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Safety of Passengers on Powered Two Wheelers

Overview

- ✓ Powered Two- and Three-Wheelers (PTWs) are an increasingly popular form of transport, especially in low- and middle- income countries, and include motorcycles, scooters, mopeds, e-bikes and auto-rickshaws (WHO, 2022, refer to page 6 for more specific information on these vehicle types).
- ✓ PTW users are more vulnerable to injury than occupants of other vehicles and account for up to 21% of all global road traffic deaths (WHO, 2023).
- ✓ Laws relating to use of PTWs and passenger safety requirements are not as well advanced as with other vehicle types, and the legal age of rider and passengers differs across the world.
- ✓ Child passenger safety on PTW requires specific consideration, particularly because for many families, this is the only feasible form of transport.
- ✓ Wherever possible, **children should not be transported on PTWs** because of the increased risk of this mode of transport compared to other modes. More information specific to child safety relating to PTW use is presented below.

The Evidence

Risks associated with PTW use

- The primary factors for PTW traffic injury are associated with the road environment, the vehicle, the road user and the standard of post-crash response.
- PTWs often share traffic space with other fast-moving motorised vehicles and heavier vehicles such as trucks and buses.
- PTWs are less visible and lack physical protection for their drivers and pillion passengers.
- PTWs are more vulnerable to poor road conditions.
- Key risk factors for PTW traffic injury are:
 - traffic mix, road and roadside hazards
 - vehicle instability, braking and handling errors
 - use of alcohol and drugs; speeding; low visibility; lack of protective clothing, including hand and footwear; and
 - non-use of helmets or use of inappropriate helmets (refer GRSP Factsheet on Motorcycle Helmets for more details, GRSP 2021).



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Interventions to improve safety of PTWs

The World Health Organization's PTW good practice guide (WHO, 2022) outlines effective proven and promising interventions that are specific to improving PTW safety, as summarised in the table below.

Safer roads	<p><i>Proven:</i></p> <ul style="list-style-type: none">• Separation of PTWs from other traffic (e.g. exclusive motorcycle lanes)¹. <p><i>Promising:</i></p> <ul style="list-style-type: none">• Protected turn lanes and widened shoulders or lanes• Removal of roadside hazards• Speed limiters and traffic calming measures• Improving road surface conditions
Safer vehicles	<p><i>Proven:</i></p> <ul style="list-style-type: none">• Antilock braking systems (ABS) <p><i>Promising:</i></p> <ul style="list-style-type: none">• Headlights at night• Daytime running headlights

¹Caution is required when assessing the literature relating to 'dedicated lanes'. The WHO manual uses the terms 'exclusive' and 'segregated' lanes interchangeably to describe a lane with some form of physical barrier, whereas the existing scientific literature, generated primarily in Southeast Asia and exclusively in non-urban environments (e.g., higher-speed roads and corridors), draws clear distinctions between exclusive (i.e., with a physical barrier for separation) and non-exclusive lanes (i.e., without a physical barrier for separation). Lane separation without physical barrier exclusion is becoming more prevalent, especially in parts of Latin America, although there is an absence of evidence about the safety benefits of this type of segregation.

There are risks with poorly designed barriers, such as serious injury due to lack of safety equipment, defective road design, and poor road maintenance. The available evidence indicates that the safety of segregated lanes varies because of their context dependency, and various factors impact the safety of any given design, such as topography, track length (extension), track width, border, distance from main carriageway, and access control. Relevant factors should be considered through case-by-case assessment, including the type of motorcycle fleet and vehicle volume, topography, and travel speeds, followed by the development of strict guidelines that can guide and regulate this type of road design (Kurniati, et al., 2020; Le & Nurhidayati, 2016; and Mama & Taneerananon, 2016).



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Safer road users	<p><i>Proven:</i></p> <ul style="list-style-type: none">• Mandatory registration of vehicles and licensing of PTW operators• Compulsory skills test for Motorcycle licence/permit• Legislation and enforcement (including strengthening of penalties) related to alcohol use, speeding, mandatory helmet use, helmet standards and protective clothing use <p>Wearing a properly fitted and retained helmet remains the most effective way to reduce the impact forces that occur during a crash and to prevent severe craniofacial injuries. Requiring the use of a high visibility full-face helmet, high visibility protective clothing, along with homologated hand and footwear protection is also important.</p> <p><i>Promising:</i></p> <ul style="list-style-type: none">• Instituting a programme for graduated licensing schemes to manage exposure to risk and inexperience associated with new PTW riders.• Demerit point penalty system
Post-crash care	<p><i>Proven:</i></p> <ul style="list-style-type: none">• Introduction of uniform treatment protocols and quick and accurate mechanisms for the rapid activation of emergency care systems. <p><i>Promising:</i></p> <ul style="list-style-type: none">• On-site helmet removal and on-site application of a cervical collar brace to the injured individual



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Risks associated with child passengers

Whenever possible, **children should not be transported on PTWs** because of the increased risk of this mode of transport compared to other modes. However, in many countries, PTWs are the primary mode of transport for families, which represents significant safety challenges. Therefore, consideration must be given to **mitigating risks and minimising harm as much as possible if children are PTW passengers**.

If a country allows children to ride as passengers on a PTW, a minimum age at which children can ride should be set by law, and standards set for protective child helmets. Therefore, it is necessary to:

- Establish age limits for children transported. Each country determines age of ridership (driver and passenger), hence issues related to “child passengers” should be considered based on the country’s definition of “child/children” with respect to PTWs.
- Establish or develop a standard for protective helmets for children (children as defined by country).
- Establish and carry out a certification regime to ensure existing commercially available motorcycle helmets are meeting the helmet standard.
- Once the helmet standard for children is in place, ensure industry compliance through product certification and market surveillance.
- Monitor compliance and safety effectiveness.
- Conduct in-country scientific research to identify and address country-specific issues.
- Children are not ‘little adults’. They have unique physiological properties that make them different to adults. This is the reason why child restraint systems were developed for child passenger safety in cars; because adult-sized safety belts are not appropriate for a child. Children have larger heads, proportionately; more fragile skulls, especially when very young; and are at great risk of injury as PTW passengers. Young children do not have the neck strength of adults; consequently, they will fatigue more quickly when wearing a heavy helmet (Vincent et al., 2006).
- Crash test analysis of rider and child pillion passenger kinematics (Carmai et al., 2019) shows that **no matter where the child is located on the motorcycle, the outcome is not good**. Through multi-body simulations, the authors demonstrated that when the front wheel of a motorcycle impacts a car, there was a high risk that skull, lower extremity, brain, and neck injuries were more pronounced. A high risk of brain injury was also noted for the child due to contact with both the motorcycle and the other vehicle. Available evidence indicates that it **is safer to seat the child pillion passenger behind the driver rather than in front of the driver** (Fan et al., 2019; Tosi et al., 2021).
- Children **have great difficulty paying attention and sitting still on a two-wheeler**. As a single track vehicle, a two-wheeled vehicle is very susceptible to shifts in weight and leans from side to side in order to properly manoeuvre and negotiate a turn. Having children as passengers who do not understand this issue or who do not properly shift their weight can make the PTW unstable and increase crash risk.



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Other issues specific to child passenger safety on PTWs

1. Appropriate helmets for children are necessary

- Studies of injury outcomes of child motorcycle passengers by helmet status have found less head injury and/or less severe injury among children that use motorcycle helmets (Hamzad et.al. 2012; Pervin et.al, 2009; Oxley et.al, 2013; Weiss et.al, 2010; Fundación Gonzalo Rodríguez, 2017).

2. Caution regarding use of inappropriate helmet sizes

- Use of oversized helmets reduces the protection provided by the helmet and can also negatively affect the position of the helmet and chin strap on the child's head (Weiss et.al, 2010).

3. Helmet standards for children

- There is no internationally recognised standard exclusively for helmets for child passengers of two-and-three wheelers. While it is possible to test a small child helmet to most international motorcycle helmet standards, the pass/fail criteria for the child helmet is currently exactly the same as the adult helmet.
- **There is no safe way to protect a child from head injury** without appropriate protection from a helmet.
- **It is strongly recommended that a child motorcycle helmet standard be developed.** This standard should recognise that children are not simply 'scaled down adults' and that current research suggests that they have a different tolerance to impact when compared to an adult. Consequently, different pass/fail criteria will likely be necessary for child motorcycle helmets.

4. Considerations if recommending helmet use for very young children

- Helmet use by, or transportation on a PTW, of very young children is NOT recommended. Due to limitations in muscle strength and endurance in children, it is recommended that any helmet standard mandates that a child helmet be significantly lighter in weight when compared to adult helmets to account for children having less neck strength than adults (Vincent et al., 2006; WHO, 2015; WHO, 2022).

5. Age

- The World Health Organization's 2015 study, *Child Development and Motorcycle Safety*, focussed on the SouthEast Asia region. It suggested **that infants under 2 years of age should not be on a motorcycle or other type of PTW.**
- The same study noted that if transportation of young children (2-5 years of age) is undertaken, the recommendations included **a helmet, proper protective clothing and footwear.**



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6. Child seating position

- Extreme caution must be exercised in considering seating positions on the vehicle. Evidence demonstrates that **children sitting/standing in front of the PTW driver had worse injury outcomes than sitting/standing behind the driver** (Fan et al., 2019; Koetiniyom et al., 2018).
- Crash testing of rider and child pillion passengers (Koetiniyom et al., 2018) has demonstrated that when the child is located in front of the **PTW driver and involved in a frontal crash, both the driver and the child pillion passenger will translate forward as a result of the crash. The child then becomes trapped between the motorcycle, other vehicle and the PTW driver** (for further information see footnote²).

7. Risks of attaching a child to a PTW vehicle

Some countries propose or allow the use of a harness / seats to attach a child passenger to the PTW driver or vehicle. **Extreme caution is required with this approach, and it is never recommended because there is no evidence to support any safety benefits from child PTW passenger restraints, harnesses or seats.** At present, there is no scientific literature that describes the results of a risk/benefit analysis of this safety device. Such a study would weigh the likely risks (in terms of injury incidence and severity) versus the likely benefits across a representative large sample of motorcycle crashes.

- There are **no internationally recognised technical standards for attaching child passengers to PTW or evaluating their effectiveness at reducing injury.**
- A potential risk of attaching a child to the PTW vehicle or driver is that the **child passenger may get crushed by the adult driver** or entangled with the PTW (Carmai et al., 2019).
- The only situation in which restraints or harnesses could be effective on a motorcycle is when the overall motorcycle design includes some type of complete protective roll cage for the rider and passenger. Unless the occupant is protected with a full harness and a roll cage, it is strongly recommended that they are not coupled or attached to the PTW.

²The child passenger will then impact directly into the motorcycle and sustain significant thoracic and neck injuries. This will further aggravate the thoracic and neck injuries. When the child pillion passenger is located behind the driver, the child will move forward and this will cause the child to travel up and over the forward leaning PTW driver. This trajectory will send the child up and over the driver and the motorcycle and cause the head of the child to strike the A-pillar of the impacted vehicle, resulting in a severe head injury to the child.



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Key Messages

The risk of injury for child passengers on PTW is high because this mode of transport offers significantly less protection and lower visibility than 4-wheelers, and because children have unique physiological and cognitive attention development challenges compared to adults.

Research demonstrates that PTW users are at greater risk of death and injury (21-34 times greater) than car passengers, per kilometre travelled (Lin et al., 2009; New Zealand Government, 2017). Therefore, children should not be transported as passengers on PTW and there is no evidence to support the use of harnesses that tether/attach a child to the vehicle or driver.

However, since many families do not have other transport choices available, risk mitigation strategies must be in place, including:

- Children **under 4 years of age should never, under any circumstance, be transported** on PTWs.
- **High quality, highly visible (white or brightly coloured) full-face helmets** have the highest safety value and **high visibility protective clothing**, including **hand and foot protection** should be used at all times by all (Wells et al., 2004).
- If needing to transport children (older than 4 years), a **high quality, well-fitted helmet that is buckled appropriately and protective clothing** should be used. In-country development of a helmet standard for this age group, accompanied by rigorous testing and research on appropriate head sizes is needed.
- Child passengers **always ride behind**, and never in front of the rider.
- Drivers always travel with **headlight on**.
- Drivers maintain a **zero-blood alcohol concentration (BAC) limit** when carrying child passengers.
- **Anti-lock Brakes (ABS) should be mandatory on all powered two-wheelers that are capable of speeds of 50km/h or greater**, even light ones (smaller engine capacity) (MIROS – ASEAN Motorcycle ABS Status Report; Rizzi et al., 2015).
- **Drivers reduce their speed when carrying a child passenger** to mitigate the impact forces applied to the body of driver and passenger in the event of a crash. This recommendation is consistent with the principle of reduced speed limits in school zones and in areas of high pedestrian activity (i.e., situations with vulnerable road users).
- Annual safety checks should be carried out to confirm safe operation.
- Maximum **speed limit** should be reduced to **10 or 15 km/hr** on paths with mix use (e.g., pedestrians and bicycles at the same time).



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