International Transport Forum

The Safety of Bike Share Systems
Discussion Paper

168
Roundtable

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The International Transport Forum

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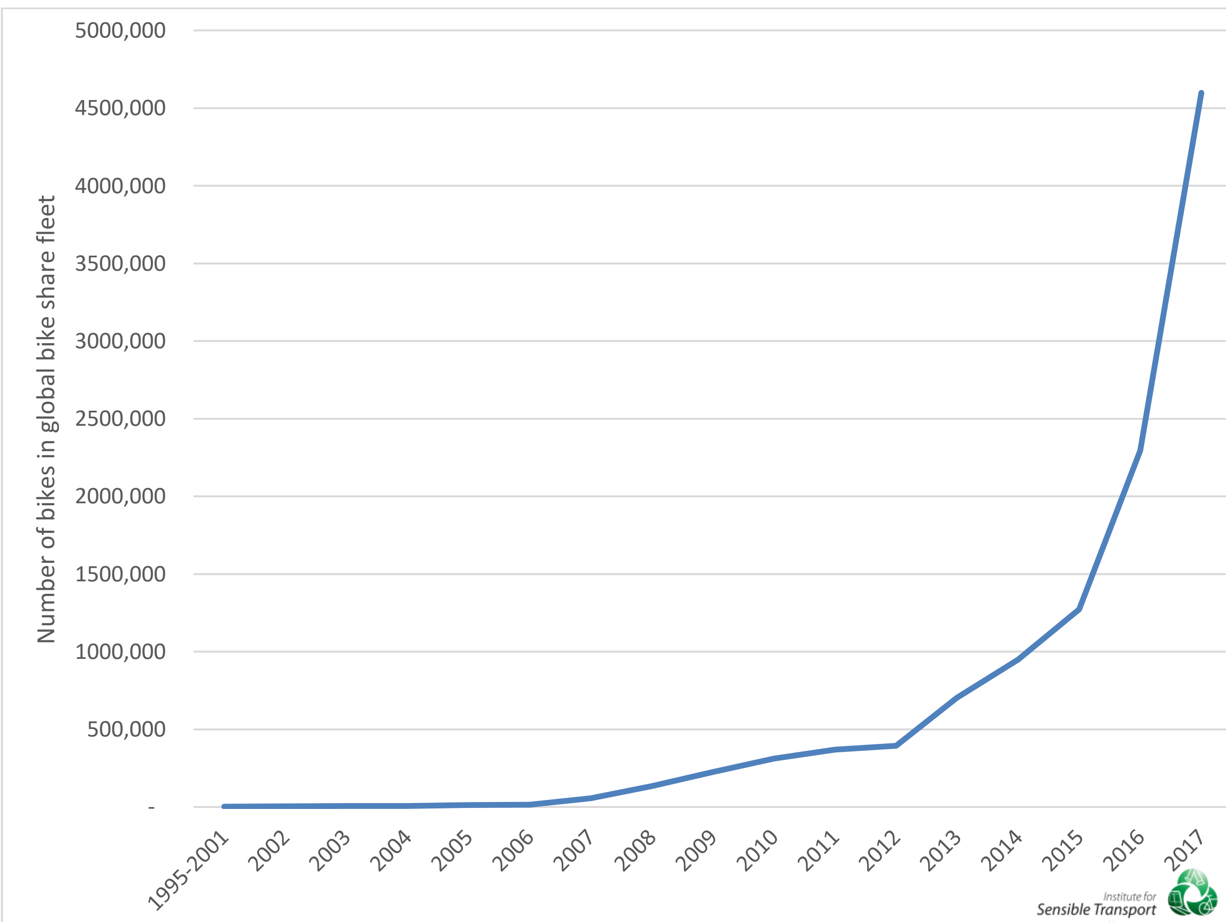
Introduction

Bike share systems are one of the fastest growing modes of transport globally. Up from just a handful of cities in the late 1990s, there are now well over 1 000 cities with bike share, and a global fleet of over 4.5 million bikes. In the last 12 months in particular, a dramatic increase in the number of bike share systems and bikes have been recorded, due largely to the emergence of dockless bike share. As shown in Figure 1, there was a rise in bike share around 2005-07, but the sharpest increase has been in the last two years, with dockless bike share accounting for the majority of this growth.

Figure 1. **Global growth of the bike share fleet**



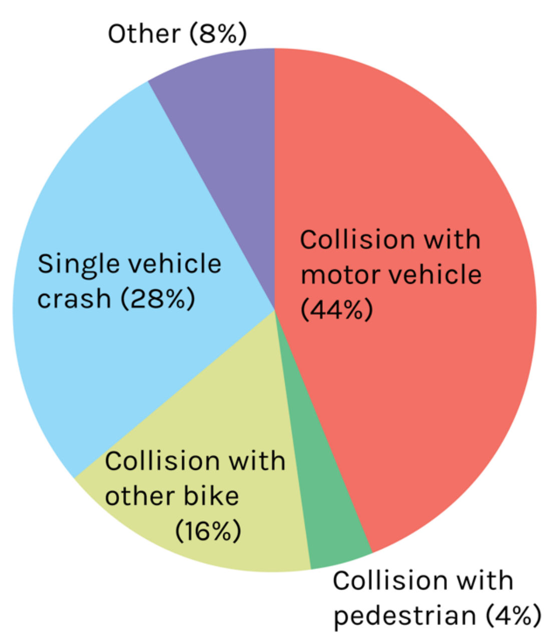
Source: Russell Meddin, 2018

Over a decade ago, Jacobsen (2003) published his landmark paper on 'Safety In Numbers' (SIN), showing that cyclists are less likely to be injured where volumes of cyclists are higher. This spurred more research into the SIN phenomenon (Elvik, 2009; Elvik and Bjørnskau, 2017; Schepers, et al., 2017). This paper aims to add to this branch of research by comparing crash risks of 'general bicycle riders' to those of bike share users. This is directly relevant to SIN because volumes of cycling are (or become) typically higher where bike share programs are introduced.

Over the last five years in particular, bike share safety has attracted a lot of attention (Bernstein, 2014). Prior to the introduction of North America's largest bike share program in New York City, a bicycle researcher was quoted in the New York Times predicting *'at least a doubling and possibly even a tripling in injuries and fatalities among cyclists and pedestrians during the first year'* (Flegenheimer, 2013). This serves to highlight the safety concerns associated with bike share have been prominent at times, particularly around the launch of new programs. As of February, 2018, only one fatality had been recorded on the New York City bike share program, since it began in May 2013.

However, scientific research on the safety of bike share users is scarce (Fishman & Schepers, 2016). The bike share literature, whilst all relatively recent, tackles a wide range of issues, from technological advancements (Ji et al., 2014), approaches to tracking bicycle movements and rebalancing (Luong et al., 2014), research on bike share barriers and facilitators (Fishman et al., 2012), and quantification of impacts (Fishman, 2015; Fishman et al., 2014, Fishman et al., 2015; Fuller et al., 2013). Even though bike share has rapidly emerged as a new transport option in over 1 000 cities, from less than a dozen little more than a decade ago (Fishman, 2015), research on crash risk of bike share users is scarce. Data provided by the operators of the Montreal bike share program is displayed in Figure 2 and shows that almost half of all reported crashes involved a motor vehicle. This type of reporting is the exception rather than the rule, and none of the operators contacted as part of this study were able to provide a breakdown in the manner shown in Figure 2.

Figure 2. **Reported crash type, Montreal bike share (2013)**



Source: BIXI Montreal (2014)

Safety issues that have been addressed in research are operational cycling speed and helmet use. A higher cycling speed may be related to more severe crashes (Hu et al., 2014; Schepers et al., 2014). A study among bike share users in Lyon showed that average operational speed - in real conditions and for average users - was 13.5 km/h, with lowest speeds recorded on weekends (10km/h) and fastest average speeds (15km/h) on weekday mornings (Jensen et al., 2010). Studies on general bike operational speeds in other countries tend to vary between 16 and 26 km/h meaning that operational speeds for bike share users are low (Schepers et al., 2017). Bicycle helmets have been found to protect against head injuries (Elvik, 2011; Elvik and Bjørnskau, 2017). Helmets and bike share has been a contentious issue, with cities having to weigh the benefits of helmets in the event of a collision et al., 2010), with the difficulties of incorporating helmets within a bike share program (Fishman, 2016), such as losses from theft and hygiene concerns. Cities such as Tel Aviv and Mexico City repealed their helmet laws to pave the way for the introduction of their bike share programs (Sadik-Khan and Solomonow, 2016). Observational studies conducted in Boston, Washington, DC, and London found private bike riders were four times more likely to wear a helmet (Fischer et al., 2012). In line with these results, Graves et al. (2014) found the proportion of head injuries among bicycle-related injuries to increase in North American cities after introduction of a bike share program.

To summarise, bike share users tend to ride at lower speeds and are reluctant to wear helmets. As the former is likely to improve cycling safety while the latter compromises cycling safety, behavioural research is not suitable to formulate hypotheses about safety. To our best knowledge, the only study including crash risk is by Woodcock et al. (2014) on the health impact of London's bike share program, which included road safety risk. The observed injury risks while using the cycle hire scheme were found to be lower than those estimated for cycling in general. The difference was significant for slight injuries and almost significant for serious injuries (Woodcock et al., 2014). Drawing firm conclusions has to be done with caution because, according to Woodcock et al. (2014), the analyses for serious injuries and fatalities were underpowered.

As research on crash risk of bike share schemes is scarce, this study sets out to examine the impact of bike share programs on cyclist's crash risk. Based on the Woodcock et al. (2014) study we hypothesize that bike share programs are associated with lower injury risks.

Materials and methods

Gathering high quality bicycle crash injury data is a challenge, particularly because of under-reporting of non-fatal bicycle crashes in the often-used police crash databases. While police statistics are sufficiently complete for cyclist fatalities, hospital data are needed for victims treated at emergency departments or admitted to hospital (Langley et al., 2003; Schepers et al., 2015). This study examines injury risk associated with bike share programs using two sub-studies to make maximum use of the qualities of different data sources.

Study 1 is a secondary analysis of longitudinal hospital injury data from the Graves et al. (2014) study from 10 North American cities, divided into two categories; 5 cities with bike share programs and 5 cities without. The analysis presented in the current study was not reported by Graves et al. (2014) because they focused on head injuries. Study 2 examines injury risk for bike share programs based on data provided by bike share operators who were contacted for this study. Although more cities were contacted, we present data only for the two large bike share programs of Paris and London, because these could be matched to general police reported bicycle injury data including cyclist fatalities which is important given the low level of under-reporting of fatalities.

Study 1: Longitudinal hospital data from bike share and non-bike share cities

Graves et al. (2014) assessed trauma centre data for bicycle-related injuries. They compared cities that recently introduced bike share programs with cities that did not with 24 months before and 12 months after intervention data. Comparison cities were selected in similar geographic regions. The bike share cities were Montreal, Washington, D.C., Minneapolis, Boston, and Miami Beach. The control cities (no bike share at the time of the study) included Vancouver, New York, Milwaukee, Seattle and Los Angeles. The study did not distinguish between private bicycle riders and bike share users. This means that the outcomes relate to cycling safety in general with and without introduction of bike share systems. In other words, the data are aggregated according to four conditions (before/after crossed with control/bike share).

Importantly, the Graves et al. (2014) study lacked exposure data. The study only provides injury counts under the aforementioned 4 conditions and an analysis of these data therefore relies on the assumption of exposure remaining constant before and after the introduction of bike share. However, as more cycling is the purpose of introducing bike share, we can safely assume that the volume of cycling increased in bike share cities after the introduction of the programs (Fishman, 2015; Fishman, 2016; Woodcock et al., 2014). This implies that if everything else remains equal, the increase of bicycle use in bike share cities after the introduction of a bike share program can be expected to increase the number of injuries among cyclists. As we don’t know by how much, we only compare numbers of injuries among cyclists before and after the introduction of the bike share programs. This means our analysis leads to an overestimation of risk in terms of injuries per bicycle kilometre in bike share cities after the introduction of the bike share program. Due to this fact we should bear in mind the risk of a Type II error, namely not rejecting the null hypothesis that cities with and without bike share programs are equally safe, while bike share cities are actually safer. Practically, this means that we can only draw conclusions if the absolute number of injuries in bike share cities significantly decreases after the introduction of bike share because that would suggest that the risk decrease (in terms of injuries per bicycle kilometre) is greater than the increase of bicycle use (with injuries being the product of risk and kilometres travelled by bicycle). On the contrary, if the absolute number of injuries remains constant or increases, we are unable to distinguish between decreased risk or increased bicycle use. For instance, a 20% increase of injuries could result from a 20% lower risk and 50% more bicycle kilometres (0.8 x 1.5=1.2), but also from an unchanged risk and 20% more bicycle kilometres (1x1.2=1.2).

Study 2: Injury data from bike share users and general bicycle riders

This study examines injury risk for bike share programs in Paris and London. The study used fatal and serious injuries reported to the bike share operator. It is standard practice for bike share users to be required to report injuries to the bike share operator and, although it is possible (indeed likely) that some incidents fail to be reported, this measure has been used because it is a relatively easily captured data source and provides a comparable data source across different systems. In the bike share operator data used in this study, injury severity has been divided into fatal injuries and injuries needing hospital admission. A fatality is defined as a death occurring within 30 days of the crash (Department of Transport, 2013). The bike share operators were provided with a description of categories of severity, and asked to identify the number of incidents reported to them in each category, for 2013. Because of the high number of zero fatalities among bike share users in 2013, we searched for additional police reported fatalities among bike share users using reports by authorities in the same regions.

The respective bike share operator has provided ridership and system data. This includes the number of trips and trip duration, which allow for estimates for total distance travelled, by applying an assumed travel speed of 10.2km/h. This data is captured automatically each time a bicycle is removed and returned to a bike share docking station (see Fishman, 2015). Speed estimates used in this study are derived from previous studies (Jensen et al., 2010). This speed accounts for stops made between origin and destination, such as dwell times at intersections. Higher travel speeds for bike share users were reported by Rojas-Rueda et al. (2011), but we restrict to the lowest value by Jensen et al. (2010) to avoid underestimation of the risk of bike share users (a higher assumed speed contributes to a greater number of kilometres in the denominator of the risk ratio). We reflect on the sensitivity of the analyses for speed immediately following Table 3.

To gain a measure of risk for general bicycle users, in terms of injury and fatality per unit of distance, travel survey data for the Paris region and Greater London were combined with police recorded injury figures between 2009 and 2011. It should be noted that these sources do not allow for excluding the minority of bike share users. We reflect on this limitation in the Discussion section. Travel surveys generally collect one-day travel diaries of all members of households, e.g. among about 8 000 households per year for Greater London (Department of Transport, 2013) and 18 000 households for Île-de-France (DRIEA, 2013). Respondents are asked to report their journeys on a given day, their start and end location, start and end time, mode of travel, etc.

Using Statistical Package for the Social Sciences (SPSS), a Chi-square test was undertaken to compare the observed injury numbers per system (private versus bike share bicycles) with the numbers expected based on the amount of bicycle use per system. Additionally, we compared the risk in terms of injuries per bicycle kilometres between bike share users and general bicycle riders using a crude Incidence Rate Ratio (IRR) based on Poisson-regression with generalised linear models in SPSS. It has the following form:

Formula 1
IRR = (IBS / DBS) / (IPB / DPB) = (IBS * DPB) / (DBS * IPB)

In which IBS and DPS are the number of injuries and distance travelled by bike share users and IPS and DPS the number of injuries and distance travelled by general bicycle riders. The distance by bike share users is the product of their travel speed (VBS) and travel time (TBS). To describe the sensitivity of our analysis for the assumed travel speed we can rewrite the formula for IRR as follows:

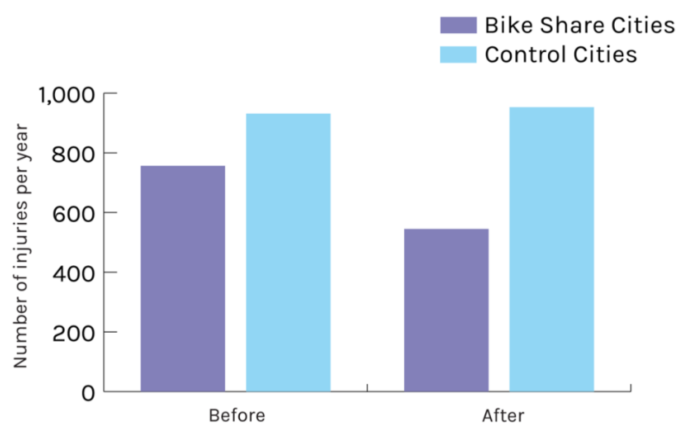
Formula 2
IRR = (IBS / {VBS * TBS}) / (IPB / DPB) = (IBS * DPB) / (VBS * TBS * IPB) =
(1 / VBS) * (IBS * DPB) / (TBS * IPB)

Results

Study 1: Longitudinal hospital data from bike share and non-bike share cities

Figure 3 shows the total number of injuries reported at trauma centres in bike share cities and control cities before and after the implementation of bike share programs. These figures are presented per year for a visual impression (the pre-period was 2 years; the post-period 1 year). The key finding shown in Figure 3 is that injuries in bike share cities went down compared to non-bike share cities.

Figure 3. **Injuries (all types), bike share cities and non-bike share cities (control)**



Source: Graves et al. (2014)

Table 1 presents the total injury figures for both city types before and after implementation. The Chi-square test is highly significant, showing that the total number of injuries per year in bike share cities decreased compared to a small increase in control cities. The drop is particularly striking because the amount of bicycle use is likely to have increased due to the introduction of the bike share program. If everything else would remain equal, an increase of bicycle use can be expected to yield a proportionally large increase of injuries. Apparently, the risk decrease is large enough to 'overcompensate' increased bicycle use and achieve a reduction of injuries. These outcomes show that cyclists' injury risk decreased after the introduction of the bike share program.

Table 1. **Injuries**

City	Before (per year)	After	Total
Bike share cities	1 513 (757)	545	2 058
Control cities	1 863 (932)	953	2 816
Total	3 376 (1 688)	1 498	4 874

Source: (Fishman & Schepers, 2016)

NB: Injuries in cities with bike share programs and control cities before (24 months) and after (12 months) introduction of bike share programs in the former ($\chi2(1, 4874)=30.3$; $p<0.001$).

Study 2: Injury data from bike share users and general bicycle riders

System use and injury data

Table 2 details key metrics, in terms of size, use and injuries provided by Paris and London bike share operators. The average number of trips per bike, per day is illustrated and this offers an indication of how well a system is used, controlling for system size. Paris recorded the largest fleet, trips and distance travelled. Paris also has the highest intensity of use. Other researchers have found that some 28% of all bicycle trips in Paris are covered by shared bikes (DRIEA, 2013). Table 2 also illustrates the number of injuries reported by users to bike share operators. Only London recorded a fatality in 2013.

Table 2. **Paris and London bike share programs, size, usage and injury data, 2013**

City	Average number of bicycles in fleet	Total trips for 2013	Average number of trips per day per bike	Estimated average trip duration (min)	Estimated distance travelled per year (km)	Serious injuries	Fatalities
Paris	18 130	35 021 999	5.3	20	118 607 837	19	0
London	9 083	8 045 459	2.4	17.5	23 841 377	17	1

Source: (Fishman & Schepers, 2016)

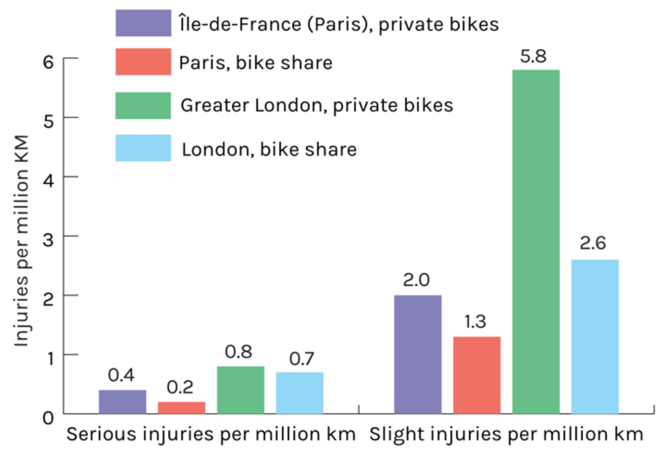
Comparing bike share injury risks to general bicycle injury risks

General bicyclist injury risks for Paris and London are shown in Table 3, using data collected for the jurisdiction known as Île-de-France (which encompasses Paris) as well as Greater London. In this analysis, travel survey data (Department of Transport, 2013; DRIEA, 2013) has been combined with police recorded injury figures between 2009 and 2011 for Île-de-France (DRIEA, 2010, 2011) and Greater London (Transport for London, 2012). The table compares the 2013 injury risks of the Paris and London bike share systems to the injury risks in 2009-2011 in the jurisdictions of which these systems are a part. The observed number of injuries are compared to expected numbers based on kilometres travelled by general and bike share bicycles using a Chi-square test. For serious injuries, the injury risks are lowest for bike share.

Because of the high number of zero fatalities among bike share users in 2013 (see Table 2), we instead calculated an average fatality risk by adding Paris data collected between 2007 and 2012, during which time police recorded eight deaths among bike share users (Byrne, 2013). Usage during this time period is estimated at some 0.58 billion bicycle kilometres. By combining these figures to those in Table 2 and 3 for Paris and London, a bike share fatality rate of some 13 per billion bicycle kilometres (nine fatalities divided by 0.72 billion bicycle kilometres) has been estimated. This is significantly lower than the 25 fatalities per billion bicycle kilometres for general bicycle riding.

Figure 4 provides a comparison of different injury rates for Paris and London, between general and public bike use. It shows bike share use has a lower injury rate per kilometre travelled, when compared to general cycling.

Figure 4. **Injuries per million km travelled**



Source: Fishman and Schepers (2016)

Table 3 also includes Incidence Rate Ratios which describe the size of risk difference. Ratios below 1 indicate risk is lower for bike share users. Incidence Rate Ratios are close to 0.5 for both serious and fatal injuries.

Table 3. **Injuries and fatalities, bicycle use and injury rates for general cycling and bike share users Île-de-France and Greater London**

Injury numbers	Serious injuries	Fatalities
General bicycle	2 015	79
Bike share	36	9
Bicycle use (billion km)		
General bicycle	3.19	3.19
Bike share	0.14	0.72
Expected based on bicycle use[1]		
General bicycle	1 964.8	71.8
Bike share	86.2	16.2
Observed versus expected based on bicycle use		
Chi-square	31.5	3.9
P	<0.001	0.048
Injury risks per billion km		
General bicycle	631	25
Bike share	253	13
Crude Incidence Rate Ratio (95% CI)[2]	0.41 (0.29 to 0.57)	0.50 (0.25 to 1.00)

Notes:
1. The product of the total number of injuries and the share of bicycle kilometres per condition, e.g. for general bicycle: (2015+36) * (3.19/3.33) = 1 964.8
2. Incidence Rate Ratio: Injury risk bike share / Injury risk general bicycle; CI assuming a Poisson distribution
Source: (Fishman and Schepers, 2016)

Sensitivity of the analysis related to the assumed travel speed

As described earlier, we assumed the lowest travel speed of 10.2 km/h that we could find in the literature for bike share users (Jensen et al., 2010), while Rojas-Rueda et al. (2011) found speeds as high as 14 km/h. Formula 2, shown earlier, describes that the Incidence Rate Ratio is proportional to the inverse to bike share travel speed (VBS in Formula 2). By assuming a 14 km/h travel speed instead of 10.2 km/h, the Incidence Rate Ratios described in Table 3, decreases by a factor 0.73 (14-1/10.2-1), from 0.41 and 0.50 for serious injuries and fatal injuries respectively to 0.37 and 0.30. This difference of almost 30% suggests that more reliable data about travel speed and distance are needed to draw firm conclusions about the absolute size of the risk difference between bike share and general bicycle users.

Dockless bike share

No dockless bike share companies contacted as part of this report responded to the author's invitation to share crash reporting data/methods. This means that our results apply to dock-based bike share. The large increase of dockless bike share described in the Introduction raises the question of how applicable our results are to dockless bike share. Dock-based bike share riders start and end their trip at docking stations, meaning that bikes are almost always used within a defined catchment. Using GPS-based tracking systems and QR codes, dockless bikes can be unlocked and dropped off across a wider area, and this may include areas of a city with less bicycle infrastructure (bike lanes and paths). This heightens road safety risk. One of the explanations for why we found dock-based bike share systems to be relatively safe may be that these bikes are generally used in the inner-core of a city, which typically holds a higher density of streets with bicycle infrastructure. As dockless bikes are used further into a city's suburbs and can be launched without sufficient planning or warning, bicycle infrastructure is unlikely to keep up with the rapid pace that dockless systems can appear. Conversely, because dockless bike share systems can usually be delivered at a fraction of the cost of docked systems, the total scale is usually larger. This may work to reduce risk of a crash, using the Safety In Numbers (SIN) hypothesis reported earlier. Moreover, dockless bike share is likely to attract a similar type of rider; one that is not high speed-performance orientated, and this may mean their average speed, and thus collision risk is lower. However, the fact that most dockless bike share schemes are run without subsidy may mean that commercial imperatives reduce maintenance, potentially lowering the effectiveness of the bike hardware to avoid crashes (e.g. condition of brakes). Given the rapid pace with which dockless bike share is expanding around the globe, more research is urgently needed to gain a detailed understanding of the road safety impact of dockless bike share. This research must engage with the commercial bike share sector, the government jurisdictions in which they operate, road safety bodies and riders themselves. Future research should also look at the total impact on road safety caused by dockless bike share, including the impact of transfers from car use to bike share, as this may have an impact on overall road safety outcomes as well.

Discussion

We conducted two studies to examine the risks associated with bike share and to test our hypothesis. Both Study 1 and 2 provide support for our hypothesis that bike share programs are associated with lower injury risks. Study 1 indicated that the introduction of a bike share system is associated with a reduction in cycling injury risk. Study 2 found that bike share users are less likely than other cyclists to sustain fatal or severe injuries. These outcomes are in line with the study by Woodcock et al. (2014) which is to our best knowledge the only published research that includes the impact of bike share on road safety risks.

An explanation for bike share users' lower road safety risk is not immediately obvious. One explanation is Safety In Numbers (SIN), i.e. increased driver awareness and cautiousness towards cyclists (Jacobsen, 2003), as drivers encounter more cyclists after the introduction of bike share systems. Specific characteristics of bike share users may also be contributing to the lower crash risk. One explanation might be that their speeds are substantially lower than for other cyclists which has been found to reduce injury risk (Schepers et al., 2014). Bike share speeds are generally in the same range as cyclists in countries with high volumes of cycling such as the Netherlands (Jensen et al., 2010; Schepers et al., 2017; van Ooijen and Li, 2013). A lower speed increases the time available for cyclists to avoid crashes that may have occurred at higher velocities. The upright position of bike share bikes may increase the visual profile of the rider in traffic and improve their field of vision. It is also possible that motorists perceive bike share users to be less experienced and/or tourists and display a greater level of caution, as revealed in qualitative research on perceptions of bike share (Fishman et al., 2012). The notion that drivers behave differently depending on the appearance of the cyclist has been established by Walker (2007) who found that drivers overtook closer to helmeted cyclists. Finally, compared to general bicycle riders, bike share users may frequently ride on roads in or nearby city centres where motor vehicles speeds are lower and injuries are less severe (Kaplan et al., 2014; Schepers et al., 2013). Bike share bikes often have full time safety lights, which may increase awareness from other road users. It is also probable that bike share catchments are often focused in the inner city, where bicycle infrastructure is likely to be more cohesive.

The study had a number of limitations. The comparison of injury numbers in Study 1 lacks exposure data. The absolute number of injuries decreased while an increase could be expected because bike share tends to increase bicycle use (Fishman, 2015; Fishman et al., 2015; Woodcock et al., 2014). We would actually like to know by how much risk in terms of injuries per bicycle kilometre decreased, but that is only possible with information about both injuries and bicycle kilometres. We recommend a study similar to the one by Graves et al. (2014) which includes ridership data to estimate the absolute size of the risk decrease. Such a study could be enhanced even further if injuries can be split amongst bikes share users and general bicycle riders.

Study 2 also has a number of limitations. Firstly, the comparison of serious injuries is hampered by the fact that our data for bike share were reported to operators while data for other cyclists were based on police statistics. This raises the question of whether a high underreporting rate for the former data source contributed to the low risks we found for bike share. While contacting cities with bike share programs, Montreal was the only city which could provide detailed information regarding crash types. About half of the crashes were crashes with no motor vehicle involved. This is less than the share of non-motor vehicle crashes reported in medical registrations which ranges between 60% and 95% (Schepers et al., 2015). On the contrary, the police rarely report these crashes (Haworth et al., 2010; Langley et al., 2003). The substantial numbers of non-motor vehicle crashes reported to bike share operators is indicative of a higher reporting rate of injuries among cyclists than is to be expected for police statistics.

Therefore, we do not expect our findings are biased by reporting rate differences. Including 'bike share' as an option on police and hospital incident forms in cities with bike share would enhance data for both groups of cyclists. Secondly, we were not able to exclude the minority of bike share injuries from the majority of police reported private bicycle injuries, hence the use of the term 'general' bicycle riders, as it is actually the general bicycle risk. Thirdly, reliable data about ridership among bike share users (the denominator of risk) is equally important as reliable injury data (the numerator of risk). To achieve a conservative estimate of the risk of bike share users, we assumed the lowest reported travel speed of 10.2 km/h found by Jensen et al. (2010). Assuming the 14 km/h travel speed among bike share users reported by Rojas-Rueda et al. (2011), would have yielded an almost 30% lower Rate Ratio and would suggest the risk among bike share users is even lower than we described in this paper. Because of the aforementioned three limitations it could be that the actual injury risks of bike share users are lower compared to private bike riders than our outcomes suggest which is why we cannot draw firm conclusions on the absolute risk difference.

Conclusions and recommendations

The results of our two sub studies lead us to conclude that, on a per kilometre basis, bike share is associated with decreased risk of both fatal and non-fatal bicycle injuries when compared to general bike riding. This contradicts worries prior to the introduction of bike share schemes (Flegenheimer, 2013). Notwithstanding the importance of creating cities that support safety riding (Jacobsen and Rutter, 2012), these results imply that concerns about decreased levels of cycling safety are unjustified and should not prevent decision makers from introducing bike share schemes.

Moreover, if bike share is introduced with a host of other supportive measures, particularly protected bicycle infrastructure and other initiatives to improve a city's bicycle friendliness (as was the case in cities like Paris and New York), it is more than plausible that the safety of all people choosing to cycle (bike share and private) will be enhanced.

As bike share systems continue to expand around the globe, it will become increasingly important for bike share operators to develop and implement consistent, detailed reporting procedures to monitor crash risk (which must include distance travelled). Shaheen et al.'s (2013) North American, multi-system study included questions to bike share operators regarding safety data. This analysis found inconsistent reporting procedures across the different cities included in the study.

This review has found that current bike share operators have not yet established a consistent reporting methodology for capturing crashes. The conceptualisation and implementation of a standardised, industry wide reporting tool needs to be developed and built into the contract cities create when establishing or renewing bike share agreements with providers/operators. As the dockless bike share industry continues to expand at a rapid rate, more needs to be done to ensure a harmonisation of reporting procedures across the diverse bike share industry. Of the four large dockless bike share companies contacted as part of this report, none responded to the author's invitation to share crash reporting data/methods. City governments may need to impose mandatory reporting requirements on the bike share industry to ensure a consistency of method and reporting.

As technologies continue to be integrated onto the bikes that make up modern bike share fleets, there is a growing opportunity to use these sensors and tracking technologies to build up a more detailed picture of crashes; where and when they occur, the speed of the rider etc. Using accelerometers, it may be possible for operators to predict when a crash may have occurred, and send a push notification through the App to ask the rider whether such an incident has taken place. When a crash is reported to an operator from a rider, some of the key attributes that should be included in what should be a universal crash data collection tool are:

- Name
- Date of Birth
- Gender
- Crash date
- Crash time
- Crash location (using online mapping tool to provide Geo-coordinates)
- Crash type
- Have police attended
- Injury severity
- Injury details
- Customer consent for safety researchers to contact victim
- Contact details.

For most of the above categories, drop down boxes with short explanations to guide the operator should be used, in order to maintain a consistency in reporting.

This review of the available evidence suggests bike share is safer than riding a private bike. The rapid pace with which the bike share industry is expanding has not included the development of detailed reporting requirements and this means there is an important gap in knowledge with which to comprehensively determine the road safety impacts of this growing form of transport. Government and industry need to work together to develop consistent tools with which to collect and report on the total impacts of bike share on safety outcomes.

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International Transport Forum

The Safety of Bike Share Systems

This ITF Discussion Paper reviews available research on the safety impacts associated with the growth in bike share use. In the last 20 years the global fleet of dock-based and dockless bike share systems has grown to well over 4 500 000; making bike share one of the fastest growing modes of transport. This rapid increase in popularity has made bike safety a priority for policy makers and calls for a framework where bike share crash data is collected consistently to ensure safety risks can be identified and reduced.

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