

## Powered Two and Three Wheeler Safety in Low and Middle Income Countries: Usage, Risk Factors and Effective Interventions for Safety

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### Abstract

Powered two and three wheeler (PTW) vehicles are widely used throughout low and middle income countries (LMIC) globally, particularly in the Asia Pacific region. They are used for personal transport, often for whole families, and for commuters and transport of goods, but are also implicated in high crash and injury rates. While there has been significant research in high income countries on risk factors and development of interventions focused on safety, much less has been done in LMIC. We sought to identify burden, risk factors and effective interventions for safety, and disseminate these via a Good Practice Guide (WHO, 2017).

### Background

In 2013, there were 516 million PTWs worldwide, accounting for 29% of all registered vehicles, most in LMIC. They were implicated in 286,000 deaths; around 23% of all road deaths in 2013 (WHO, 2015). PTW are used differently around the world: in high income countries they are used primarily for transport and recreation. In LMIC they are used for transport (of goods and people), and as an income source. The WHO South East Asian region has the highest proportion of PTW, with 74.5% of the registered fleet (WHO, 2015). Growth of the PTW has been particularly rapid in China, which has the largest local motorcycle production facilities (Haworth, 2012). Between 2007 and 2013 the number of motorcycles in China increased by 21%, to 109 million (PRC, 2014). There has been rapid growth in use of E-bikes in China and fatality rates rose 5 fold between 2004 and 2008 (Yao & Wu, 2012).

### Risk factors

There is little research on risk factors for crashes for PTW in LMIC. The available research highlights helmet non-use as a major risk factor for death and injury (UN, 2016). Other risk factors include alcohol use, speed, mixed traffic design of road infrastructure, PTW stability and lack of protective equipment.

### Effective interventions for safety in LMIC settings

We assessed interventions and graded them (Table 1), according to the following criteria adapted from public health evidence assessment frameworks (Atkins et al., 2004; Gill, King, Webb, & Hector, 2005).

1. Effective intervention: evidence from studies demonstrate these interventions are effective in reducing PTW-related fatalities and injuries, or bring about desired behaviour change, combined with likely feasibility or cost-effectiveness.
2. Promising intervention: some safety benefits have resulted, but further evaluations from diverse settings are required and thus caution is needed when implementing such an intervention.

3. Insufficient evidence: evaluation has not reached a firm conclusion about its ability to reduce fatalities and injuries or bring about desired behaviour change (lack of evidence, or no effect).

**Table 1. Key measures and specific interventions for improved PTW safety**

| Key measures                    | Specific interventions  | Effectiveness |           |                       |
|---------------------------------|---|---------------|-----------|-----------------------|
|                                 |   | Proven        | Promising | Insufficient evidence |
| <b>Safer roads and mobility</b> | Exclusive motorcycle lanes  |               |           |                       |
|                                 | Protected turn lanes and widened shoulders or lanes               |               |           |                       |
|                                 | Removal of roadside hazards                                       |               |           |                       |
|                                 | Improving road surface conditions                                 |               |           |                       |
|                                 | Modifying the composition of roadside barrier building material   |               |           |                       |
| <b>Safer vehicles</b>           | Antilock brake system   |               |           |                       |
|                                 | Daytime running headlights  |               |           |                       |
|                                 | Configuration to enhance stability                                |               |           |                       |
|                                 | Intelligent transport system                                      |               |           |                       |
|                                 | Airbags for motorcycles   |               |           |                       |
|                                 | Brake lights  |               |           |                       |
|                                 | Periodic inspection for mechanical defects                        |               |           |                       |
| <b>Safer road users</b>         | <i>Setting and enforcing helmet legislation</i>                   |               |           |                       |
|                                 | Mandatory helmets   |               |           |                       |
|                                 | Helmet standards  |               |           |                       |
|                                 | <i>Strengthening penalties</i>                                    |               |           |                       |
|                                 | Criminalizing offences (eg alcohol, speed)                        |               |           |                       |
|                                 | Demerit point system  |               |           |                       |
|                                 | <i>Wearing reflective and protective clothing</i>                 |               |           |                       |
|                                 | Reflective clothing use   |               |           |                       |
|                                 | Protective clothing use   |               |           |                       |
|                                 | Thermal resistant shields   |               |           |                       |
|                                 | <i>Regulating and licensing of PTWs</i>                           |               |           |                       |
|                                 | Mandatory registration of vehicles and licensing of PTW operators |               |           |                       |
|                                 | Graduated licensing system  |               |           |                       |
|                                 | Age restrictions for children riding or as passengers on PTWs     |               |           |                       |
|                                 | Restriction on multiple pillion passengers                        |               |           |                       |
|                                 | Minimum eight as pillion passenger                                |               |           |                       |
|                                 | Smaller engine size for learner riders                            |               |           |                       |
|                                 | <i>Training</i>   |               |           |                       |
|                                 | Compulsory skill test for motorcycle permit                       |               |           |                       |
|                                 | Post-licence training   |               |           |                       |
| <b>Post-crash response</b>      | On-site helmet/collar brace removal                               |               |           |                       |

Interventions that were found to be effective and promising are as follows;

1. Road safety management: include strong government role in setting legislation and policy enforcement, in licensing PTW operators and registering vehicles.
2. Safer roads and mobility: separation of PTWs from other traffic, where at least 20–30% of road users are PTWs.

3. Safer vehicles: advanced braking systems, such as antilock braking systems (ABS) and addressing mechanical defects in all PTWs.
4. Safer road users: legislation and enforcement related to alcohol use, speeding, helmet and protective clothing use; instituting a programme for graduated licensing; increased visibility of PTWs.
5. Post-crash response: introduction of uniform treatment protocols and quick and accurate mechanisms for rapid activation of emergency care systems.

## Summary

There is a significant burden of death and injury due to PTW use globally, particularly in LMIC. While improving safety in such settings has various challenges, there are effective proven and promising interventions specific to improving PTW safety. General interventions effective for other road safety issues that are of equal benefit to PTW safety can also readily be applied in LMIC settings. Such interventions should be implemented in LMIC in the context of a Safe System approach, which provides a framework for the planning and implementation of effective and promising interventions.

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