World Health Organization

FIA FOUNDATION

GLOBAL ROAD SAFETY PARTNERSHIP

WORLD BANK GROUP

HELMETS

A road safety manual for decision-makers and practitioners

Second edition

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Helmets: a road safety manual for decision-makers and practitioners, second edition

ISBN 978-92-4-006982-4 (electronic version)

ISBN 978-92-4-006983-1 (print version)

Suggested citation. Helmets: a road safety manual for decision-makers and practitioners, second edition. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

Chapter break photo source: Muhammad Marizwan bin Abdul Mana

Design by Inis Communication

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Preface

Road traffic injuries are a major public health problem and a leading cause of death and injury around the world. Each year approximately 1.3 million people die and millions more are injured or disabled as a result of road crashes, mostly in low- and middle-income countries (LMICs). As well as creating enormous social costs for individuals, families and communities, road traffic injuries place a heavy burden on health services and economies. The cost to countries, many of which already struggle with economic development, may be as much as 5% of their gross national product. As motorization increases, preventing road traffic injuries will become an increasing social and economic challenge, particularly in LMICs. If present trends continue, road traffic injuries will increase dramatically in most parts of the world over the next two decades, with the greatest impact falling on the most vulnerable citizens.

Appropriate and targeted action is urgently needed. The *World report on road traffic injury prevention*, launched jointly in 2004 by the World Health Organization (WHO) and the World Bank, identified improvements in road safety management and specific actions that have led to dramatic decreases in road traffic deaths and injuries in industrialized countries active in road safety. Addressing the safety of powered two- and three-wheelers (PTWs), the report showed, has saved thousands of lives. The introduction of speed limits, enacting and enforcing helmet use laws, the creation of safer infrastructure, the enforcement of limits on blood alcohol concentration (BAC) while driving, and improvements in vehicle safety are all interventions that have been tested and repeatedly shown to be effective.

The international community must continue to take the lead to encourage good practice in road safety management and the implementation of the interventions identified above in other countries, in ways that are culturally appropriate. To speed up such efforts, the United Nations General Assembly has passed several resolutions urging that greater attention and resources be directed towards the global road safety crisis. These resolutions stress the importance of international collaboration in the field of road safety.

These resolutions also reaffirm the commitment of the United Nations to this issue, encouraging Member States to implement the recommendations of the *World report on road traffic injury prevention* and commending the collaborative road safety initiatives taken to date. They encourage Member States to focus on addressing key risk factors and to establish lead agencies and coordination mechanisms for road safety. These were further encouraged through the Moscow Declaration (2009), Brasilia Declaration (2015) and the Stockholm Declaration (2020).

To contribute to the implementation of these resolutions, WHO, the Global Road Safety Partnership (GRSP), the FIA Foundation, and the World Bank have collaborated to produce a series of manuals aimed at policy-makers and practitioners. This manual on helmets is one of them. Initially published in 2006, it has been updated to include new evidence and case studies. These manuals provide guidance to countries wishing to improve road safety organization and to implement the specific road safety interventions outlined in the *World report on road traffic injury prevention*.

The manuals propose cost-effective solutions that can save many lives and reduce the shocking burden of road traffic crashes around the world. We encourage all to use these manuals.

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Acknowledgements

WHO coordinated the production of this manual and acknowledges, with thanks, all those who have contributed to its preparation. Particular thanks are due to the following people:

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Financial support:
WHO acknowledges with thanks the financial support from Bloomberg Philanthropies for the production of this manual.

Abbreviations

BAC	blood alcohol concentration
GRSP	Global Road Safety Partnership
HICs	high-income countries
LMICs	low- and middle-income countries
M&E	monitoring and evaluation
PTWs	powered two- and three-wheelers
UNECE	United Nations Economic Commission for Europe
WHO	World Health Organization

Executive summary

Road traffic injuries kill approximately 1.3 million people every year – more than two every minute – with nine in ten deaths occurring in low-and middle-income countries (LMICs) *(1).* Globally, road traffic crashes are the leading cause of death among children and young people aged 5–29 *(1).*

In 2016, 28% of all road traffic fatalities reported to WHO involved powered two- and three-wheelers (PTWs), such as motorcycles, mopeds, scooters and electric bikes (e-bikes). Yet, as the use of PTWs increases, particularly in developing countries, the use of life-saving helmets often lags far behind.

Head injuries are the main cause of death in most motorcycle crashes. Quality helmets reduce the risk of death by over six times, and reduce the risk of brain injury by up to 74%. Yet despite this, a number of challenges are slowing the uptake and proper use of quality helmets, particularly in developing countries. These challenges include availability and affordability of quality helmets, improperly fastened helmets, a lack of available helmets for children, hot weather and even misinformation.

It is crucial that all relevant authorities and bodies put the laws, frameworks and actions in place to boost the availability and uptake of quality, life-saving helmets. Rooted in successful actions and evidence, this updated manual sets out what is needed.

Helmet law: A universal helmet law, applicable to all drivers and passengers of motorcycles, when enforced, significantly increases helmet use and reduces head injuries and deaths of motorcyclists. Australia, Malaysia and Thailand offer good examples.

Helmet standards: Good helmet standards save lives by ensuring quality. Standards must be suitable for all ages and appropriate for the local weather conditions. Good helmet standards in use are those from the Netherlands, the United Kingdom, the United Nations Economic Commission for Europe [UNECE] and Viet Nam, among others.

Enforcement and education: As enforcement increases, so does compliance with the law. Combining enforcement with education is eight times more effective than enforcement alone, and around 12 times more effective than education alone.

In the 10 years since the first edition of this manual, the global landscape has changed significantly. The rapid increase in PTW use, as well as e-bikes, pose new challenges. With the adoption of the United Nations Decade of Action for Global Road Safety 2021–2030 and the subsequent political declaration adopted by the United Nations General Assembly in July 2022, countries are adopting the Safe System approach, which recognizes that road transport is a complex system with interconnecting elements that all affect each other.

A Safe System can only be achieved if safety becomes a fully integrated element in how we organize, design and build out our mobility systems. It requires looking at how mobility systems are designed and organized, how they operate and how people, vehicles and infrastructure all affect the decisions made by the users of the system.

In this context, actions to ensure motorcyclists can and do wear quality helmets must be part of a holistic and whole-of-government approach to road safety and safe mobility.

Introduction

Why were these manuals developed?

Since 2006, the WHO, World Bank, FIA Foundation and Global Road Safety Partnership (GRSP) have produced a series of good practice manuals, which provide guidance on implementation of interventions to address specific risk factors in road safety, supporting the implementation of good practices in road safety to help make the world's roads safer for all. The topics covered in the initial series of manuals were: helmets (2006), drinking and driving (2007), speed management (2008), seat-belts and child restraints (2009), data systems (2010), pedestrian safety (2013), road safety legislation (2013), powered two- and three-wheeler safety (2017) and cyclist safety (2020). In addition, WHO produced a road safety technical package, Save LIVES (2017), which provides 22 evidence-based interventions related to speed management, leadership, infrastructure, vehicles, enforcement and post-crash care.

Why are these manuals being revised?

Since the series of manuals was first published, the scientific evidence base relating to various risk factors and the effectiveness of interventions has continued to expand. Contemporary research has refined our knowledge about specific risk factors, such as distracted driving, and vehicle impact speed and risk of death for pedestrians. New issues and practices have arisen, such as a tropical helmet standard and anti-braking control standard for motorcycles. New and existing interventions have been implemented and evaluated, with increasing application in LMICs. Research attention and policy responses have also increasingly been applied to emerging road safety issues including e-bikes, drugs other than alcohol, fleet safety, urban mobility, micro mobility options, air and noise pollution, public transport and technological advances.

As a result of these developments, the good practice manuals required revision so that they can continue to be key references for road safety policy implementation and research. This is particularly important given the emphasis placed on road safety within the framework of the 2030 Agenda for Sustainable Development and because of the global impetus to reduce road deaths and injuries resulting from the declaration of the two United Nations Decades of Action for Road Safety (2011–2020 and 2021–2030). The manuals have been revised to reflect these developments as they continue to be valuable resources providing evidence-based and cost-effective solutions to save lives and reduce injuries. An extensive literature review has informed the revision and updating of all the manuals, and additional information has been collated to allow more contemporary case studies to be showcased. In addition, the need to broaden the topics covered in the manuals to include aspects such as qualitative research methods and participatory approaches to designing and evaluating interventions was identified. An emphasis on shifting traditional thinking away from blaming road users towards more contemporary frameworks, such as the Safe System approach is key in the revised manuals. An area requiring ongoing consideration is decolonizing knowledge and practice within the road safety field.

A review of the evidence on risk factors and interventions was conducted for information for revision of this manual. The review utilized text mining techniques to gather evidence on risk factors and outcomes of interventions. This technique creates computational algorithms for reading and extracting texts from a large volume of information in a short period of time. The review was limited to literature from January 2008 to December 2019, with the understanding that the previous manual had drawn on the evidence that existed before January 2008. Only papers in English, French, Portuguese and Spanish were included in the literature review. Studies excluded were those presented in conference proceedings, editorials and draft papers. The full search generated 157 abstracts relevant to PTW safety, including helmet use, which were screened to produce 53 full studies for review for this manual. The two experts who conducted the literature review grouped the interventions into three categories – proven, promising and insufficient evidence – based on existing best practices in road safety. The Advisory Committee reviewed the categories and refined them based on the existing best practices in road safety policy and their expert knowledge.

Safe system approach

The Safe System approach recognizes that road transport is a complex system and places safety at its core *(2)*. It also recognizes that humans, vehicles and the road infrastructure must interact in a way that ensures a high level of safety (Fig. 1). A Safe System therefore *(2)*:

- anticipates and accommodates human errors;
- incorporates road and vehicle designs that limit crash forces to levels that are within human tolerance to prevent death or serious injury;
- motivates those who design and maintain the roads, manufacture vehicles and administer safety programmes to share responsibility for safety with road users, so that when a crash occurs, remedies are sought throughout the system, rather than solely blaming the driver or other road users;
- pursues a commitment to proactive and continuous improvement of roads and vehicles so that the entire system is made safe rather than just locations or situations where crashes last occurred; and
- adheres to the underlying premise that the transport system should produce zero deaths or serious injuries and that safety should not be compromised for the sake of other factors such as cost or the desire for faster transport times.

Fig. 1 Safe System approach

Source: (3).

Module 1
Why are helmets needed?

1.1 Powered two- and three-wheeler related deaths

PTWs are motor-operated two- or three-wheeled vehicles, powered by either a combustion engine or rechargeable batteries. The main categories of powered two-wheeler covered in this manual are motorcycles, mopeds, scooters and electrical bikes (e-bikes) (Fig. 1.1).

Fig. 1.1 Types of PTWs

E-bike

Motorcycle

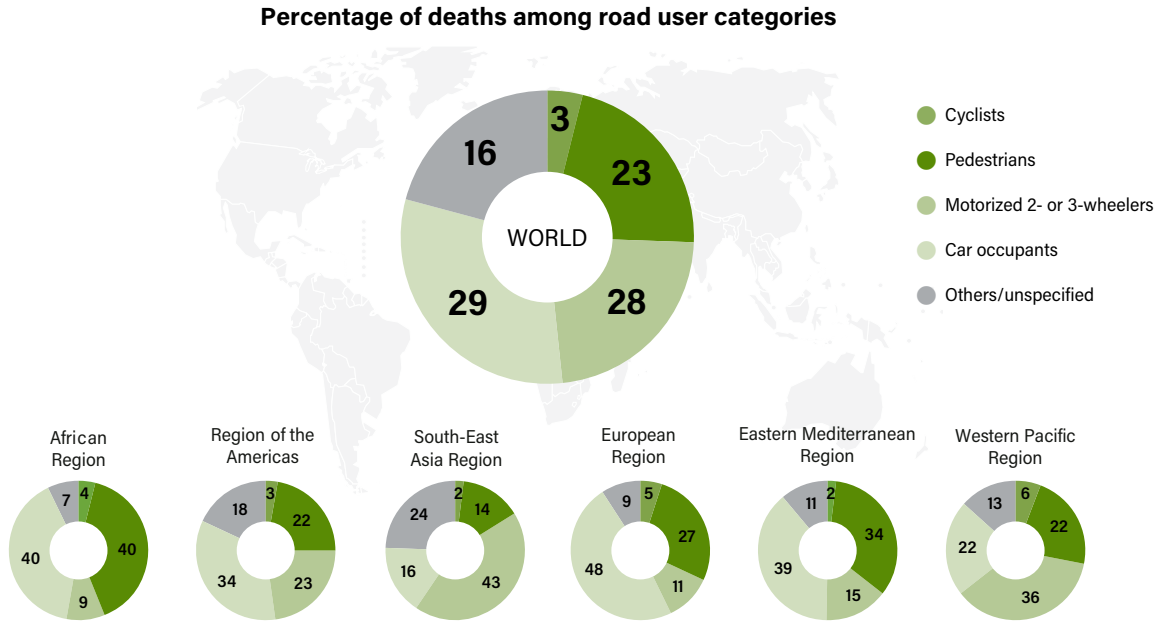
E-scooter

Moped

Auto-rickshaw

Road traffic crashes represented the 12th leading cause of death globally in 2019, claiming approximately 1.3 million lives. At the global level, PTW fatalities reported to WHO in 2016 constituted an estimated 28% of total road user fatalities. The proportions of different road users killed in WHO regions are given in Fig. 1.2. The highest proportion of PTW fatalities in 2016 was 43% in South-East Asia and the lowest was 9% in Africa. However, in each region there were countries with much higher rates for PTW deaths.

Fig. 1.2 Road traffic deaths by type of road user, WHO region, 2016



Source: Based on *(4)*[1].

Since PTW and bicycle riders are not surrounded by protective steel enclosures, they are susceptible to serious injuries which can lead to death in the event of crashes with other vehicles and fixed objects. The increased risk is also because they often share traffic space with fast-moving cars, buses and trucks, and they are less visible. Even in countries where the share of PTW and bicycle riders is less than 20%, their share of serious injuries and fatalities can be significant. PTW and e-bike use is increasing in many countries around the world and encouragement of bicycle use has become a part of transportation policies internationally *(5–9)*. Therefore, implementation of safety interventions directed at all two-wheeler riders has become important worldwide.

1.2 Head injuries – a leading cause of death and disability

Head injuries are the main attributable cause of death in a majority of motorcycle crashes *(9–13)*. Reports from around the world show that in many countries, the incidence of PTW injuries is on the increase *(7, 14–16)*, and a large proportion of the riders sustain head injuries in crashes.

A hospital-based study from Western Kenya reports that 42% of the PTW riders admitted sustained head injuries *(11)*. In Viet Nam, head injuries accounted for 70% of motorcycle-related hospitalizations *(17)*. In Taiwan, China, 82% of head injuries were associated with road traffic crashes, 71% of which directly involved motorcycle riders *(17)*. A review of PTW injury risk indicates that the majority of fatal injuries are to the head, even among riders with a helmet *(18)*. Even when they do not lead to death, head trauma can result in injuries to the brain leading to disability due to problems with brain function,

[1] The distribution of deaths among road user categories is based on data reported by countries. In some countries these data are not available or are incomplete, which contributes to the large percentage of those identified as "others" or "unspecified".

locomotion, problems coping with physical stresses at work and loss of income, employability and lifelong medical expenses *(19,20).*

On 13 May 1935 TE Lawrence (Lawrence of Arabia) had a crash on a Brough Superior SS100 motorcycle on a narrow road near his cottage near Wareham (United Kingdom of Great Britain and Northern Ireland). Lawrence lost control and was thrown over the handlebars. He was not wearing a helmet and suffered serious head injuries which left him in a coma; he died in hospital 6 days later. One of the doctors attending him was Hugh Cairns, a neurosurgeon *(21)*. Dr Cairns was profoundly affected by treating TE Lawrence and began a long study of what he saw as the unnecessary loss of life by motorcycle dispatch riders through head injuries. In 1943, he, along with Dr H Holbourn, published a paper titled "Head injuries in motorcyclists with special reference to crash helmets" in the *British Medical Journal* and concluded that "the crash helmet is effective in diminishing local damage to the brain and its coverings at the site of impact, and it tends to lower the incidence of cases of prolonged amnaesia" *(22)*.

It is fascinating that more than 75 years ago, Cairns and Holbourn had already published data showing that even very old-style helmets (with an outer shell composed mainly of hard vulcanized rubber or of compressed wood pulp but with no polystyrene padding) appeared to be effective in reducing the severity of head injuries in motorcycle crashes. We have come a long way since then, with a much better understanding of the biomechanics of head injuries *(23,24)* and how to design better motorcycle helmets *(25,26)*. There are three main types of helmets: full face, open face and half coverage (Fig. 1.3). A full-face helmet covers the head and neck and includes a chin bar. An open-faced helmet covers the top, back and sides of the head, while the face is exposed and there is no chin bar. Half-coverage helmets cover the top of the head and the area from the forehead to the brows, while the rest of the face is left exposed *(27)*.

Fig. 1.3 Types of helmets for PTW riders

Full face | Half coverage | Open face

Source: (28).

There are counterfeit helmets that do not adhere to helmet standards (see Module 2). These types of helmets do not provide adequate protection and need not be used. Examples of such helmets are novelty helmets. Novelty helmets do not have expanded polystyrene lining inside the outer shell. They are often made of thin plastic. In a standard helmet, it is this lining that absorbs and redistributes energy from an impact to the head. According to a study by Rice et al. *(28),* motorcycle riders wearing a novelty helmet are almost twice as likely to die in a crash than those wearing a full-face helmet. In comparison, the risks of dying were not significantly different among other types of helmets (full face, half face and open face).

1.3 The mechanism of head injuries

An appreciation of the anatomy of the head is important in understanding the mechanism of injuries to the head and brain (Fig. 1.4). Briefly, the important anatomical information on the head to note is:

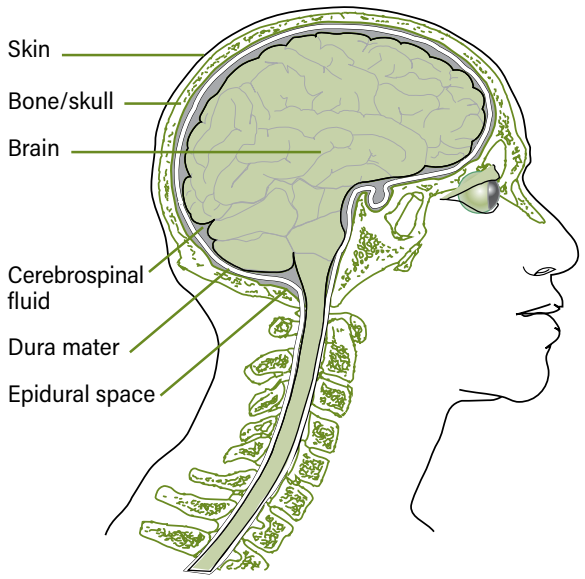
- The brain is enclosed within a rigid skull.
- The brain "sits" on bones that make up the base of the skull.
- The spinal cord passes through a hole in the underside of the brain.
- Under the skull, adhering to the bones, is a tough tissue called the dura that surrounds the brain.
- Between the brain and the dura is a space containing cerebrospinal fluid that protects the brain tissue from mechanical shock.
- The brain "floats" in the cerebrospinal fluid but it can only move about 1 mm in any direction.
- The skull is covered by the scalp, which provides some additional protection.

During a motorcycle crash there are two principal mechanisms of injury to the brain:

- Through impact of the head with the road surface causing injuries to the scalp or the bony structure of the skull resulting in fractures.
- Through movement of the brain inside the skull causing it to impact the insides of the skull and/or rotate within the skull. This results in damage to the brain tissues and blood vessels causing bleeding inside or outside the epidural space. The bleeding can result in putting pressure on the brain by an increase in fluid volume. At times this bleeding ends up pushing the brain downwards (termed coning) which can also result in long-term sequalae. Serious brain injuries can be sustained without accompanying skull fractures *(29,30)*.

When a motorcycle is involved in a collision, the rider's head can hit other vehicles, fixed hard objects around the road or the surface of the road. The risk of serious injury and death increases with increase in impact velocity of the head with respect to the hard object. However, head injuries can also result among two-wheeler riders falling off at low speeds (10–15 km/hr) *(31,32)*. Therefore, two-wheeler riders must wear a helmet when moving, and those who do not, run a much higher risk of sustaining head and traumatic brain injuries, or a combination of them. Helmets provide a cushion around the head and thus protect the wearer from some of the more severe forms of traumatic brain injury.

Fig. 1.4 Structure of the head and brain



1.4 Reasons for non-use of helmets

The key risk factor is non-use or improper use of helmets by PTW riders. There are several reasons for non-use of helmets.

Availability of affordable and standard helmets

It is important to ensure that helmets of standard design are easily available in the market and are affordable *(33)*. Their unavailability or high cost limits accessibility and use by PTW riders.

Fixation status of helmet

A helmet that is not strapped or not strapped tightly could eject during the event of a collision. This could render the helmet useless in providing safety to its user. Fixation status, therefore, has greater impact on risk of a head injury than the type of helmet *(34,35)*. Helmet laws should specify fixation status as one of the conditions for compliance and should include provisions for penalty for non-compliance.

Helmets for children

There is often lack of availability of standard helmets in the market for children, which prevents mass uptake. If the helmet law in a country includes helmets for all motorcycle users and enforcement ensures that adults are penalized for non-compliance by children, the availability of appropriate helmets for children should increase and be more widely used.

Hot weather

In hot climates, helmet use can be inconvenient. Thus, the voluntary uptake of full-face helmets with a chin bar is likely to be much lower in these contexts. In such cases, strict enforcement of helmet use is critical to achieve high levels of compliance.

Misinformation about helmets

There has been a concern in some countries that helmets could result in neck injury in children. There is no evidence to support this claim or concern. This myth, if prevalent across a large section of the population, could result in low helmet use or use of substandard lightweight helmets among children. This myth needs to be tackled through mass awareness programmes and strict enforcement.

Motorcycle taxis

Motorcycle taxis, which are growing in number across many LMICs as a mode of public transport, are posing a new challenge for the safety of users. Taxi drivers operate their vehicles for a much longer duration than those using motorcycles for personal use. They are also more likely to be used at night. This results in fatigue of drivers and a greater likelihood of crashes. In hot climates, many drivers can be hesitant to wear helmets for a long duration, exposing them to even greater risk of injury in the case of a crash *(36)*. Additionally, there could be hesitancy among passengers of these taxis in wearing a shared helmet *(37)*. Either taxi operators providing passengers with a helmet or passengers carrying their own helmets can help alleviate this problem, but this needs regulations and enforcement.

Motorcycle riders wearing other headgear

The motorcycle users wearing other headgear like turbans for their religious beliefs (e.g. Sikhs) cannot use helmets *(38)*. This is an added risk for those users.

Inadequate enforcement of helmet-wearing laws

Though a helmet law alone is not effective in improving prevalence of helmet use in a population, there should be sustained enforcement so it has its intended effect on the driver population *(39,40)*. Some countries do not have a helmet law for bicycle and e-bike riders. According to WHO, a large majority of countries have reported poor enforcement of their helmet law, and many of these are LMICs with high usage of motorcycles *(41)*. There is evidence from several countries around the world that helmet use increases significantly with enforcement, and the effectiveness of enforcement increases many times if it is combined with awareness programmes *(42)*.

1.5 Summary

Head injuries are the leading cause of death in a majority of motorcycle crashes internationally. When a motorcycle is involved in a collision, the rider's head can hit other vehicles, fixed hard objects around the road and the surface of the road. Head injuries can also result from two-wheeler riders falling off at low speeds. Riders of PTWs must wear a helmet when moving and those who do not run a much higher risk of sustaining head and traumatic brain injuries, or a combination of these.

Module 2
Evidence-based interventions

2.1 Overview of interventions

The effectiveness of helmets in reducing head injuries and preventing death has been established by several studies (Table 2.1 and Section 2.2). Table 2.1 is based on a review of evidence on PTW safety, including helmet use, from January 2008 through December 2019, resulting in an additional 53 full studies that were considered in this update. The effectiveness of interventions relates to the reduction of fatalities or injuries as well as other measurable change(s) in the behaviour of the road user targeted by the intervention. The evidence on interventions is categorized into one of three groups: proven, promising or insufficient evidence. The assessment of effectiveness and impact was made using several tools developed in evidence-based medicine and policy research *(2,4).* For the purpose of this document the following intervention category definitions are used:

- **A proven intervention** means that evidence from studies such as systematic reviews, experimental trials, case–control or cohort studies demonstrates that these interventions are effective in reducing head injuries, or in bringing about desired behaviour change, combined with likely feasibility or cost-effectiveness.
- **A promising intervention** means that evidence from studies shows that some safety benefits have resulted from this intervention, but further evaluations from diverse settings are required and thus caution is needed when implementing such an intervention.
- **An intervention with insufficient evidence** refers to a situation where the evaluation of an intervention has not reached a firm conclusion about its ability to reduce fatalities and injuries or bring about desired behaviour change. This may be due to a lack of quality evidence on this intervention or what evidence exists may be equivocal. Also, this group may include strategies that do not appear to work – but evidence is limited to the contexts under which they have been evaluated.

As already indicated, other interventions are needed to ensure universal use of helmets among PTW users before the benefits in injury reduction can be achieved. These interventions include developing and passing a law for helmet use among PTW users, developing helmet standards suitable for all age groups and appropriate for the local weather, enforcement of the law by police, and education programmes to increase awareness of the law and benefits from compliance.

Table 2.1 Key measures and specific interventions for effective helmet programme

Intervention	Effectiveness			
	Proven	Promising	Insufficient evidence	Harmful
Motorcycle helmets	■			
Types of helmet and fixation status	■			
Helmet law	■			
Education plus enforcement	■			
High-quality affordable helmets	■			
Helmets for tropical weather		■		
Degree of enforcement			■	
Novelty helmets				■

2.2 Evidence base for helmet interventions

A brief description of each of the interventions presented in Table 2.1 is provided in this section.

Motorcycle helmets

Considerable research has been conducted over the past 50 years on the effects of wearing a helmet on the risk of head injury as a result of a collision *(43–55).* Systematic reviews for effectiveness of motorcycle helmets have been conducted by a number of researchers and groups *(46)*. Overall, the results, as summarized by the European Union SafetyCube Horizon 2020 project *(56)*, show that the use of PTW helmets in the majority of outcome measures led to reduced injury or fatality risk to a helmeted PTW user compared with those not wearing helmets. The estimates for reductions in injuries are *(56):*

- Fatal injury: 28–64%
- Head injury: 58–60%
- Brain injury: 47–74%
- Face injury: 14–63%
- Neck injury: 14–48%.

Types of helmets and fixation status

Studies conducted on the types of helmets (Fig. 1.3) show that a full-face helmet is more effective in preventing head and cervical injuries than half-coverage or open-face helmets *(57)*. There are concerns that full-face helmets, because of their higher weight, result in greater risk of neck injuries *(58)*. However, many studies from around the world have found this claim to be untrue *(56,59–65).*

Another factor that determines the effectiveness of a helmet in preventing injuries is the fixation status. A loosely fastened helmet can be ejected during a high-impact crash and therefore offers no protection. Motorcyclists with loosely fastened helmets compared with those with firmly fastened helmets increased

their risk of head injury almost two-fold *(34)*. Motorcyclists that had their helmets ejected during the crash were many times more likely to sustain facial or head injuries than those whose helmets remained fixed *(35,66)*. The likelihood of ejection in the case of a crash is also determined by the type of helmet. According to multiple studies *(67)*, a full-face helmet is less likely to be ejected than an open-face helmet, and therefore, provides greater safety. Therefore, both fixation status of the helmet and the type of helmet can modify the effectiveness of a helmet *(67,68).*

Helmet law

A systematic review of 60 studies from the United States of America found that implementation of a universal helmet law (UHL), applicable to all riders and passengers of motorcycles, resulted in a 47 percentage point increase in helmet use, as well as a reduction in head injuries and deaths of motorcyclists *(69)*. While a similar review is not available for international settings, individual studies from diverse settings point towards similar outcomes. These include studies from Australia *(70)*, Malaysia *(71),* a southern European country with high motorcycle use *(72),* China *(73),* Thailand *(74)* and Viet Nam *(17,40,75).* The evidence from a range of countries shows that it is possible to enforce a mandatory helmet law successfully in all countries irrespective of income level. It is important that when motorcycle helmet-wearing legislation is introduced, there is effective enforcement, a ready supply of affordable helmets, and widespread education campaigns for both the police and the community. It is also imperative that the evaluation of such legislation is planned prior to implementation, so that the effectiveness of the intervention may be assessed.

Education plus enforcement

Studies evaluating the impact of a law on motorcycle helmet use and injury outcomes provide evidence for settings where a new helmet law has been passed. In many countries, despite the existence of a helmet law, helmet use remains low. For these settings, more relevant evidence is of the effectiveness of enforcement and education campaigns. A systematic review and meta-analysis of the impact of enforcement and education campaigns on the helmet use of motorcycle riders and passengers concluded that the two interventions combined have a much greater impact compared with when they are implemented individually *(42)*. The effect of a combined strategy is around eight times greater than enforcement alone, and around 12 times greater than education alone. The review also found that mass media campaigns only affect helmet use when they are run for more than a year. A shorter duration is not enough to change behaviour.

Lack of success of educational campaigns to improve driver behaviour is not limited to motorcycle helmets and has been found to be true in other areas of traffic safety. For example, education and persuasion programmes to improve seat-belt use have not been found to be effective. Since travelling on the road is a daily activity for most people and an injury incident (even for those not wearing a helmet) is a rare event, drivers are rewarded for their behaviour every time they complete the trip without an incident. Drivers also tend to overestimate their skills in avoiding a crash and believe that they are aware of safe driving behaviour. Therefore, education of drivers is not enough, and individuals should also be given incentives to change their behaviour. In the presence of strict enforcement and penalty for non-compliance, drivers may perceive a monetary incentive for complying with the helmet law *(76)*.

Some settings do not have a comprehensive law for motorcycle helmets and the prevalence and knowledge of helmet use is low. In such contexts, education programmes can help increase awareness

of helmets and benefits of helmet use among the population as well as decision-makers. This can help set the stage for the formulation of a helmet law. Once the law is passed, the education programmes that were in place can help increase awareness of the law and the associated penalty for non-compliance. For this effort to be successful, there should also be visible and sustained enforcement on the road *(76)*. Avoiding penalty is often reported by motorcycle users as one of the reasons to wear helmets *(77)*.

There are several helmet standards in the world. Examples of helmet standards in use are:

- United Nations Economic Commission for Europe: UNECE 22.05 (to be replaced by UNECE 22.06). Many countries use UNECE standard for helmets or have their own standards.
- Viet Nam: TCVN 5756:2001 (protective helmets for motorcycle user) and TCVN 6979:2001 (protective helmets for children travelling on motorcycles).
- Netherlands: NTA-8776 for e-bike helmet.
- United Kingdom: British Standard BS 6658:1985.

High-quality affordable helmets

Laws and enforcement and education campaigns are not effective by themselves. The availability of helmets that meet international best practices and are also affordable for motorcycle users are necessary conditions for their high effectiveness *(33)*. Helmet laws should specify the helmet design standard to be adhered to. Governments should issue regulations for helmet manufacturers to follow the standards. The helmets should have labelling to indicate their design standard. This will help enforcement officers to detect non-compliance and to discourage sales of non-standard helmets.

Helmets for tropical weather

Helmet use can be inconvenient in tropical weather. To address this problem, an effort has been made to design helmets suitable for hot climates such as those of South Asian and South-East Asian countries with extremely hot and humid climates. They are actually half-head helmets with ventilation holes to provide a maximum flow of air so as to reduce the heat.

The case of Viet Nam shows how a country can devise a motorcycle helmet standard specifically tailored to meet its climatic and traffic conditions while adhering to international standards. Viet Nam's original helmet standard (TCVN 5756:1993) restricted certification to only full-face helmets. This standard was found to be inappropriate given the constantly high levels of heat and humidity in the country. Helmets that would be more suitable, like the half-head model, were unable to meet standard specifications. This made people reluctant to wear helmets, which prevented a helmet use programme from getting off the ground. In 2001, the standard was revised. Standards TCVN 5756:2001 (protective helmets for motorcycle user) and TCVN 6979:2001 (protective helmets for children travelling on motorcycles) now allow more suitable partial-coverage helmets. Importantly, the standard allows for ventilation holes in the helmet. Such helmets can be lighter in weight and have more ventilation and, as a result, be cooler for wearers – an important consideration in hot climates. The new standard is also in line with UNECE Regulation No. 22 in terms of general specifications, testing and labelling. Given that a large number of LMICs where motorcycle use is high or is expected to grow are located in tropical regions, modification of the helmet standard to suit local weather conditions could be a promising intervention for greater uptake of helmet use.

Degree of enforcement

The level of compliance with a law depends on the degree or intensity of enforcement. The limited empirical evidence on the relationship between degree of enforcement (e.g. police stops per 1000 drivers) and level of compliance shows a nonlinear relationship between the two *(78)*. As the degree of enforcement increases, so does the compliance. However, the evidence for this relationship is not available for LMICs or for motorcycle helmets. As a result, the decisions to deploy enforcement often remain ad hoc and not guided by evidence.

2.3 Summary

The effectiveness of helmets in reducing head injuries and preventing death has been found by multiple studies. However, ensuring the use of helmets requires additional interventions. These include developing and passing a law for helmet use among PTW users, developing helmet standards suitable for all age groups and appropriate for the local weather, enforcement of the law by police, and education programmes to increase awareness of the law and benefits from its compliance.

3

Module 3
Implementing evidence-based helmet interventions

This module provides guidance on:

- Cycle of improvement – a continuous examination of programme implementation and outcomes.
- Pathways to change – a systematic approach to understanding the pathway to change in order to reach a long-term goal.
- How to assess the situation – numerous types of assessments can provide the information needed to design, deploy and maintain an effective programme.
- Opportunities and challenges in implementing helmet interventions – implementation success can be maximized by understanding the challenges and seizing opportunities.
- Evaluation of progress and using results for improvement – evaluating results is vital in effective decision-making and modifying a course of action.

3.1 Cycle of improvement

Improving use of helmets in a country requires continued effort of planning, executing and evaluating programmes. It is not a one-off undertaking but rather a continuous cycle of action and learning. There are opportunities as well as unexpected challenges that need to be managed as this cycle moves on in each country. Implementing a continuous cycle of road safety improvement begins with an assessment of the existing system followed by the development, execution, evaluation and refinement of a national or a local plan of action. A plan of action will not yield improvements unless it is translated into practical solutions in countries. In addition to identifying and prioritizing actions that should be taken, there are key ingredients that need to be considered and made available or developed: human and financial resources, sharing responsibility among different agencies, and political commitment *(2)*.

3.1.1 Pathways to change

Applying the Safe System approach to road safety results in a complex set of interacting interventions which makes the interventions quite difficult or sometimes even unethical to implement and evaluate using traditional research methods such as a randomized controlled trial. For this reason, some researchers have proposed that "understanding the public health intervention's underlying theory of change and its related uncertainties may improve the evaluation of complex health interventions" *(79)*.

A theory of change is therefore basically the pathway(s) followed to achieve the objective of a programme (Box 3.1). It "explains how activities are understood to produce a series of results that contribute to

achieving the final intended impacts. It can be developed for any level of intervention implementation – an event, a project, a programme, a policy, a strategy or an organization" *(80)* or the evaluation of such interventions or set of interventions (impact evaluation). It encourages "systems thinking" through the understanding of the complex social change processes, different perspectives, assumptions and the contexts needed to optimize success.

A theory of change is a systematic approach to understanding the pathway to change in order to reach a long-term goal. It should always begin with a good situational assessment in order to understand the causes, risk factors, opportunities and challenges in the local situation where an intervention is to be implemented. It should then be guided by a participatory approach – bringing together multiple key stakeholders, through a workshop, for example, to discuss the proposed approaches or interventions that need to be implemented to optimize impact.

Although developing a theory of change is an iterative process, and there are many ways it can be developed, it should include the following basic steps *(81)*:

1. Identify the long-term outcome
2. Develop a pathway of change
3. Operationalize outcomes
4. Develop interventions
5. Articulate assumptions
6. Monitor and evaluate the process.

As a final output of stakeholder discussions, a visual map of the change being explored should be developed to show the relationships between proposed actions/interventions and outcomes and how these interact in order to achieve the goal.

The benefits of developing a realistic and implementable theory of change are articulated in Box 3.1. In general, this process challenges the status quo and gets stakeholders to "think outside the box" so that mistakes are not made when interventions are implemented. It also forces stakeholders to think about resources and how these will be best utilized to bring about the required change. Finally, the process develops a shared understanding of the actions to be taken and expected outcomes on one hand and accountability on the other.

Box 3.1 How a theory of change would benefit your programme

It provides:

- A clear and testable hypothesis about how change will occur that not only allows you to be **accountable for results**, but also makes your results **more credible** because they were predicted to occur in a certain way.
- A **visual representation** of the change you want to see in your community and how you expect it to come about.
- A **blueprint for evaluation** with measurable indicators of success identified.
- An **agreement among stakeholders** about what defines success and what it takes to get there.
- A powerful **communication tool** to capture the complexity of your initiative.

Source: (79).

3.2 How to assess the situation

A helmet use situational assessment provides key information that will inform prioritization and help make decisions about managing programmes to improve helmet wearing. A situational assessment helps to:

- **Identify the problem and the priorities for action:** Analysis of information gathered will illustrate the types of head injuries common in a given area; where the greatest need for intervention is; inform the nature of the intervention required; and the reasons why PTW users do or do not use helmets or comply with helmet use laws.
- **Provide evidence on why a specific intervention should be supported:** Successful helmet use programmes need the support of all stakeholders, especially policy-makers, PTW users and the public in general. Accurate data on the level of helmet use in a given project area and the potential of the proposed intervention to reduce this burden will help show policy-makers what can be gained by implementing evidence-based, effective interventions.
- **Provide baseline data and evidence of progress on key programme monitoring and evaluation (M&E) indicators:** M&E is an integral component of any helmet use strategy. Data from the situational assessment help to define baseline M&E indicators. Such indicators range from outcome measures (such as deaths and injuries) to process measures linked to specific interventions (such as compliance with legislation and public opinion on a given helmet use policy).

3.2.1 What is to be assessed?

A comprehensive situational assessment involves the systematic gathering of information on the magnitude of the problem of crashes, injuries and fatalities related to helmet non-use; risk factors for these outcomes; and opportunities and barriers to helmet use. The assessment needs to focus on injury and deaths related to non-use of helmets, helmet use policies and laws, existing helmet programmes and stakeholders.

3.2.2 Assessing the burden of injury and death related to non-use of helmets

Identifying the number of injuries and deaths related to non-use of helmets is an important starting point for any helmet safety planning. This type of epidemiological assessment involves a scientific study of the occurrence, distribution, causes and risk factors of injuries and deaths related to non-use of helmets in a given population.

The epidemiological assessment is done by:

- Measuring the incidence of injuries and fatalities related to non-use of helmets.
- Defining the age and sex distribution of people that suffer injuries and fatalities related to non-use of helmets.
- Describing the times and places where injuries and fatalities related to non-use of helmets occur.
- Analysing the causes, risks and protective factors involved.

- Assessing the consequences of crashes related to non-use of helmets.

Depending on the availability of data, the following variables can be considered for an additional assessment:

- Time: on what day of the week and at what time of day do most non-use of helmet crashes occur?
- Severity: how serious are the injuries related to non-use of helmets (types of injury by severity and fatalities)?
- Cost: how big is the helmet injury problem in terms of health and socioeconomic costs?
- Disability: what type of non-use of helmet crashes lead to disability or life-threatening outcomes?

The extent of the epidemiological assessment in a given setting will be limited by the availability of information. The most easily available, accessible and immediately relevant data sources tend to be used first (see Table 3.1). In settings where there are no data, or where routinely collected data sources do not provide adequate information, new information on key indicators may be collected through purpose-built surveys.

Table 3.1 Key sources of road traffic injury and incident data

Source	Type of data	Observations
Police	Number of road traffic incidents, injuries, and fatalities Incidents involving PTW riders Age and sex of casualties Police assessment of cause(s) of crashes Use of safety equipment (e.g. helmets) Locations and sites of crashes Prosecutions/enforcement activities	Level of detail varies from one country to another, and there are typically large within-country differences too Police records can be inaccessible Underreporting is a common problem Precise location data (e.g. map coordinates) may not be available
Health settings (hospital in-patient records, emergency room records, trauma registries, ambulance or emergency technician records, health clinic records, family doctor records)	Fatal and nonfatal injuries Age and sex of casualties Nature of injury Type of care provided Alcohol or drug use	Level of detail varies from one hospital to another Cause of injury may not be properly coded, making it difficult to extract road traffic injury data for analysis Information on the injured person may not be disaggregated by type of road user
Vital registration	Fatal injuries Age and sex of casualties Type of road user(s) involved	Completeness and comprehensiveness varies between countries Cause of death may not be properly coded, making it difficult to extract road traffic injury data disaggregated by road user for analysis Population coverage may be poor

Source	Type of data	Observations
Government departments and specialized agencies collecting data for national planning and development	Population estimates Income and expenditure data Health indicators Riding exposure data (e.g. km travelled) Pollution data Energy consumption Literacy levels	These data are complementary and important for analysis of road traffic injuries The data are collected by different ministries and organizations (although there may be one central agency that compiles and produces reports, including statistical abstracts, economic surveys and development plans). These data can be important for planning interventions and garnering support for these interventions
Special interest groups (research institutes, nongovernmental advocacy organizations, victim support organizations, transport unions, consulting firms, institutions involved in road safety activities, insurance companies and others)	Number of road traffic incidents, including fatal and nonfatal injuries Type of road user involved Age and sex of casualties Vehicles involved Causes Location and sites of crashes Social and psychological impacts Risk factors Interventions Insurance claims/costs	The various organizations have different interests and data collection and research methods may not be sound

3.2.3 Assessing existing helmet policies, laws and regulations

This assessment seeks to provide an understanding of the types, characteristics and specifics of existing helmet use policies, laws and regulations (and any gaps in these), and the context within which legislative and policy changes can be made. It is important to assess the level of quality control for helmets and existence of trade policies requiring manufacturers and distributors to adhere to helmet standards in cases where helmets are imported into a country.

The assessment can reveal the adequacy of existing laws and/or their enforcement and is thus a necessary step in defining the direction of future helmet use policies. Enacting helmet-related laws, however, is influenced by many factors, including: the policy environment and the political will of policy-makers; the resources made available by the government for enforcement; and the acceptability of the laws to a majority of the public. As such, planning and implementing a comprehensive policy environment assessment should be carried out to ensure all factors are taken into account.

The scope of the task of conducting a policy assessment will vary between countries. It is important that the approach is tailored according to the context in which the new or amended policy will be adopted, and the specific objectives of the policy that serve to enhance helmet use among PTW riders in that nation, region or subregion. For effective use of findings it is also important that the analysis provides some insight about the institutions primarily responsible for the formulation and enforcement of the law and regulations.

3.2.4 Assessing existing helmet use interventions

An intervention assessment takes stock of existing and potential helmet use interventions and initiatives. It is important to have this information in order to inform the prioritization process and, ultimately, mobilize the support of stakeholders for maximum uptake of new initiatives. Unlike the epidemiological assessment described earlier, the intervention assessment is used for defining and prioritizing possible areas of intervention. It requires an understanding of the current situation in terms of intervention implementation and is particularly important to minimize duplication of efforts and ultimately maximize the impact of any helmet use effort. Some of the issues that the interventions assessment can address include:

- The status of past and existing interventions and initiatives: what is already being done in the country, municipality, state or province?
- The types of interventions and implementation level: which interventions have been implemented and tested in the locale? What is the level of implementation at national, regional or local levels?
- The effectiveness of existing initiatives: what is their potential effectiveness (based on available evaluation findings or latest research data)?
- Gaps in knowledge: which key information areas are lacking in relation to target groups?
- Available resources: is there an allocated government budget for road safety and, specifically, for PTW safety and helmet use initiatives? Are other stakeholders (government, private sector or nongovernmental organizations) providing resources?
- Visibility of the issue: do any of the potential stakeholders provide opportunities to raise the profile of helmet use?

3.2.5 Stakeholder and target group assessment

While the assessment of existing national laws and regulations is meant to provide planning information on the policy environment, the stakeholder and target group assessment sheds light on the social environment in which policies are being developed and implemented. Key objectives of a stakeholder and target group assessment include:

- Identifying key partners and their characteristics and examining how they will affect or be affected by a policy (e.g. their specific interests, likely expectations in terms of benefits, changes and adverse outcomes).
- Consulting with the target group to identify their concerns, motivations and issues that may impact the success of the strategy. Participatory research is an important component of the situational assessment. What are the sociocultural factors that need to be considered in selecting the intervention? How can the intervention be made equitable and accessible to those who are socially and economically disadvantaged in the target group?
- Assessing partners' potential influence on the development, approval and implementation of the policy – including possible conflicts of interest – to understand the relationship between stakeholders; the capacity of different stakeholders to participate in policy development; and to assess the likelihood of their contributing to the policy development process.
- Deciding how stakeholders should be involved in the process to ensure the policy is as strong and viable as possible.

Understanding the position of key stakeholders, the relationship between different entities and clearly identifying the supporters and opponents of road safety policies (i.e. those of divergent views) is key for effective engagement of all concerned parties.

3.2.6 Using situational assessment findings for targeted action

Data gathered through the situational assessment, together with information on the effectiveness of known helmet use interventions, provide the evidence to inform the process of prioritizing intervention activities. Results from the situational assessment should be used to prioritize a target group with the following attributes:

- Jurisdictions with comprehensive and effective laws and a strong enforcement culture.
- Target areas with the strongest political will.
- Communities that are supportive and fully on board.

These three factors are key to creating a favourable environment to successfully implement a given helmet use programme or intervention and achieve a positive outcome in terms of reduction in number of injuries and deaths, or reduction in risky behaviour.

3.3 Challenges in implementing interventions for helmet use

There are challenges encountered during the implementation of helmet interventions. Examples of these opportunities and challenges are briefly summarized below.

Helmet use enforcement

Improving compliance with a helmet law is challenging. Passing a law for mandatory use of helmets for PTW users is the first and necessary step towards a successful helmet use programme. The law should lay down the various conditions under which a road user is required to wear a helmet, such as age of passenger, vehicle type and type of roads. It should also specify helmet standard and correct use of helmets (e.g. proper strapping and adequate size), and set the penalties in case of non-compliance. However, there are multiple examples across the world where existence of a mandatory helmet law does not ensure high prevalence of helmet use. To achieve increased helmet use calls for a combined approach involving a range of sectors and disciplines. Efforts to get motorcyclists to wear helmets should be directed at both voluntary and compulsory use. There is strong evidence that it is the combination of the two strategies that has the greatest effect on increasing compliance rate *(42)*.

Rapid increase in motorcycles and e-bikes in countries that had low levels until recently

In newly motorizing countries, it is important for decision-makers to be aware of the fast-changing trends in transportation. The example of Bangladesh, where motorcycle ownership had been much lower than its neighbours in South and South-East Asia but then witnessed a quadrupling of motorcycle registrations in less than a decade, shows the challenges that arise. For example, compliance with the helmet law does not appear to be accompanying this rapid increase in the number of motorcycles. Similarly, there has been a rapid growth of e-bikes in several countries. E-bikes are an evolving technology and cover a

wide range of vehicle size and operational speed. There is a lack of understanding about which e-bikes to include within those categories of PTW that need to comply with helmet law.

Ensuring helmet quality, compliance with standards and eliminating novelty helmets from the market

Though the importance of helmet laws specifying the helmet design standard to be adhered to has been highlighted in this document, compliance with these standards remains a challenge in several countries. In addition, the challenge of poor-quality helmets that are not designed to standard persists as does the challenge of eliminating novelty helmets from the market. These challenges underscore the need for governments to regularly review and address progress on helmet use initiatives.

Legislating helmet use for e-bikes and personal scooters

These modes of transport are quickly evolving around the world, allowing riders to reach relatively high speeds. However, legislating helmet use for these modes has not been undertaken in several countries, showing that policy response is lagging behind developments in transport technology. Testing and research for helmet use among these categories is relatively limited. There is a need for policy response to be quickened to address the legislation gaps for these developments in a timely manner.

3.4 How to evaluate progress and utilize results for improvement in helmet use

For any helmet use programme or intervention it is vital to undertake M&E to determine whether it works, to help refine programme delivery, and to provide evidence for continuing support of the programme. Evaluation will not only provide feedback on the effectiveness of a programme but will also help to determine whether the programme is appropriate for the target population, whether there are any problems with its implementation and support, and whether there are any ongoing concerns that need to be resolved as the programme is implemented.

The key practices to follow:

- **Plan the evaluation:** Ensure that M&E are included in any helmet programme, strategy or intervention at national or local level. It is best to plan for evaluation from the beginning rather than doing so once implementation has begun. Determining the aims of the evaluation, type of evaluation and indicators to adopt during the planning phase of a programme will improve the ultimate quality of the evaluation.
- **Identify existing M&E activities in your setting and the responsible agencies:** This exercise helps with identification of relevant existing data and can develop partnerships with the existing agencies in M&E. Collect baseline data using surveys, and existing databases if they exist.
- **Identify suitable indicators to monitor processes, outputs and outcomes.**
- **Conduct the evaluation consistently, as planned:** Once the appropriate evaluation design and methods have been specified – with respect to the unit of analysis, population, sample and methods of data collection and analysis – conduct the evaluation according to those methods.
- **Disseminate evaluation results:** Use evaluation results to improve the programme and inform the public and other stakeholders about successes or failures. The results of the evaluation need to be disseminated, discussed and used by programme staff, government, the public and sponsors of road

safety initiatives. These different groups need to consider what the interventions can do better and what they can avoid in order to improve helmet use.

3.5 Summary

PTW use is increasing rapidly in several countries; hence the importance of ensuring that PTW riders use helmets to reduce the injuries and deaths that result from non-use of helmets during a collision. Though measures for increasing and sustaining helmet use are known, their implementation faces several challenges such as inadequate enforcement, persistent use of poor-quality helmets and lack of legislation for helmet use for e-bikes.

These challenges need to be addressed by countries through a proactive approach that involves continued effort in planning, executing and evaluating helmet use interventions. Effective planning and implementation of a helmet initiative requires a comprehensive understanding of the risk factors involved in different settings, the nature of the problem, stakeholders, and what is already in place. Identifying and leveraging opportunities for advancing helmet use interventions is necessary for decision-makers and practitioners who work on safe mobility, sustainable development and the Decade of Action for Road Safety 2021–2030.

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