

Compact accident research No. 98

# Accident risk of parking for pedestrians and cyclists



# Imprint

## Publisher

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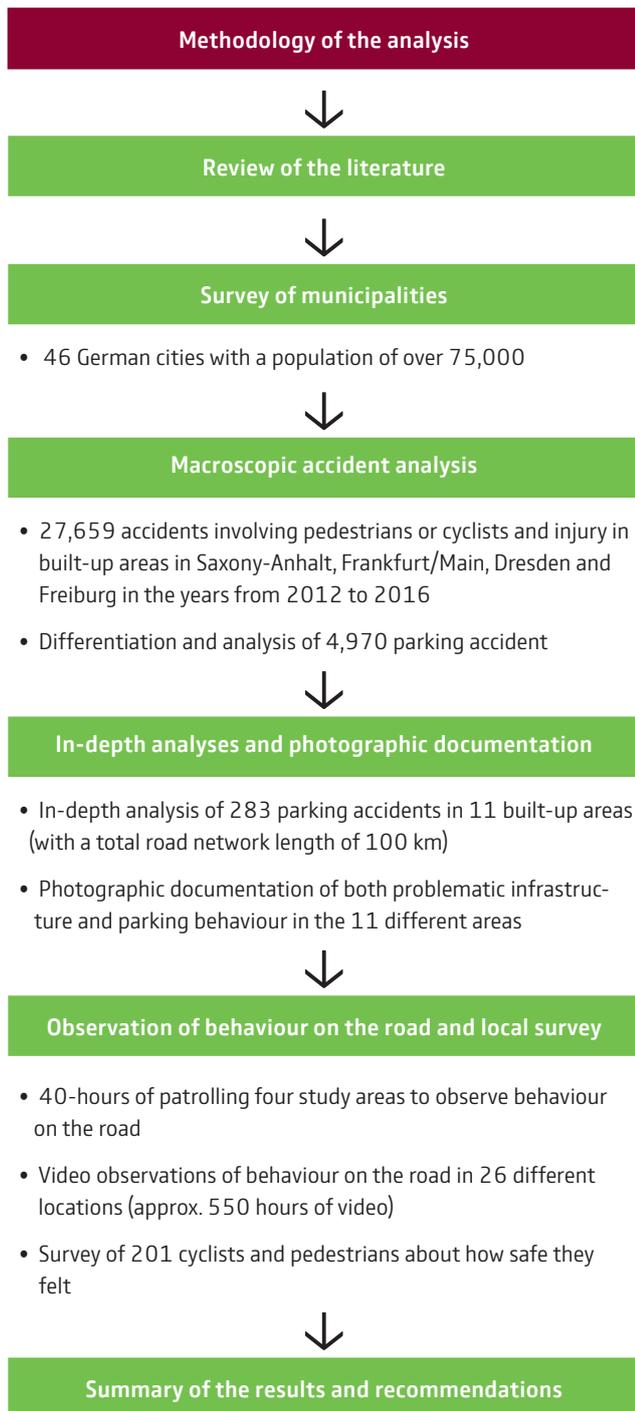
03/2020



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depth. The relevant police accident descriptions were then examined again manually. Both problematic infrastructure in the road network and parking behaviour were documented with photographs in the relevant locations and subsequently analysed.

In a further step, the behaviour of pedestrians and cyclists was observed during patrols of the relevant areas and by means of video recordings at fixed locations. A total of four 10-hour observation patrols were conducted, and almost 550 hours of video recordings were analysed. Situations in which parked or parking vehicles caused road users to adjust their behaviour either directly (as a result of a parking manoeuvre, for example) or indirectly (in cases in which these obstructed their view, for example) were of interest. In addition, at five prototypical locations in the 11 different areas, 131 pedestrians and 70 cyclists were asked how safe they felt and what they did to keep themselves safe.

Based on the results of the different stages of the study, recommendations were obtained on how to prevent accidents occurring in connection with parking.

**Figure 1:** Study methodology

## Review of the literature

The German Road Traffic Regulations (StVO) and the associated General Administrative Regulations (VwV-StVO) already contain numerous regulations that apply to parking. A central element of these is the 5-metre rule. This stipulates that before and after intersections and T-intersections, parking is not allowed less than 5 metres from the point at which the edges of the roads intersect (StVO section 12). The General Administrative Regulations (VwV-StVO) also require the no-parking zone to be suitably extended (by means of markings, for example) in cases where the 5-metre zone does not permit an adequate view of the other road or makes it difficult to turn off. In the German Directives for the Design of Urban Roads (RASt 2006), significantly larger no-parking zones are required than in the StVO. The RASt directives require a no-parking zone of 20 metres before and 15 metres after a crossing facility on roads with a speed limit of 50 km/h.

It became evident during the project that the way in which the regulation on cycling on the right is formulated (StVO section 2, paragraph 2) is also relevant in connection with parking accidents. It urges cyclists to keep as far as possible to the right, “not just when there is oncoming traffic, when being overtaken, where there are humps in the road, in bends or in situations where there is insufficient clarity”. This isn’t detailed enough and may be misunderstood by cyclists and cause them to cycle too close to parked vehicles.

Many municipalities consider illegal parking to be relevant to road safety and view the management and monitoring of parking as an effective means of preventing it (e.g. BAUER et al. 2016 and AGFS 2015).

A number of studies have demonstrated that parking pressure, parking frequency and the way in which parking spaces are laid out or designed have an effect on road safety (e.g. ALRUTZ et al. 2009, MAIER & ENKE 2009, AURICH 2012 and AURICH et al. 2015). Vehicles leaving parking spaces, vehicles reversing and vehicle doors being opened (dooring accidents) are commonly involved in accidents connected to parking (e.g. UDV 2015, JÄNSCH et al. 2015 and WANNENMACHER 2016). Other empirical findings already exist on the effects of parking on behaviour that may be relevant to safety. Parked vehicles at the side of the road are associated

with lower driving speeds on the road. However, these are not sufficiently low to compensate for the reductions in safety caused, for example, by parked vehicles obstructing people’s view (e.g. SCHÜLLER 2010 and EDQUIST et al. 2012).

Previous studies of parking assist systems in vehicles (e.g. reverse assistance cameras or sensors) have revealed further shortcomings, particularly when these systems require the intervention of drivers. Moreover, the studies also revealed that the assistance provided by the systems was sometimes counteracted by what drivers did. For example, they didn’t look over their shoulders as much when using the system (FÄRBER et al. 2017, KIDD & McCARTT 2016).

## Survey of municipalities

All 46 of the municipalities surveyed reported problems caused by parking pressure. To reduce parking pressure, the surveyed municipalities adopt various parking management measures. Very often, the right to use parking spaces is restricted (to residents, for example, or time restrictions are imposed). Overall, the municipalities value parking management as an effective approach.

A very large number of municipalities reported frequent parking violations at managed parking spaces, parking violations on sidewalks and parking in the vicinity of intersections or on the road. According to the municipalities, they monitor these parking violations on an incidental or random basis as a minimum. Parking violations in managed parking spaces are monitored most intensively.

To reduce the proportion of illegally parked vehicles, in many municipalities the frequency of monitoring is increased or vehicles are more often towed away. It is believed that both of these measures bring about at least a slight improvement in road safety. In addition, many cities try to reduce illegal parking by using signs or markings and consider these measures to be effective.

Structural measures, such as the installation of bollards or extending the kerb at certain points, thus widening the sidewalk and providing a good view of and for pedestrians who are about to cross the road, are used less often but considered to be more effective.

80 per cent of the municipalities stated that conflicts caused by parking that have an impact on safety are common. The municipal representatives stated that indirect conflicts resulting from an obstructed view are more common than direct conflicts where a vehicle is manoeuvring into or out of a parking space. In addition, almost half of the municipalities reported that delivery vehicles represent a hindrance.

Almost three-quarters of the municipalities surveyed stated that the 5-metre no-parking zones required by the StVO at intersections are not complied with by road users. Moreover, more than 40 per cent of the municipalities stated that a 5-metre zone is insufficient. Where there are longer zones, this is generally indicated by means of signs or markings.

## Significance of parking in the accident statistics

### Macroscopic accident analysis

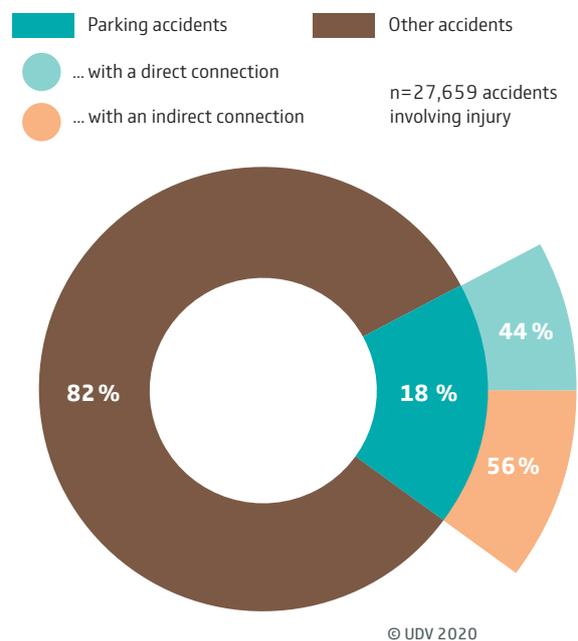
In the sample studied in the project, accidents involving stationary vehicles (defined as stopping for less than three minutes for a reason unrelated to the traffic situation) or parked/parking vehicles (in other words, accidents corresponding to accident type 5) accounted for a relatively small percentage (5%) of all pedestrian and cycling accidents involving injury in built-up areas. This corresponds roughly to the national percentage for all accidents of this type in built-up areas caused by stationary or parked/parking vehicles and involving injury (4.5% in the period from 2012 to 2016).

In addition, a large number of further accidents connected to parking were identified by means of an automated keyword search of the police accident descriptions in the sample. In this way, a total of 18 per cent of pedestrian and cycling accidents in built-up areas were found to be connected to parking (figure 2). Almost one in five accidents in built-up areas involving pedestrians or cyclists and injury is thus connected to parking. Accordingly, the actual impact of parking on road safety is more than three times as high as it appears when the accident figures are analysed exclusively by accident

type. Around two-thirds of the identified accidents are cycling accidents, while a third are pedestrian accidents.

### Almost one in five pedestrian and cycling accidents is connected to parking

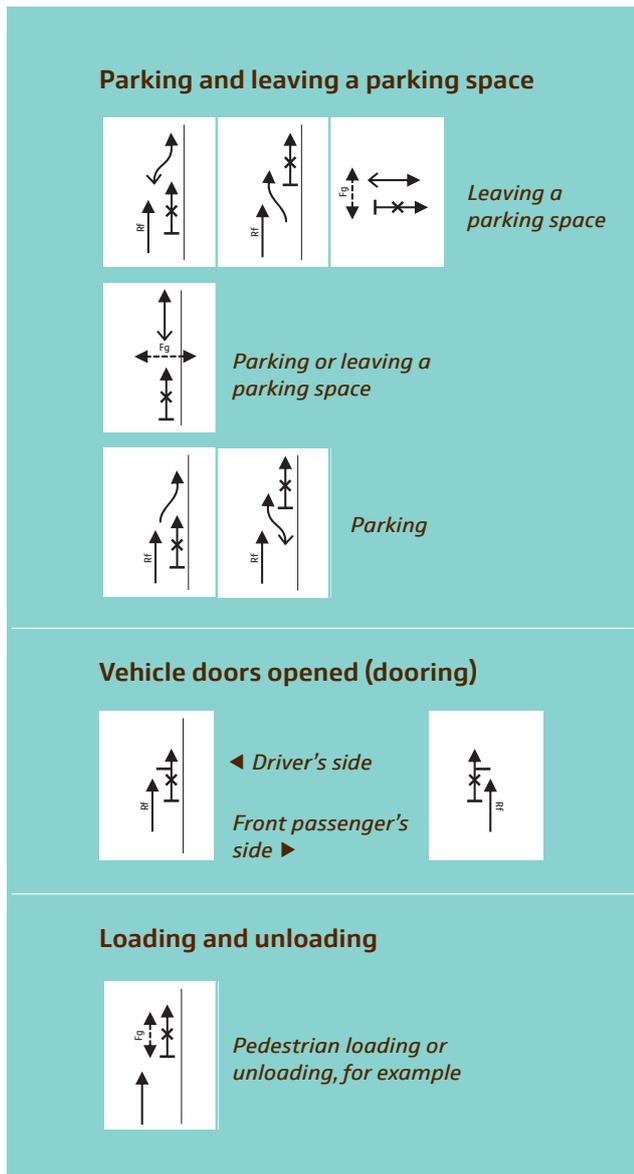
**Figure 2 · Accidents connected to parking as a percentage of all pedestrian and cycling accidents involving injury in built-up areas in the whole sample**



By combining different keywords with further variables of the accident data analysed (above all, the accident type), different accident constellations in connection with parking were differentiated. First, a distinction was drawn as to whether the identified accidents had a direct or indirect connection to parking. Accidents with a direct connection were those that occurred during a parking manoeuvre or when a vehicle's occupants were getting in or out (see figure 3). Accidents with an indirect connection, on the other hand, were those in which, for example, parked vehicles obstructed the view of pedestrians or cyclists, made it difficult to recognize intersections or entrances to properties or restricted the road space available (see figure 4). Indirect accidents accounted for 56 per cent of all the accidents identified in connection with parking (figure 2). Particularly in this group, many other accidents were found that were not covered by accident type 5.

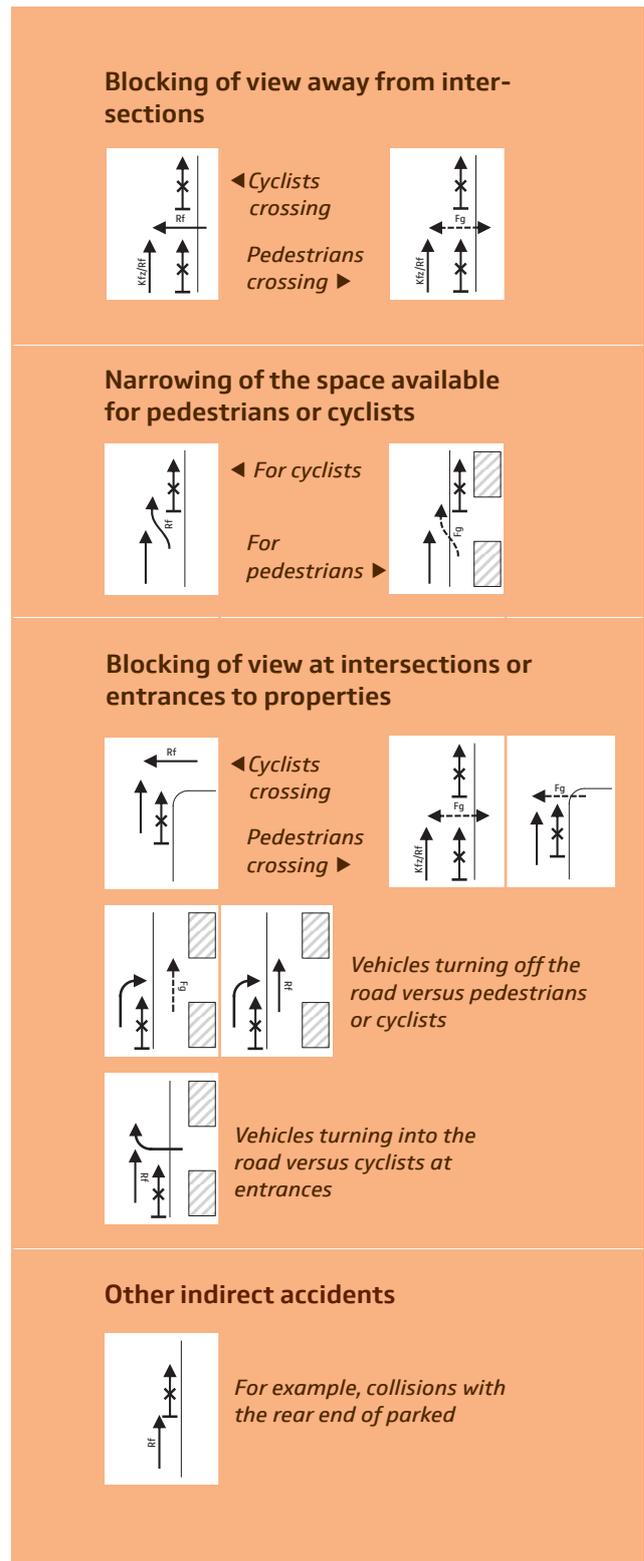
Accidents directly connected to parking (examples)

Figure 3



Accidents indirectly connected to parking (examples)

Figure 4



The three-digit accident type was also available for Saxony-Anhalt, so it was possible to differentiate the accident constellations for 1,432 accidents in even greater detail. It was found that very many of the accidents directly connected to parking were dooring accidents. These accounted for a total of 18 per cent of all identified parking accidents. Accidents involving pedestrians and cyclists while a vehicle was parking or leaving a parking space were also very common. Accidents indirectly connected to parking were often either accidents involving cyclists and an obstructed view at intersections and entrances to properties, or they were accidents involving crossing pedestrians and an obstructed view on stretches of road away from intersections (see table 1).

Moreover, an analysis of accident densities revealed that around 20 per cent more parking accidents per kilometre occurred on main roads than on local access roads.

### Detailed analysis

In the detailed analysis of 283 accidents in the 11 selected built-up study areas, there were some differences in the distribution of the various accident constellations compared to the macroanalysis (see table 1). Dooring accidents accounted for 41 per cent of the parking accidents identified in the detailed analysis, which was particularly high. Almost three-quarters of the dooring accidents happened on stretches of road used by both cyclists and motor vehicles in mixed traffic. A further 16 per cent of the accidents occurred on roads with marked cycle lanes. In 14 of the 17 cases, there was no safety strip separating the cycle lane from the parked vehicles. One in five dooring accidents in the 11 study areas occurred on roads with tram tracks that were flush with the road surface. Depending on the location of the tracks in the road cross-

## Specific accident constellations directly and indirectly connected to parking

Table 1

Influence	Group	Accident situation	Percentage	
			Macro-analysis*	Detailed analysis**
Direct	Accident between vehicle and pedestrian/cyclist	Manoeuvre to enter or leave a parking space	15 %	20 %
		Dooring	18 %	41 %
		Loading or unloading	0 %	0 %
		Other direct accidents	5 %	0 %
Indirect	View obstructed away from intersections	Crossing pedestrian	13 %	14 %
		Crossing cyclist	4 %	2 %
	View obstructed at intersections or entrances	Crossing pedestrian	2 %	0 %
		Vehicle turning off versus pedestrian	1 %	0,4 %
		Crossing cyclist	10 %	1 %
		Vehicle turning into the road versus cyclist (at an entrance)	10 %	3 %
		Vehicle turning off the road versus cyclist	6 %	2 %
	Narrowing of the space available	For pedestrians or cyclists	3 %	4 %
Other indirect accidents		12 %	12 %	

\* n = 1,432 pedestrian and cycling accidents involving injury connected to parking in built-up areas in Saxony-Anhalt

\*\* n = 283 pedestrian and cycling accidents involving injury connected to parking in 11 built-up study areas

section, cyclists may not be able to keep an adequate distance from parked vehicles without crossing the tracks. In addition, getting out of the way when vehicle doors are opened can cause cyclists to get caught in the tracks and fall. However, the descriptions of the accidents that were examined in the study did not make it explicitly clear whether these circumstances actually led to the accident. At the same time, it does seem self-evident that the tracks would have a negative effect. Cycling accidents connected to parking at intersections or entrances were not found in the 11 study areas as often as in the macro-analysis of the entire sample.

## Local inspections and photographic documentation

In the local inspections carried out in the 11 built-up study areas, typical parking violations and shortcomings of the infrastructure were documented that might be expected to have an impact on parking behaviour and road safety. Shortcomings of the infrastructure were defined as deviations from the applicable regulations.

Illegal parking at intersections was observed in all 11 study areas. This included non-compliance with the no-parking zones by intersections as stipulated in the StVO (the 5-metre rule) and non-compliance with signed or marked no-parking zones at intersections (see figure 5).

Double parking (parking on the road beside a vehicle that is already parked there and thus blocking it) also occurred in many of the study areas (see figure 6). Loading and unloading of double-parked vehicles occurred primarily in commercial areas, but it was also found in some cases in residential areas. In most cases, these were the vehicles of freight carriers or companies delivering goods purchased by mail order or online, both at intersections and on stretches of road away from intersections. However, the observed vehicles generally stopped only for a short time, and problematic conflicts with pedestrians or cyclists thus rarely occurred, even in the subsequent behavioural observation stage.

Parking on the sidewalk, marked cycle lanes, hatched areas on the road and entrances to properties on open stretches of road were also frequently observed (see figure 6).



Figure 5: Vehicles are often parked at intersections

The frequencies with which these violations occurred differed greatly between the different study areas.

In addition, shortcomings of the infrastructure were found in the study areas that may make accidents connected to parking more likely. On multiple roads in different areas, there were marked cycle lanes alongside parking strips without a safety strip between them (see figure 7). The cyclists were thus cycling right next to parked vehicles and exposed to danger when vehicle doors were opened suddenly. Parked vehicles were also often not completely within the markings of their parking spaces, which exacerbated the problem.



**Figure 6:** Double parking or parking on cycling facilities

It was striking in almost all study areas that there were roads where the boundary between the parking strips and the road or sidewalk was not clear. As a result of missing, worn or faded markings, above all, vehicles were parked poorly and at different distances from the road, the cycling facility or the sidewalk.

In many cases, errors made by road users and shortcomings of the infrastructure combined to worsen the situation in the study areas. Non-compliance with the width of parking spaces was particularly noticeable when marked parking spaces were very narrow. This was seen primarily in the case of parking spaces marked or laid out half on the sidewalk and half on the road.



**Figure 7:** The absence of a safety strip may make dooring accidents more likely

## Behavioural observation

The behaviour of a total of 1,605 crossing pedestrians and of 5,198 cyclists in longitudinal traffic was observed in the observation patrols and in the stationary video recordings.

Almost half of the pedestrians observed crossing the road were affected by parked vehicles (45%). In 95 per cent of the cases, these were legally parked vehicles. Only around one in four of the pedestrians (27%) affected in this way showed any visible signs of compensating for this by, for example, bending forward or stepping onto

the road carefully at first to check whether any vehicles were coming. Conflicts were frequently observed when pedestrians stepped onto the road suddenly between parked vehicles or crossed behind vehicles that were reversing into or out of a parking space (see figure 8). Such cases were also frequently found in the macroscopic accident analysis.



**Figure 8:** Pedestrians were frequently observed crossing between parked vehicles, which is dangerous

The 5,198 cyclists observed in longitudinal traffic rarely made directly visible adjustments to their cycling due to parked vehicles (only in 5% of cases). The extent to which cyclists maintained a greater distance from parked vehicles than from the edge of the road in locations where there were no parked vehicles was not studied. Where cyclists made visible adjustments, in 70 per cent of cases

this was due to illegally parked vehicles. These were generally vehicles that were parked or waiting on the marked cycle lane or were double parked. Adjustments were observed in a few cases when vehicles were reversing into parking spaces or vehicle doors were opened. The cyclists generally just swerved to avoid them; they rarely braked or accelerated.

In addition, cyclists were often observed cycling close to parked vehicles and passing on the right of stationary vehicles. Both of these behaviours can lead to dooring accidents, and these were found frequently in the accident analysis.

## Local surveys

The on-the-spot survey of 131 pedestrians and 70 cyclists revealed that they often felt bothered by parked vehicles but not automatically less safe. They often tried to compensate for the restricted view or reduction in safety associated with parked vehicles by behaving in a more safety-conscious way.

For example, the respondents rated the view of the traffic at intersections where the 5-metre rule had been violated as worse than at intersections where there were no vehicles within the 5-metre no-parking zone. However, this did not have a statistically significant impact on how safe the pedestrians and cyclists felt.

Over half of the pedestrians surveyed stated that, when their view was impaired, they inched forward carefully and slowly when about to cross the road. Some of them reported listening for traffic more carefully. Only a few of the pedestrians were prepared to walk further in order to cross at points offering a better view of the road.

The great majority of cyclists surveyed (91%) reported that they cycled differently on roads with parked vehicles. 80 per cent of the cyclists reported cycling with greater focus and attention. Around half of them stated that they kept a greater distance from parked vehicles. Only a few of them (3%) reported choosing a different route to avoid roads with parked vehicles.

Illegal parking on the sidewalk or the cycling facility was the parking violation mentioned most often as being a problem by both pedestrians (55%) and cyclists (81%). Almost all of the cyclists and more than three-quarters

of the pedestrians who were bothered by this also considered it dangerous. More than one in four surveyed pedestrians and cyclists were also bothered by illegal parking at intersections (violation of the 5-metre rule in the StVO) and considered it dangerous.

The respondents were also asked about conflicts they had experienced. The cyclists reported having experienced significantly more conflicts with parked vehicles than the pedestrians did. For both pedestrians and cyclists, indirect conflicts accounted for around two-thirds of the conflicts reported. Conflicts with moving traffic as a result of avoiding a double-parked vehicle or a vehicle parked on a cycling facility were reported most often (see table 2). The percentage of conflicts that resulted in accidents was higher for cyclists than pedestrians (23% compared to 11%)

## Conflicts connected to parking that were most often reported by the road users surveyed

Table 2

Road users	Direct/ indirect conflict	Description of the conflict	Percentage of respondents reporting a conflict	Reported conflicts resulting in accidents
Cyclists	 Indirect	Conflict with moving traffic as a result of avoiding a double-parked vehicle or a vehicle parked on a marked cycling facility	41 of 70	3 of 41
Cyclists	 Direct	Conflict as a result of a vehicle door being opened (dooring)	17 of 70	3 of 17
Cyclists	 Direct	Conflict with a vehicle entering or leaving a parking space	14 of 70	4 of 14
Cyclists	 Indirect	Conflict with a vehicle turning off as a result of the view at the intersection being blocked by parked vehicles	10 of 70	0 of 10
Pedestrians			9 of 131	0 of 9

Database: 94 conflicts reported by 70 cyclists, 26 conflicts reported by 131 pedestrians

## Summary

As the study shows, the influence of parking on the incidence of accidents is significantly greater than would appear from an analysis based purely on accident type 5 (accidents involving stationary or parked/parking vehicles). A detailed analysis of the descriptions of a large sample of pedestrian and cycling accidents involving injury in built-up areas indicated that almost one in five of these accidents was connected to parking. Around two-thirds of the accidents identified were cycling accidents, while about a third were pedestrian accidents.

The biggest problems were dooring accidents involving cyclists and accidents where parked vehicles obstructed the view. Dooring accidents accounted for 18 per cent of the total sample and thus represented the most common of the different accident situations connected to parking. In the 11 built-up areas studied in depth, they accounted for as much as 41 per cent of the total.

More than half of the parking accidents identified were indirectly connected to parking. Accidents in which parked vehicles restricted the view of the road users played a particularly prominent role here. Most affected by this were pedestrians emerging from between parked vehicles to cross a road some distance away from any intersections and cyclists cycling straight ahead at intersections and entrances to properties. Illegal parking was a particular problem for cyclists. The majority of pedestrians, on the other hand, were affected by legally parked vehicles.

Cyclists were only very rarely observed taking directly visible action to compensate for the presence of parked vehicles (changing course to avoid the vehicles, accelerating or braking, above all). However, many of the cyclists surveyed did at least state that they cycled with increased focus and attention when passing parked vehicles or generally kept a greater distance away from them. Nevertheless, short distances between cyclists and parked vehicles were often seen in the behavioural observation stage of the study. Only just under half of the pedestrians showed visible signs of taking compensatory action when affected by parked vehicles. In these cases, they generally bent forward or stepped onto the road very carefully in order to see whether there were any vehicles coming.

The study also revealed various shortcomings of the infrastructure that can make accidents connected to parking more likely. These included, in particular, the absence of a safety strip next to parked vehicles, a lack of parking spaces, a lack of clarity in the layout of parking spaces and missing, worn or faded markings. Although many municipalities stated that structural measures were highly effective in preventing illegal parking, such measures were rarely taken.

## Recommendations

Based on the results of the research project, the UDV recommends the following measures to prevent pedestrian and cycling accidents connected to parking

### Ensure adequate space at the side of parked vehicles

- In cases where cyclists are required to use the road (either in a cycle lane or in mixed traffic with other vehicles), a safety strip should always be marked next to parked vehicles.
- There should also be sufficient buffer space provided between the parking spaces and the sidewalk, because parts of the vehicles overhang beyond the parking space when they enter or leave it.
- The way that the regulation on cycling on the right (StVO section 2, paragraph 2) is currently formulated is misleading for cyclists and may cause them to cycle too close to parked vehicles. This should be clarified to explicitly stipulate that, while cyclists must keep to the right, they must also maintain an adequate distance from parked vehicles.

### Ensure adequate lines of sight by effectively preventing parking in inappropriate locations

- The no-parking zone stipulated by the StVO that extends 5 metres from intersections is not enough to ensure an adequate view for and of crossing pedestrians and cyclists. Section 12, paragraph 3 of the StVO should be amended accordingly. On roads with a speed limit of 50 km/h or more, parking at the side of the road should not be allowed for 20 metres before and 15 metres after an intersection, T-intersection or any other crossing point for pedestrians or cyclists. On roads with a lower speed limit, parking should not be allowed for 10 metres before and 5 metres after.

- If a municipality decides that parking is to be permitted close to an intersection or crossing point, the lines of sight should be kept free by structural measures (kerbs, bollards, etc.), and the sidewalk should be extended to the edge of the road and possibly protrude into it.

- Any parking at entrances to properties should not prevent drivers who are turning off the road into the entrance or into the road from the entrance from having an adequate view of pedestrians and cyclists in the space at the side of the road or on the road. To achieve this, parking should generally be prevented by structural means (or by means of bollards) for at least 10 metres before the entrance to the property. The General Administrative Regulations of the StVO (VwV-StVO) should be amended to take these aspects into account.

- To prevent pedestrians from crossing the road from between parked vehicles lining the road, suitable crossing facilities must be provided at points where there is high demand to cross. Where pedestrians want to cross all along a stretch of road, facilities such as central reservations or islands must be provided.

### Take measures to introduce vehicle systems

- To prevent dooring accidents, vehicle systems should be developed that either warn vehicle occupants that cyclists are approaching before they open the doors or simply prevent the doors from being opened. The use of these systems in vehicles should be encouraged.
- In addition, autonomous emergency braking (AEB) can prevent or at least mitigate the consequences of accidents involving pedestrians or cyclists who suddenly emerge from behind parked vehicles. Any measures that contribute to these systems being more widely introduced should be encouraged in order to prevent accidents connected to parking.

### **Intensify monitoring of and impose harsher sanctions for illegal parking**

- The focus of the monitoring of illegal parking should shift further towards violations that have an impact on safety. These include, above all, parking that blocks lines of sight at intersections, crossing facilities and entrances to properties, double parking, and parking on cycling facilities and sidewalks.
- Since the police and municipalities generally have limited capacity available for monitoring purposes, the fines and sanctions imposed for traffic-related offences should be revised. Harsher sanctions must be imposed for the parking violations described above, in particular, in order to maximize the deterrent effect.

### **Promote road safety and educate road users**

- Campaigns focusing on dooring accidents should warn cyclists to constantly maintain an adequate distance from parked vehicles. It should also be made clear to drivers that, although cyclists on the road are meant to keep to the right, they should not be so far to the right that they endanger either themselves or other road users.
- In addition, pedestrians should be made more aware of the importance of crossing the road at the intended points, where safety features of various kinds are provided, and it should be made clear to drivers that parking legally is important in terms of safety.

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A large grid of small dots, intended for taking notes.





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