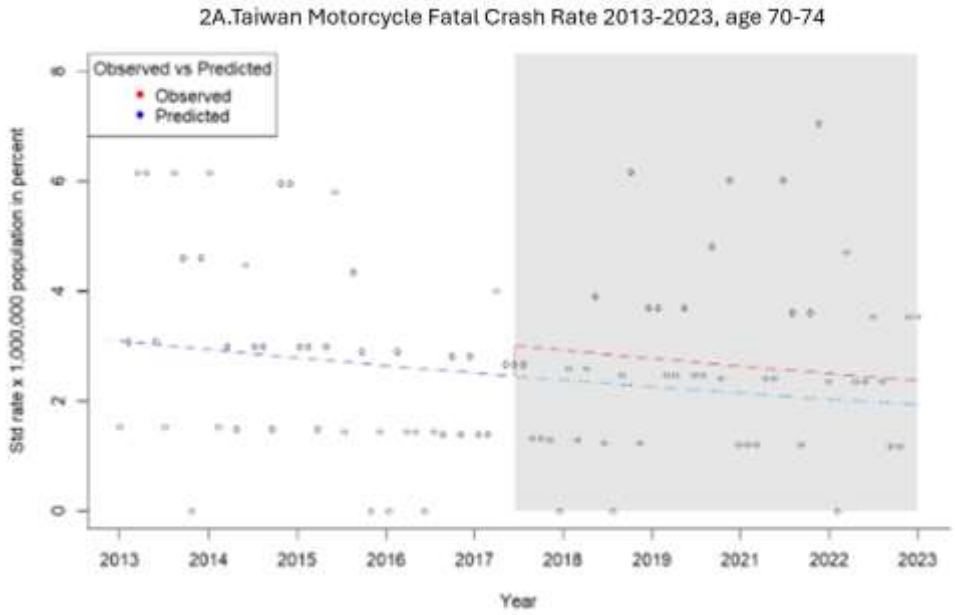

Figure 2A. Motorcycle fatal crash rate 2013-2023 for riders aged 70-74 years old, Taiwan

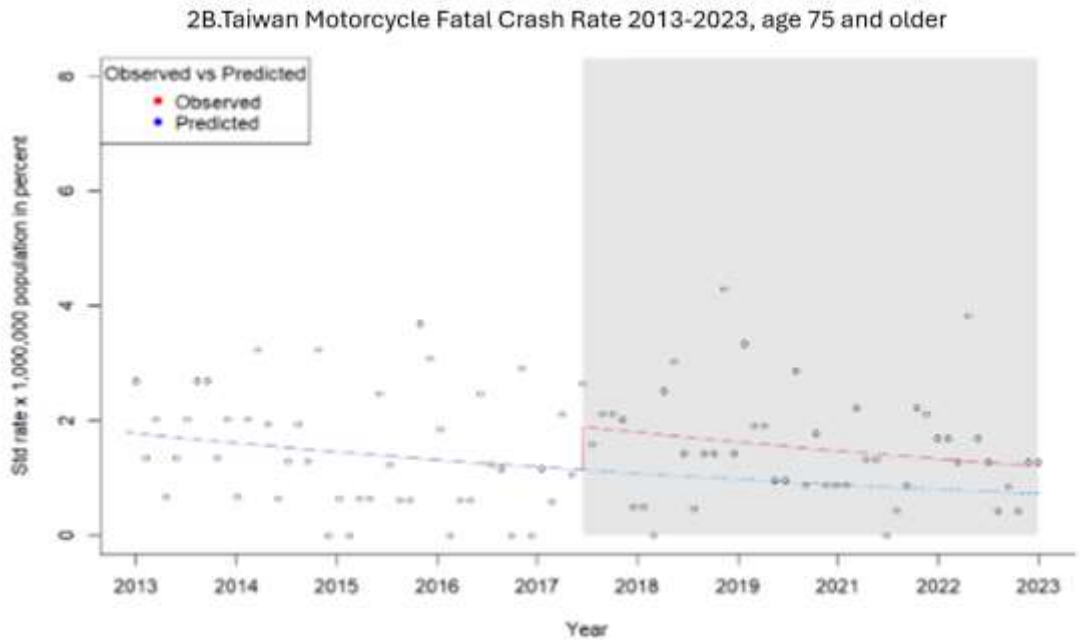

Figure 2B. Motorcycle fatal crash rate 2013-2023 for riders aged 75 years old and older, Taiwan

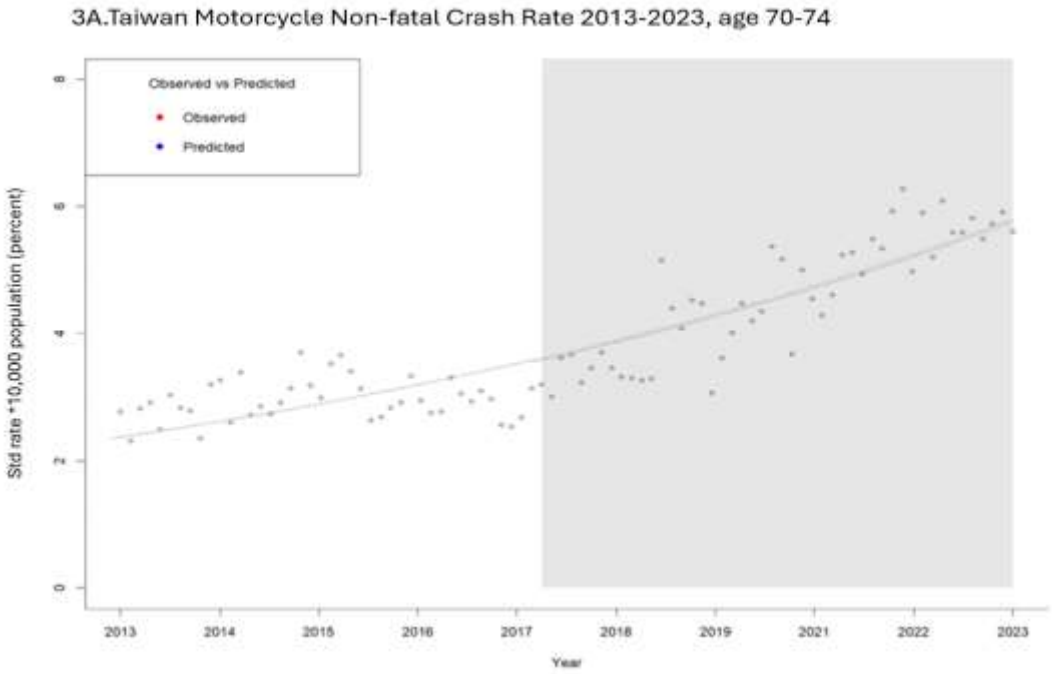

Figure 3A. Motorcycle non-fatal crash rate 2013-2023 for riders aged 70-74 years old, Taiwan

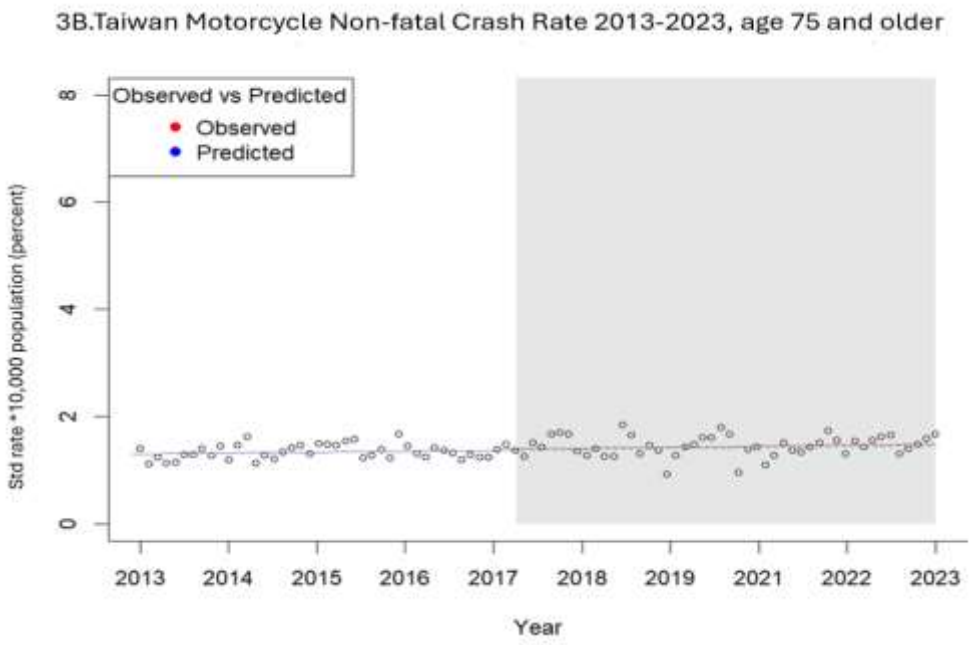

Figure 3B. Motorcycle non-fatal crash rate 2013-2023 for riders aged 75 and older, Taiwan

When adjusting for the crash rates in control group (riders aged 70 to 74), the fatal crash rates of riders aged 75 and older did not change after the legislation (point-change: IRR=3.21; 95CI%=0.82, 12.4; P=0.09. slope-change: IRR=0.98; 95%CI=0.95, 1.01; P=0.15). On the other hand, there is a significant increase in the non-fatal crash rates after the legislation in point-change by 59% (IRR=1.59; 95%CI=1.40, 1,80; P<0.0001) but a significant decrease in slope-change by 1% (IRR=0.99; 95%CI=0.98, 0.99; P<0.0001) (Table 3).

Table 3. Random effects quasi-Poisson AR (1) model estimations of reduction in fatal and non-fatal crash rates, using age group 70–74-year-olds as reference.

Age group 70-74 as reference	Point estimates	IRR (95% CI)	p-value
Riders aged 75 years and more			
Fatal crash			
Point change	1.17	3.21 (0.82, 12.4)	0.09
Slope change	-0.02	0.98 (0.95, 1.01)	0.15
Non-fatal crash			
Point change	0.46	1.59 (1.40, 1.80)	<0.0001
Slope change	-0.01	0.99 (0.98, 0.99)	<0.0001

6. 結論與建議

Discussion

This study investigates longitudinal patterns in licensing and crash rates in older motorcycle riders in Taiwan in the context of aged-based licensing reform and implementation of the mandatory health assessments for those aged 75 years and older. For this group of riders, there was no significant difference in fatal crash rates directly associated with the policy reform. For non-fatal crash rates, a significant decrease in the trend (slope-change) was estimated, and a significant increase was estimated in the observed non-fatal crash rate (point-change) after the policy reform.

Based on the observational data, fatal crash rates exhibit a declining trend over time in the age groups of 75 and older, irrespective of the licensing reform. This overall reduction in post-crash fatality rates may be attributable to multiple factors, including advances in medical technology and improvements in emergency care. In contrast, the higher average fatal crash rates observed in this age group of riders during the post-legislative period may reflect increased self-confidence among older riders following successful completion of health assessments. Additionally, these increases may be partly explained by greater travel exposure and changes in riding behavior following the easing of COVID-19 lockdown restrictions.

An important observation is the steadily increasing rate of non-fatal crashes among riders aged 70–74 years. As this age group serves as the control group in the present study, direct comparisons of crash rate estimates with other motorcycle rider age groups are not available. Nevertheless, this trend suggests the need for further investigation of this population and for consideration of targeted measures to enhance road safety in Taiwan. Our findings are also consistent with the forthcoming policy mandating health and cognitive assessments prior to licensing or license renewal for this age group of riders, which is scheduled to be implemented in early 2026.

In conclusion, based on the crash rate data, the 2017 aged-based licensing reforms with mandatory health assessment had the largest impact on non-fatal crashes, but not fatal crashes. It is also encouraging that fatal

crash rate has been reducing over the 10-year period for riders aged 70 years and older in Taiwan.

7. 參考文獻

1. Oeppen, J., & Vaupel, J. W. (2002). Broken limits to life expectancy. *Science*, *296(5570), 1029-1031.*
2. Hertz, E., Hebert, J. R., & Landon, J. (1994). Social and environmental factors and life expectancy, infant mortality, and maternal mortality rates: results of a cross-national comparison. *Social Science & Medicine*, *39(1), 105-114.*
3. Zarulli, V., Sopina, E., Toffolutti, V., & Lenart, A. (2021). Health care system efficiency and life expectancy: A 140-country study. *PLoS One, 16(7), e0253450.*
4. Fries, J. F. (1980). Aging, natural death, and the compression of morbidity. *The New*
   England Journal of Medicine, 303(3), 130-135.
5. Buono, M. D., Urciuoli, O., & LEO, D. D. (1998). Quality of life and longevity: a study of centenarians. *Age and Ageing, 27(2), 207-216.*
6. Spinney, J. E., Newbold, K. B., Scott, D. M., Vrkljan, B., & Grenier, A. (2020). The impact of driving status on out-of-home and social activity engagement among older Canadians. *Journal of Transport Geography, 85, 102698.*
7. Fernandes, S. C., Esteves and, J. L., & Simoes, R. (2018). Psychological and cognitive
   aspects of ageing: The importance of driving on senior living. *Journal of Health Science, 6(1), 1-10.*
8. Edwards, J. D., Lunsman, M., Perkins, M., Rebok, G. W., & Roth, D. L. (2009). Driving
   cessation and health trajectories in older adults. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 64, 1290–1295.*
9. Fonda, S. J., Wallace, R. B., & Herzog, A. R. (2001). Changes in driving patterns and
   worsening depressive symptoms among older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 56, S343–S351.*
10. Choi, M., Lohman, M. C., & Mezuk, B. (2014). Trajectories of cognitive decline by
    driving mobility: Evidence from the Health and Retirement Study. *International Journal of Geriatric Psychiatry, 29, 447–453.*
11. OECD (2001), Ageing and Transport: Mobility Needs and Safety Issues, OECD Publishing, Paris, https://doi.org/10.1787/9789264195851-en.

12. Sivak, M., & Schoettle, B. (2012). Recent Changes in the Age Composition of Drivers in 15 Countries. *Traffic Injury Prevention, 13(2), 126–132.*
13. Freed, S. A., Staplin, L., Sprague, B. N., & Ross, L. A. (2024, March). State of knowledge on older drivers (Report No. DOT HS 813 535). National Highway Traffic Safety Administration.
14. 政府資料開放平臺：機車駕照性別統計，汽車駕照性別統計 Government Open Data Platform http://data.gov.tw/dataset. [access on 21/August/2024]
15. Hajek, A., Brettschneider, C., Eisele, M., van den Bussche, H., Wiese, B., Mamone, S., ... & König, H. H. (2019). Prevalence and determinants of driving habits in the oldest old: results of the multicenter prospective AgeCoDe-AgeQualiDe study. *Archives of Gerontology and Geriatrics, 82, 245-250.*
16. Hakamies-Blomqvist, L., Raitanen, T., & O'Neill, D. (2002). Driver ageing does not cause higher accident rates per km. *Transportation Research Part F: Traffic Psychology and Behaviour, 5(4), 271-274.*
17. Cox, A. E., & Cicchino, J. B. (2021). Continued trends in older driver crash involvement rates in the United States: Data through 2017–2018. *Journal of Safety Research, 77, 288-295.*
18. Pitta, L. S. R., Quintas, J. L., Trindade, I. O. A., Belchior, P., Gameiro, K. D. S. D.,
Gomes, C. M., ... & Camargos, E. F. (2021). Older drivers are at increased risk of fatal crash involvement: results of a systematic review and meta-analysis. *Archives of Gerontology and Geriatrics, 95, 104414.*
19. Elvik, R. (2023). Driver mileage and accident involvement: a synthesis of evidence. *Accident Analysis & Prevention, 179, 106899.*
20. Tavris, D. R., Kuhn, E. M., & Layde, P. M. (2001). Age and gender patterns in motor
vehicle crash injuries: importance of type of crash and occupant role. *Accident Analysis & Prevention, 33(2), 167-172.*
21. Freeman, J., Scott-Parker, B., Wong, I., & Haworth, N. (2012). Vulnerable road user groups: a review of younger drivers, motorcyclists and older drivers. *Vulnerable Groups & Inclusion, 3(1), 14889.*
22. Chang, H., Min, J. Y., Yoo, D., Lee, S. U., Hwang, S. Y., Yoon, H., ... & Kim, T. (2021).
National surveillance of injury in the Republic of Korea: Increased injury vulnerability in the late middle age. *International Journal of Environmental Research and Public Health, 18(3), 1210.*

23. Champahom, T., Se, C., Jomnonkwao, S., Boonyoo, T., & Ratanavaraha, V. (2023). A Comparison of Contributing Factors between Young and Old Riders of Motorcycle Crash Severity on Local Roads. *Sustainability, 15(3), 2708.*
24. Dellinger, A. M., Langlois, J. A., & Li, G. (2002). Fatal crashes among older drivers:
decomposition of rates into contributing factors. *American Journal of Epidemiology, 155(3), 234-241.*
25. Brown, J. B., Bankey, P. E., Gorczyca, J. T., Cheng, J. D., Stassen, N. A., & Gestring, M. L. (2010). The aging road warrior: national trend toward older riders impacts outcome after motorcycle injury. *The American Surgeon, 76(3), 279-286.*
26. Cicchino, J. B. (2015). Why have fatality rates among older drivers declined? The relative contributions of changes in survivability and crash involvement. *Accident Analysis & Prevention, 83, 67-73.*
27. Chang, H., Min, J. Y., Yoo, D., Lee, S. U., Hwang, S. Y., Yoon, H., ... & Kim, T. (2021).
National surveillance of injury in the Republic of Korea: Increased injury vulnerability in the late middle age. *International Journal of Environmental Research and Public Health, 18(3), 1210.*
28. Lee, D. J., Arheart, K. L., Lam, B. L., Zheng, D., Christ, S. L., McCollister, K. E., ... &
Caban-Martinez, A. J. (2009). Trends in reported visual impairment in United States adults. *Ophthalmic Epidemiology, 16(1), 42-49.*
29. Kahane, C. J. (2013). Injury vulnerability and effectiveness of occupant protection technologies for older occupants and women (No. DOT HS 811 766).
30. Miller, S. M., Taylor-Piliae, R. E., & Insel, K. C. (2016). The association of physical
activity, cognitive processes and automobile driving ability in older adults: A review of the literature. *Geriatric Nursing, 37(4), 313-320.*
31. Klein, R. (1991). Age-related eye disease, visual impairment, and driving in the elderly. *Human Factors, 33(5), 521-525.*
32. Lombardi, D. A., Horrey, W. J., & Courtney, T. K. (2017). Age-related differences in fatal intersection crashes in the United States. *Accident Analysis & Prevention, 99, 20-29.*
33. Dugan, E., Barton, K. N., Coyle, C., & Lee, C. M. (2013). US policies to enhance older driver safety: a systematic review of the literature. *Journal of Aging & Social Policy, 25(4), 335-352.*
34. Asbridge, M., Desapriya, E., Ogilvie, R., Cartwright, J., Mehrnoush, V., Ishikawa, T., & Weerasinghe, D. N. (2017). The impact of restricted driver's licenses on

crash risk for older drivers: a systematic review. *Transportation Research Part A: Policy and Practice, 97, 137-145.*

35. Shen, S., Ratnapradipa, K. L., Pervall, G. C., Sweeney, M., & Zhu, M. (2020). Driver
License Renewal Laws and Older Adults' Daily Driving, United States, 2003–2017. *The Journals of Gerontology: Series B, 75(10), 2268-2277.*
36. Levy, D. T., Vernick, J. S., & Howard, K. A. (1995). Relationship between driver's license renewal policies and fatal crashes involving drivers 70 years or older. *JAMA, 274(13), 1026-1030.*
37. Inada, H., Tomio, J., Nakahara, S., & Ichikawa, M. (2023). Association between mandatory cognitive testing for license renewal and motor vehicle collisions and road injuries. *Journal of the American Geriatrics Society, 71(4), 1145-1155.*
38. Tefft, B. C. (2014). Driver license renewal policies and fatal crash involvement rates of older drivers, United States, 1986–2011. *Injury Epidemiology, 1, 1-11.*
39. Koppel, S., Bugeja, L., Stephens, A., Cartwright, A., Osborne, R., Williams, G., ... &

Charlton, J. L. (2020). The safety benefits of older drivers attending an in-person licence renewal. *Journal of Transport & Health, 17, 100845.*