



Baseline



Methodological guidelines – KPI Helmet use among Cyclists and Powered two-wheelers (PTWs)

Version 2.1, April 28, 2021



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| Project: | This document has been prepared in the framework of the BASELINE project, for which a grant has been awarded by the European Commission. Information on this project can be found on the website www.baseline.vias.be |
| References: | (1) Grant agreement under the Connecting Europe Facility (CEF) No MOVE/C2/SUB/2019-558/CEF/PSA/SI2.835753 collection of Key Performance Indicators (KPIs) for road safety (2) Consortium agreement among the 19 partners of the Baseline project |
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| Publisher: | Vias institute, Brussels, Belgium (www.vias.be) |
| <i>Please refer to this document as follows:</i> “Moreau, N. et al. (2021). <i>Methodological guidelines – KPI Helmet use of Cyclists and Powered Two-wheelers (PTWs)</i> . Baseline project, Brussels: Vias institute” | |
| Any comments or feedback regarding these guidelines should be sent to baseline@vias.be . | |

Version history

| Version | Date | Changes |
|---------|------------------|--|
| 1.0 | January 22, 2021 | First draft version - intended as a framework to discuss methodological issues in the KPI expert group on helmet use |
| 2.0 | March 15, 2021 | Second draft version – incorporating all experts comments |
| 2.1 | March 17, 2021 | Minor adjustments |
| 2.2 | April 28, 2021 | Restructuration and minor additions and adjustments |
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1 Introduction and aims

The Communication of the European Commission “Europe on the Move – Sustainable Mobility for Europe: safe, connected and clean” of the 13th of May 2018 confirmed the EU's long-term goal of moving close to zero fatalities in road transport by 2050 and added that the same should be achieved for serious injuries. It also proposed new interim targets of reducing the number of road deaths by 50% between 2020 and 2030 as well as reducing the number of serious injuries by 50% in the same period. To measure progress, the most basic – and important – indicators are of course the result indicators on deaths and serious injuries.

In order to gain a much clearer understanding of the different issues that influence overall safety performance, the Commission has elaborated, in cooperation with Member State experts, a first set of key performance indicators (KPIs). The KPIs relate to main road safety challenges to be tackled, namely: (1) infrastructure safety, (2) vehicle safety, (3) safe road use including speed, alcohol, distraction and the use of protective equipment, and (4) emergency response. The aim of the KPIs is connected to EC target outcomes.

The aim of the BASELINE project, funded partially by the European Commission, is to assist participating Member States’ authorities in the collection and harmonized reporting of these KPIs and to contribute to building the capacity of Member States which have not yet collected and calculated the relevant data for the KPIs. The outcomes of this project will be used to set future European targets and goals based on the KPIs.

The purpose of this document is to further describe the minimal methodological requirements to qualify for the BASELINE KPIs for helmet use, defined as:

Percentage of riders of powered two-wheelers and bicycles wearing a protective helmet

As data must be presented separately for PTW riders and for cyclists, these guidelines actually concern two KPI measurements: one on helmet use among PTW riders and the other on helmet use among cyclists.

The minimal requirements set by the EC for this KPI are described in the Commission Staff Working Document SWD (2019) 283 (referred to as ‘SWD’). These requirements are quantified and specified in this document. This is mainly based on expert consultation (BASELINE Key Expert Group), on Hakkert et al. (2007), WHO (2006) and additional information provided by Ireland, Portugal, and Germany.

Next to the specification of the minimum requirements to deliver the main KPI and the disaggregated indicators (always marked bold), each section will also include optional supplementary methodological recommendations. Member States can decide whether to follow the minimal requirements only or to extend (part of) their methodology, depending on available means and own research questions.

The target audience of this document are the persons in the Member States participating in the BASELINE EC project that will collect and/or analyse the data to deliver the KPIs.

2 Scope

2.1 Vehicles

The UNECE Transport Glossary¹ includes the following definitions for the vehicles concerned:

- **BICYCLE:** A road vehicle which has two or more wheels and generally propelled by the muscular energy of the persons on that vehicle, in particular by means of a pedal system, lever or handle (e.g., bicycles, tricycles, quadricycles, and invalid carriages). Included are cycles with a supportive power unit (e.g., electric bikes).
- **MOPED:** A two or three-wheeled road motor vehicle which is fitted with an engine having a cylinder capacity of less than 50cc and a maximum authorized design speed in accordance with national regulations. Where limitations concerning the engine displacement are not applicable, a restriction in terms of motor power may be in force. This relates to categories L1 and L2 of the UN Consolidated Resolution on the Construction of Vehicles (R.E.3).

¹ https://unece.org/DAM/trans/main/wp6/pdfdocs/Glossary_for_Transport_Statistics_EN.pdf - see pages 39-40

- **MOTORCYCLE:** A two or three-wheeled road motor vehicle not exceeding 400 kg of unladen weight. All such vehicles with a cylinder capacity of 50cc or over are included, as are those under 50cc which do not meet the definition of moped. This relates to categories L3, L4 , L5 , L6 and L7 of the UN Consolidated Resolution on the Construction of Vehicles (R.E.3).

Although optional, it is recommended to provide a variable “vehicle type” including different vehicle types for both KPIs. For PTWs, we recommend making at least the distinction between “moped” and “motorcycle”; for bicycles, we suggest making at least the distinction between “bicycle” (non-electric) and “electric bike / e-bike”. Their specific categorization should be clearly defined and illustrated for readers.

2.2 Riders and passengers

The objective of the roadside observation study is to estimate **the percentage of powered two-wheelers (P2Wers) (motorcycles and mopeds) and cyclists (including electric bicycles) wearing a protective helmet.** Therefore, the theoretical population for these two KPIs refers to the total number of kilometres ridden over the national territory by P2Wers and by cyclists. Hence, by weighting the results by number of kilometres ridden (or a proxy of traffic volume), the percentage of riders wearing a helmet will also reflect the percentage of kilometres ridden with a helmet.

For cyclists, data for children (0-14 years old) should be shown separately. If national legislation makes cycle helmets compulsory for children, but using another age limit (e.g., up to 10 years old), this age category should be added (i.e., data should be shown separately for children aged “0-10”, for those aged “11- 14” and for people older than 14“≥15”).

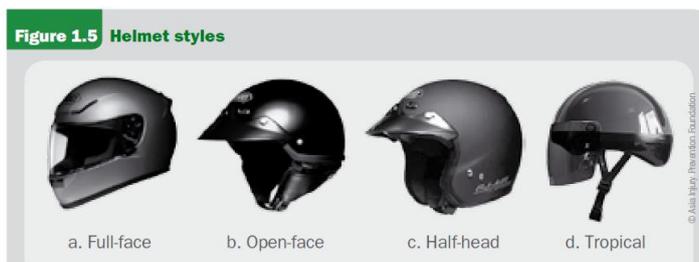
2.3 Protective helmet

As Hakkert and colleagues (2007) have highlighted: “Under the term helmet, we understand a crash/safety helmet designed for two wheelers, whether motorized or non-motorized.” Examples of types of helmets are shown in the figures below:

- Helmets for cyclists²:



- Helmets for motorcyclists (WHO, 2006):



As legislation on helmet use can vary between countries, it is requested that all countries document their legislation on helmet use regarding each type of vehicle.

² https://en.wikipedia.org/wiki/Bicycle_helmet

2.4 Road types

The KPI should cover use of helmets on **motorways, rural non-motorway roads, and urban areas**. Obviously, motorways are only relevant for motorcyclists and not for cyclists and moped riders. This is the assumption in the rest of this document. Rural non-motorway roads are to be interpreted as roads outside built-up areas and urban roads as roads inside built-up areas. The results should be presented separately for these three different road types.

The proportion of observations sampled for each of the three road types should be above 20% to ensure a minimal number of observations for each stratum, even if this would imply disproportional sampling. The three road types should be well defined in the methodology (e.g., typical characteristics, traffic signs, speed regimes, number of lanes, ...).

3 Sample size and choice of observation locations

3.1 Introduction

The methodological guidelines for all KPIs are designed to ensure international comparability between KPI values while taking into account feasibility and affordability. To that end the methodological guidelines have been defined in such a way that accurate and representative results can be obtained for all parameters of interest at a reasonable cost.

Obviously, the larger the sample of observations and locations for observation, the more accurate the KPI estimates for the different strata will be (e.g. a KPI value for a particular type of road, or a particular part of the week). Increasing the number of observations and locations however implies increasing field work costs. Statistically, the required minimum sample size depends mainly on the desired accuracy of the final estimates, for which no absolute value can be determined *a priori*. Therefore, for the main KPI estimates a pragmatic evaluation was made of the expected confidence intervals at different sample sizes and population parameters. Giving priority to feasibility and affordability, as a rule of thumb the minimum total number of observations was set at 2,000, the minimum number of observations for different strata at 500. It was agreed that this should allow to identify statistically meaningful differences between countries at an affordable price. For some countries, this will imply disproportionate sampling of certain strata compared to the distribution of traffic volumes over different strata. This is however required to allow statistically meaningful international comparisons at the level of each of the strata at interest.

The same pragmatic logic was followed for determining the minimum number of 10 locations for observation for each of the required road types of interest. Once again, there is no statistical rationale for determining the required minimum number of locations to ensure representativeness of the observations for the entire country. This mainly depends on the amount of variance between locations and within a country. Giving priority to affordability, a rule of thumb was also used to define the minimum number of locations at 10 per stratum. In order to ensure representativeness for the entire country larger numbers of locations might be required for larger countries. Taking field work costs into account, it was however decided to only identify the minimum requirements and leave decisions on the final number of locations to the discretion of the member states. Equally importantly, in order to ensure representativeness of the measurement locations these should be randomly selected as far as possible.

The main objective in defining the minimum methodological requirements is to keep a balance between affordability of the field work and the requirements to make meaningful international and historical comparisons. Therefore, the emphasis is placed on the minimum requirements that can also be taken into account by smaller countries. It is however of interest to any member state to increase the accuracy of the KPI estimates by boosting the number of locations and the number of observations.

3.2 Minimal sample size

A minimum of **2,000 observations overall** is recommended **for each of the two KPIs on helmet use** (e.g., 2,000 PTWs and 2,000 bikes). For the first stratification level (e.g., road type), a minimum of 500 observations per stratum is recommended. Countries that are not able to achieve the minimum requested number of observations will need to indicate the reasons in the methodological report (see last paragraph in the section on expected results).

When considering the minimal sample size, it should be noted that this refers to number of **observations that include the minimal requested data** (i.e., excluding observations with missing values in relation to the minimal requested data). The minimum number of observations should be understood as the minimum number of vehicles observed. Some of the vehicles observed will have not just a rider but also a passenger.

For more information on the determination of the minimal sample size and for the random sampling of locations, the SafetyNet general recommendations for SPIs (safety performance indicators) can be consulted: http://www.dacota-project.eu/Links/erso/safetynet/fixed/WP3/sn_wp3_d3p8_spi_manual.pdf

3.3 Stratifications and subpopulations

SWD requires to take into account:

- **Road types (3):** motorways (only for motorcycles), other rural roads (or roads outside built-up areas), and urban roads (or roads inside built-up areas).
- **Periods (2):** weekday / weekend day.

Unless nation-wide surveys support the absence of major regional differences, countries might have to consider an additional stratum related to regions.

Since the overall estimate is expected to be representative for the total of all kilometres driven in a country, theoretically the optimal strategy to estimate the overall prevalence would be to sample all strata according to traffic volume of each combination of the different strata. This strategy would, however, be detrimental for the accuracy of specific low volume strata that are of interest. Certain road types could have a lower traffic volume than others, as do weekends compared to weekdays. As a result, a strictly proportional sampling would lead to much smaller confidence intervals for certain strata.

For representativeness, the recommended **minimum numbers of locations** are therefore:

- 10 locations per stratum in the first stratification level (i.e., in this KPI, 10 locations for each of the 3 road types; and 10 locations for each of the two periods (week/weekend))
- at least 2 locations for each stratification combination (e.g., 3 road types X 2 periods = 6 combinations and a minimum of 2 locations in each combination.).

3.4 Selection of locations

The selection of locations should be as **random** as possible, covering the geographical area of the country, optionally using regions like NUTS₁ regions (e.g., stratified random sample). The basic process for the choice of locations consists of three steps:

- (1) The required number of different locations (for the country or per region) is determined.
- (2) The number of locations is randomly selected on the map using the entire area under consideration (e.g., country or region), taking a sufficient geographical spread into account. The specific requirements for each location do not have to be taken into account at this point. This step is to ensure a reasonable geographical spread of the randomly selected locations.
- (3) The final locations that will be used for the observations are manually chosen in the area surrounding the locations randomly selected in the previous step. At this point, the final selection must be based on the location requirements (different road types), inclusion/exclusion criteria (if applicable), and practical considerations. This final selection may be done using Google Street View. Care should be taken to ensure that the different road types are also sufficiently geographically spread.

A convenient way of selecting locations randomly (step 2) is to use a GIS system (e.g. cartographic software like ARCVIEW/ARCGIS) as such software can automatically select location points within defined areas randomly (e.g., <https://desktop.arcgis.com/en/arcmap/latest/extensions/geostatistical-analyst/an-introduction-to-sampling-monitoring-networks.htm>). If Member States have no GIS software, step 2 can also be carried out manually using a national geographic map, e.g., Google Maps/Google Earth.

A random selection of locations will often include locations with low traffic flow for each stratum. If traffic flow is too low, it is acceptable not to include these locations. A minimum traffic flow for selecting a location can be defined as at least 10 relevant vehicles (PTWs or cyclists) per hour. Also, locations where the composition of the traffic deviates significantly from normal traffic (e.g., locations where 90% of the cyclists are sports cyclists) should be avoided.

If it is not possible to identify 10 locations with at least 10 relevant vehicles per hour for the 1st stratification level indicators, we recommend different alternative strategies to reach the minimum number of observations:

- including summer months in the measurement period to increase the probability of traffic volume for PTWs and cyclists;
- increasing the number of locations (with few vehicles per hour)

If these strategies do not allow to reach the minimum number of observations within factors of the 1st stratification level, it will be accepted to exclude these stratification level indicators. Countries facing this issue will estimate the KPI per available stratification level and no national KPI will be estimated.

The method used for location selection should be described in the methodological report. The rationale for choosing the observation locations should be provided. Basic characteristics of the locations should be recorded: coordinates (if possible), address or other geographical information, target lane or path and direction to be observed, traffic signs, speed regime, number of lanes, traffic flow and visibility of the traffic from the location.

4 Observation method

4.1 Direct observation

SWD prescribes **direct observation** as the data collection method and allows the use of **cameras** if appropriate. Direct observation should preferably be carried out along the roadside (or another convenient place). If the use of cameras is adopted, they should not be installed exclusively on one type of road so as to avoid selection bias.

For both KPIs, observations of helmet use on urban and rural roads can be carried out from a safe place along the road, preferably at locations where driving speed is reduced relative to the speed limit, such as intersections. For PTWs on motorways, observations of helmet use could be carried out at the last intersection before on-ramps, at the first intersection after an off-ramp, after the exit to a petrol station, or from the bridge over the motorway.

4.2 Observation procedure

For both KPIs on helmet use, the most straightforward approach involves observing one bike or PTW, encoding the data, and then observing the next passing bike/PTW. When it is not possible to code the observational data for all the road users who pass by, cyclists and PTW riders should be randomly selected from all the possible road users at the observation location. The easiest and most efficient way is after coding one observation to observe the next passing target road user.

The observations must be made by well-trained independent observers (not uniformed police or other officers) under the supervision of a coordinator. Observers should receive rigorous theoretical and practical training and be given clear guidelines about the road section and traffic direction they should observe, the duration of observation periods and how to manage any potential difficulty that would hamper the data collection. They should be given clear guidance on the procedure to be followed when observations cannot be performed (due to weather conditions, concerns with visibility, safety problems, etc.) (Hakkert & Gitelman, 2007). Wherever possible, it will be valuable to ensure consistency between observers (the inter-rater reliability) before the start of and during the fieldwork.

It is recommended that the KPIs on helmet use are measured by two observers (one for PTW riders and one for cyclists). If data for both KPIs are collected during the same measurement by only one observer, a rule should be defined to determine the next observation subject (cyclist or PTW) in the case of high traffic volumes.

One observation session should last at least 30 minutes (ideally 1 hour), excluding the time needed for counting traffic and collecting environmental data (see section 5.2). Each observation location can be used for different observation sessions (at different time intervals) or each location can be assigned (randomly) to a specific time interval.

The fieldwork procedure should be described in the methodological report.

4.3 Temporal requirements

Data collection should be carried out during daylight hours; observations should cover all the daytime. One may organize the observation sessions during different periods of the day (e.g. morning, noon, evening) or taking account of peak hours (e.g. 07:30 to 10:30 (AM peak), 12:00-15:00 (Inter-Peak) and 16:00 to 19:00 (PM peak)). In such cases, it is recommended that each location is observed during all the different periods. Dates and hours of the measurements should be reported in the meta-data.

Helmet use has to be observed both during **weekends** and during **weekdays**, because the purpose and duration of riding may vary considerably between weekdays and weekends. The KPIs should be presented separately for weekdays (excluding bank holidays) and weekends.

When planning the observation periods, one should ensure a balanced combination of road types and time periods, in order to avoid a systematic sample bias (e.g. all motorway observations at the weekend and all other roads on weekdays; or all motorway sessions in the morning and all urban sessions in the afternoon). The same balance should be sought across all combinations of periods and other time considerations, avoiding, for example, all the sessions during the weekdays being planned for the morning only.

It is recommended to implement the measurement at the **end of spring or at the beginning of autumn**. In principle, all months are allowed except December, January, July, and August (in some Member States June also). However, for countries facing difficulties in reaching the minimal number of observations, the measurement can be extended to summer months. In the interests of representativeness, sessions during official feast days and holidays should be avoided.

Member States willing to measure helmet use during two seasons (in late spring and early autumn) can apply the minimal sample size requirements for the two measurements together. The data from both sets of observations can be combined to deliver the main and disaggregated indicators. When Member States have historical series of measurements, it is recommended to use the same period(s) of the year as for the earlier measurements.

4.4 Requirements for automatic detection via roadside cameras

SWD allows the use of cameras to collect data on helmet use by cyclists and PTW riders; after recording, the still or video images can be analysed to encode the data. In some applications, helmet detection is automatically performed by the software. There are some clear advantages in using cameras instead of observers, particularly in terms of, for example, reliability and duration of the observation sessions (including nighttime use, although this not relevant for the Baseline project).

Possible disadvantages should however be evaluated, such as privacy/GDPR issues (identifiability of riders) and the risk of lacking key variables. This technology should be tested and validated before use. On account of privacy issues, faces should not be caught on camera. Each country will have to deal with national requirements regarding the ethics and protection of private lives.

It should be ensured that the cameras are installed on all types of road to avoid selection bias.

4.5 Optional elements

4.5.1 Regions

Disaggregated data for regions is not part of the minimal requirements. Member States are free to choose supplementary stratifications by region within the country (e.g., NUTS 1 regions). One can consider collecting data from each region or from a representative selection of regions. Member States that want meaningful KPIs at regional level should apply the minimal methodological requirements to each region (see Section 3). If stratification by regions is used, results should be weighted according to traffic volumes by region.

4.5.2 Optional additional data collection

One may consider the observations as an opportunity to collect additional data related to helmet use or other behaviours among PTW riders and cyclists. Some examples to consider are:

- types of bicycle (electric or not, city/sport bike, ...)
- types of PTW (moped, e-moped, motorcycles of certain types, ...)
- type of helmet (full face, open face, half helmet, tropical, ...)
- correct use of the helmet (properly fastened, not properly fastened, not fastened at all, and wearing the helmet backwards) (WHO, 2006).
- use of other protective equipment (gloves, jacket, trousers, shoes, ...) (Hakkert & Gitelman, 2007).
- the colour of the helmet (dark, with lights, reflective, ...)
- wearing of reflective clothing
- private or a public/shared vehicle
- professional/non-professional rider
- gender
- age category
- wearing earphones (only for cyclists)
- using mobile phone
- ...

5 Data analysis

5.1 Statistical analysis and post stratification weights

Since sampling will typically be nested in locations, for statistical analysis it is recommended to use models for two-stage stratified cluster sampling (e.g., 1st stage= road type and 2nd stage= period). Approximations assuming simple random sampling can be used as long as results are weighted according to traffic volumes.

For each level of stratification, results should be weighted according to traffic volumes by level of stratification. For these 2 KPIs, this implies that the results should minimally be weighted according to traffic volume data by type of road and period of the week (weekdays/weekend). Traffic volumes can either be inferred from existing national mobility data or estimated by using traffic counts during the observations. When traffic counts are used to infer traffic volumes per stratum, road network length by type of road should be considered (see Section 5.2).

If other stratification criteria are considered (e.g., regions), then the weighting should take them into account (e.g., traffic volume data by region, type of road and period of the week). It is recommended to use the exact values for each combination of stratification levels considered (e.g., traffic volume of PTWs on weekdays on motorways). If these

combined data are not available, the second-best option is to assume independence of all levels of stratification and use combinations of marginal totals to estimate specific combinations.

All methods used should clearly documented.

5.2 Traffic volume and traffic counts

The weighting by traffic volume for cyclists and PTWs in the country is ideally based on national mobility data (driven vehicle-kilometers). If such traffic volume data is not available, it is recommended to use a combination of data on road length with traffic counted during the observations. If no official data on road length are available, it is recommended to request estimates from experts from the relevant administration services.

For both KPIs on helmet use (among PTWs and among cyclists), traffic counts should be performed at each location and during each observation session. The purpose is to count all the relevant vehicles. For KPIs on helmet use, this means that each PTW or cycle who rides in the same direction as those who are being observed will be counted. Note that if the observers succeed in observing helmet use among all PTWs (or cyclists) who pass by, there will be no need for the traffic count as it will be equal to the number of observations.

It is recommended to count the traffic of PTWs and bikes for a minimum of 10 minutes (either 5 minutes before and 5 minutes after the observation, or 10 minutes in the middle of the observation session). These counts should then be extrapolated for the whole duration of the session.

It is stressed that traffic volume should also be counted even when national traffic volume statistics according to road type are available. This information is necessary to calculate the share of helmet users per observation session and to correctly calculate the confidence intervals and weighing factors.

6 Expected results

6.1 KPI values to be calculated

The main indicator is the percentage of riders wearing a helmet across all times and locations, separately for users of bikes and PTWs, and for riders and passengers. So overall there are 4 main KPIs for which a point estimate and a 95% confidence interval is to be calculated:

- riders of bicycles (including e-bikes)
- passengers of bicycles (including e-bikes)
- riders of PTWs (mopeds and motorcyclists)
- passengers of PTWs (mopeds and motorcyclists).

In some countries, the number of passenger observations is expected to be very low. Countries facing this limitation will not be included in the results on helmet use among passengers.

It is also recommended to distinguish values:

- for cyclists: values for children (0-14 years old) and older people separately; if national legislation requires children cyclists to wear helmets up to a certain age, this age category should be added (i.e. data should be shown separately for children aged “0-10”, for those aged “11- 14”, and for those older than 14 “≥15”)
- for PTWs: values for mopeds and motorcycles separately.

For each of the 4 main KPIs, it is also required to calculate a point estimate and a corresponding 95% confidence interval for the disaggregated levels:

- road type (3 levels) (motorways, rural non-motorway roads and urban areas)
- period of the week (2 levels) (weekdays and weekend days)
- region (if applicable).

It is recommended to provide specific estimates for combinations of levels (including the confidence interval).

Together with the above estimates, a methodological report should be submitted that describes the specificities of the methodology of the field work and the statistical techniques used to weight and analyse the results, and to calculate the CIs.

6.2 Calculation of confidence intervals

Assuming simple random sampling and depending on prevalence levels, the 95% confidence intervals (CI) for n=2,000 and n=500 are estimated using the formula:

$$CI = \text{prevalence} \pm z * \sqrt{\frac{\text{prevalence} (100 - \text{prevalence})}{n}}$$

| Prevalence | Lower bound, n=2,000 | Upper bound, n=2,000 | Lower bound, n=500 | Upper bound, n=500 |
|------------|----------------------|----------------------|--------------------|--------------------|
| 50% | 47.8% | 52.2% | 45.5% | 54.5% |
| 75% | 73.0% | 76.9% | 71.0% | 78.7% |
| 90% | 88.6% | 91.3% | 87.0% | 92.5% |

References

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- Helmets - A road safety manual for decision-makers and practitioners, WHO, 2006 (p 35) -
https://www.who.int/violence_injury_prevention/publications/road_traffic/helmet_manual.pdf

Annex

COMMISSION STAFF WORKING DOCUMENT

EU Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero", SWD (2019) 283 final

<https://ec.europa.eu/transport/sites/transport/files/legislation/swd20190283-roadsafety-vision-zero.pdf>

Rationale

The use of a protective helmet is often cited to be an essential passive safety measure for powered two-wheeler riders (for whom it is mandatory) and for cyclists.

Definition of the KPI

Percentage of riders of powered two-wheelers and bicycles wearing a protective helmet.

Minimum methodological requirements

| | |
|------------------------|---|
| Data collection method | Direct observation (if appropriate, using cameras). |
| Road type coverage | The indicator should cover motorways, non-urban roads and urban areas. The results could be presented separately for the three different road types if available. |
| Vehicle type | The indicator should include riders (also passengers) of powered two-wheelers (motorcycles and mopeds) and cyclists (including those riding power-assisted bicycles). Results should be disaggregated for driver and passengers. The results for bicycles should be presented separately. Where available, data for children should be shown separately, to take into account any legal requirements. |
| Location | Random sample (methodology for Member States to decide). |
| Time of day | Observations to take place during daylight. |
| Day of week | Separate observations for week days and weekend and data to be shown separately. |
| Month | Late spring, early autumn. |

NB: A note should accompany the results for cyclists stating the existing state of the legal requirements (or the absence of requirements) concerning helmet use.