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## NEW RISKS TO CITY DWELLERS' HEALTH AND SECURITY DUE TO MICROMOBILE DEVICES DEVELOPMENT

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### Abstract

The dynamic development of urban areas and the growth in the number of city dwellers are leading to an increasing burden on transport systems. The growing number of vehicles generates a number of problems, such as air pollution, noise, traffic congestion and a deterioration in the quality of residents' life. In this context, micro-mobility is becoming an important element of modern urban transport systems, offering environmentally friendly solutions for short-distance travel and contributing to reducing the negative effects of motorisation. However, the development of micromobility requires a coherent urban policy, investment in infrastructure and effective regulations to ensure the users' safety and comfort. The aim of this article is to analyse the impact of the development of micromobility on the health and safety of city residents. The research is based on a pilot survey conducted among pedestrians and users of micromobility vehicles in Gdańsk, Warsaw and Berlin, supplemented with photographic documentation from fieldwork. The results of the study allow identifying key risks associated with the development of micromobility in the context of the health and safety of urban population.

### Key words

micromobility development, city dwellers' health, new urban health risks, health and security.

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### 1. Introduction

With the global expansion of urban areas and population growth, the number of users of both public and private transport is also increasing. According to current World Bank forecasts, by 2050, the percentage of the population living in cities will increase to 70% (Urban Development, World Bank Group). This results in a greater demand for an efficient and effective transport system, which at the same time should consider a need to protect the natural environment

(Tomanek, 2023). The ongoing process of urbanisation poses increasingly serious challenges for urban transport systems. The growing number of residents and vehicles requires continuous development and modernisation of transport infrastructure, which is a major financial challenge for municipal authorities. Urbanisation also leads to the spatial expansion of existing cities, which requires transport systems to be adapted to the changing spatial structure and is associated with changes in the residents' lifestyle, including their transport preferences (Dąbrowska et al., 2023).

Although transport is essential for the smooth functioning of cities, road transport is one of the main sources of air pollution in cities. Exhaust emissions and particulate matter generated by vehicles contribute to the deterioration of air quality in urban areas, thus having adverse consequences for the residents' health. Increased vehicle traffic leads to noise pollution and traffic congestion, resulting in longer journey times and higher transport costs. In turn, traffic congestion negatively affects the residents' quality of life, including their mental well-being (Mielczarek-Mikołajów, 2023). Micromobility is currently becoming an integral part of modern urban transport systems around the world, offering alternative solutions for short journeys and contributing to the reduction of traffic congestion and pollutant emissions in cities. However, the development of micromobility requires a well-thought-out urban strategy, appropriate investments in infrastructure and the implementation of effective regulations that guarantee users' safety and comfort when using these forms of transport (Janczewski, 2020; Fan, Harper, 2022).

The aim of this article is to analyse the current situation regarding micro-mobility and to explain how its rapid development in cities affects the health and safety of their residents. The analysis is based on a pilot survey conducted among pedestrians and users of micro-mobility devices in Gdańsk, Warsaw and Berlin. An important supplement to this study is the photographic documentation taken during fieldwork, showing examples of problems and challenges related to the safety of people living and staying in these cities in the context of the development of micromobility.

## **2. The development of micromobility as a new threat to urban health and safety**

Micromobility is a rapidly growing segment of urban transport that has the potential to significantly improve the quality of life in cities. It fits in with the idea of smart cities, i.e. safe and efficient urban transport using modern technologies (Mielczarek-Mikołajów, 2023). Micromobility vehicles are a group of small, lightweight means of transport with limited speeds, usually not exceeding 25 km/h, which are powered and controlled directly by the user. This category includes a wide range of vehicles, such as electric scooters, traditional and electric bicycles (including pedal-assisted ones), skateboards, rollerblades, roller skates and small three- and four-wheeled microcars. Micromobility also includes electric wheelchairs for seniors and people with physical disabilities, as well as innovative means of transport such as Segways, hoverboards and electric skateboards (Janczewski, Janczewska, 2020b). Micromobility transport,

especially the one using electric propulsion, has been able to develop on a massive scale thanks to the widespread use of GPS technology and mobile payments in applications, improvements in smartphones with access to high-speed Internet, and the increase in the capacity of electricity storage devices (Janczewski, 2020).

Despite its undoubted advantages, such as greater flexibility in movement, complementing public transport, reducing air pollution, and saving time and money, the development of micromobility generates a number of technical, organisational and social problems and challenges, including issues of user and pedestrian safety, rational management of public space and adaptation of the legal framework to the dynamically changing realities of transport. Among the most important challenges accompanying the intense development of micromobility in the urban environment, the issue of safety in shared spaces, used by both micromobility vehicle users and pedestrians, who are the most vulnerable group of road users, is currently of particular importance (Mering, Wachnicka, 2021).

Users of micro-mobility vehicles must constantly negotiate their right to public space on roads and pavements. While cyclists and electric scooter users in particular share space with cars, they often feel unsafe and are sometimes disregarded by drivers. When sharing space with pedestrians, they can pose a threat to the latter, as the high speed of bicycles and scooters among pedestrians creates a serious risk of collision. Although such conflicts are inherent to the nature of public space, they largely depend on how new forms of transport are organised (Cubells et al., 2023).

A strict division of space into areas exclusively for pedestrians and separate areas for vehicle users is obvious only in theory, but difficult to implement in reality. According to custom and law, pavements and paths are adapted to certain wheeled devices, including, for example, wheelchairs, rollerblades and sometimes bicycles. Meanwhile, new types of personal mobility devices are constantly emerging, and their users are also demanding access to areas designated for non-motorised transport (Janczewski, 2019; Janczewski, Janczewska, 2020a). For transport organisers and road network managers, the development of alternative vehicles can have various consequences, from the need to design new elements of road system infrastructure to the amendment of legal provisions regulating the use of vehicles (Janczewski, 2019). Many cities are actively developing infrastructure adapted to micro-vehicles, which is a key factor in the popularisation of this type of transport (Fang, 2022; An et al., 2023).

It is worth mentioning that the development of micromobility is part of a broader transport policy implemented in Poland, Germany and other European Union countries. Currently, one of the most important goals of the EU is to achieve climate neutrality, as confirmed by Article 2 of the European Union Regulation of 30 June 2021, according to which national greenhouse gas emissions and removals regulated by EU law should be balanced in the EU by 2050 at the latest, thereby reducing emissions to net zero. Achieving this goal is to facilitate the implementation of two other proposals related to reducing greenhouse gases by 55% by 2030 compared to 1990 levels, which requires differentiated measures and also applies to both public and private transport (Mielczarek-Mikołajów, 2023; Sydorów et al., 2023; Mroczek-Czetwertyńska, 2025).

The need to reduce the use of private transport stems from the phenomenon of congestion observed in cities, i.e. excessive load on road infrastructure in relation to its original design assumptions. Reducing the number of passenger cars and changing residents' transport habits is possible thanks to the development of efficient public transport systems, supported by alternative means of transport (Mroczek-Czetwertyńska, 2025). Nevertheless, despite the numerous benefits of micromobility, its development is associated with a number of challenges. The most important ones include the safety of users and pedestrians, the provision of adequate infrastructure, and the development of detailed legal regulations, including at the local government level (Dorocki, 2022; Mielczarek-Mikołajów, 2023).

The issue of safety in the context of the development of micro-mobility transport remains a

relatively poorly understood topic in Poland, especially given its dynamic growth in recent years. Research on personal transport devices is mainly conducted in countries where micro-mobility has been developing for a long time and has a more established position in transport systems. Three key areas are of particular importance in current research analyses: firstly, assessing micromobility as an element of sustainable transport; secondly, determining the legitimacy and feasibility of integrating these devices into existing transport systems; and thirdly, ensuring safety for both users of micromobility vehicles and pedestrians (Janczewski, 2019; Straub, Gajda, 2020; Tarczydło, 2022).

As part of original field research conducted in Gdańsk, Warsaw and Berlin, observations and site visits were made in selected areas of particular transport and social importance, such as tourist attractions, public transport hubs and university campuses. On this basis, extensive photographic material was collected, documenting key problems occurring in the common spaces of the studied cities, which have a direct impact on their users' safety. The most frequently observed phenomena include: blocking pedestrian walkways and cycle paths by incorrectly parked micro-mobility vehicles (Fig. 1), randomly leaving shared devices in places not designated for this purpose (Fig. 2), users failing to comply with traffic restrictions, exceeding speed limits, carrying passengers on single-person vehicles, and the lack of personal protective equipment, especially helmets, among users of electric scooters.

In response to the problems described above, more and more cities are introducing local regulations and solutions aimed at addressing issues related to



Fig. 1. Scooters, bicycles and electric scooters blocking pedestrian walkways in the Bielany district of Warsaw (left photo) and near Hauptbahnhof station in Berlin (right photo).

Source: own collection.



Fig. 2. An electric scooter thrown into the Strzyża River in Gdańsk (left photo), an electric scooter placed in a rubbish bin in Skwer Kościuszki in Gdynia (right photo).  
Source: www.trojmiasto.pl.

parking and micro-mobility vehicle traffic. These include speed limits, no-entry zones and regulations on movement in specific areas of the city (Czekaj et al., 2022). Paris, considered a city friendly to low-emission means of transport, is an example of a strict policy towards electric scooters. In 2022, there were 22 fatal accidents involving electric scooters in France, which sparked a wide-ranging public debate and led, among other things, to a referendum on the future of these vehicles. Although only 10% of eligible voters took part in the vote, as many as 89% of participants were in favour of not renewing contracts with companies providing public e-scooters in Paris (Troost, 2023) (Fig. 3).

Alarming data on the scale of accidents involving scooters also applies to Poland, where in 2025 their number doubled compared to the previous year and exceeded 1,000 reported incidents (according to the

Police Headquarters), in which 10 people were killed, half of whom were children (Brzeziński, 2025). The main problem lies in the use of private scooters from which speed restrictions are removed.

While parking infrastructure for city bikes, especially those requiring docking stations, is widely available, shared scooters did not have designated and marked parking areas in their early years of operation. This resulted in an accumulation of parked vehicles in critical locations in many cities, often making these places not only aesthetically unattractive, but above all, difficult to navigate. Local governments make effort to respond to these challenges, such as for example in Gdańsk, where 200 parking spaces for electric scooters appeared in 2020 (Fig. 4).

The city authorities have entered into an agreement with scooter operators, under which they are to park their vehicles there, and users who park

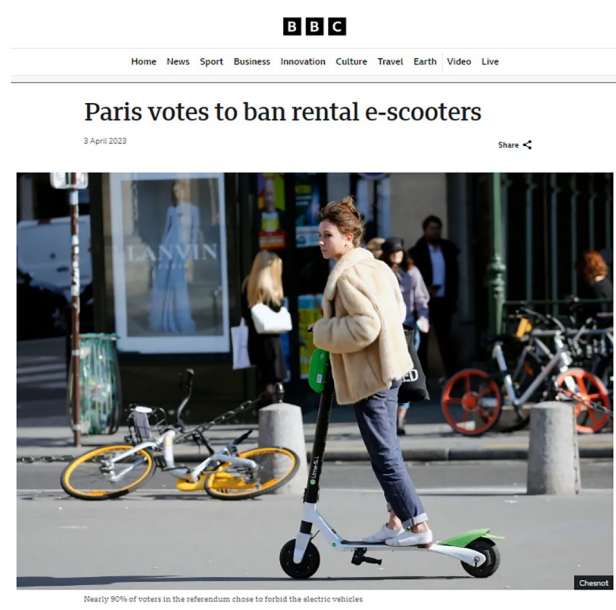
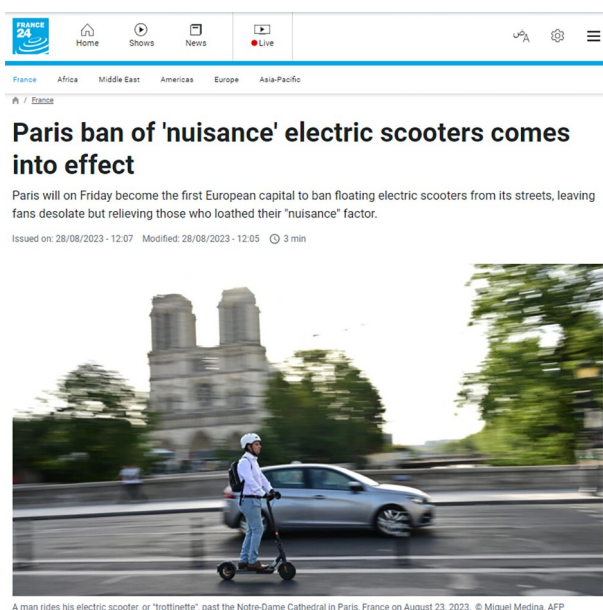


Fig. 3. Examples of media headlines referring to the results of the referendum in Paris on the withdrawal of shared electric scooters from the city.

Source: Paris ban of..., 2023 (left photo); Paris votes to..., 2023 (right photo).

them in designated areas can count on discounts. In addition, a speed limit of 12 km/h has been introduced for electric scooters in the Main Town area of the city (Mrowicki, 2020).

In Berlin, there are also designated parking spaces for city bikes and shared scooters in certain parts of the city (Fig. 4). At the end of 2023, the Berlin authorities introduced new regulations limiting the number of electric scooters available in the sharing system to 19,000 vehicles from the current 25,000 in the S-Bahn railway area (approx. 10% of the city's area). The new rules are to apply especially during the summer, and if the city authorities decide that there has not been sufficient improvement in clearing pavements of electric scooters, the permitted number will be reduced even further (Logan, 2023).

This is a result of real problems with ensuring safety in the city for users of public spaces, especially

the most vulnerable, such as blind or visually impaired pedestrians, elderly people with limited mobility or people with motor disabilities, as well as children. Scooters scattered on pavements are also a major hindrance to the large number of cyclists in Berlin, and the city is one of the best-adapted cities for cycling in Western Europe.

In the context of the discussion on the safety of users of urban areas, it is also worth noting the new transport solutions appearing in cities, resulting from contemporary trends in urban mobility, which are not directly related to the previously discussed individual personal transport devices. These include autonomous (driverless) vehicles, such as small buses designed to transport small groups of people over short distances. Such buses have been tested in Gdańsk on the route to the Zoological Garden (in 2019), at Łostowice Cemetery (in 2021) (Fig. 5) and at the airport (in 2022) (Korolczuk, 2019; Okurowski, 2020; Frączak, 2022).



Fig. 4. Shared electric scooters on a dedicated lane near Potsdamer Platz in Berlin (top left photo), Veturilo city bikes at a docking station near the Copernicus Science Centre in Warsaw (top right photo) and electric scooters in the Main Town area of Gdańsk (bottom photo).

Source: own collection (top photos), phot. karolina misztal / polska press/dziennik bałtycki (bottom photos).



Fig. 5. An autonomous bus in Gdańsk undergoing testing on the route to the Zoological Garden (2019) and at the Łostowice Cemetery (2021).

Source: Maciej Korolczuk / Trojmiasto.pl (left photo), UM Gdańsk (right photo).

So far, these vehicles have been used in the city for testing purposes, but it cannot be ruled out that they will be introduced for temporary or permanent use in the future. The buses travel at a limited speed of up to 11 km/h along a programmed route, during which they scan their surroundings to react to any obstacles that may appear. During the tests, there was an operator in the vehicles to ensure the safety of passengers and other users.

Another example of innovative semi-autonomous devices, although not used to transport people but goods, are robots developed by the Polish company Delivery Couple. The Lublin-based start-up has developed semi-automatic robots that can assist in delivering meals or products to customers. Initially, the robots were mainly intended for the catering industry, but soon the creators expanded their scope of application to the delivery of various products. The robots Kasia and Mateusz, as they were named by their creators, are the first robots in Poland to deliver

food and shopping directly to customers. The robot travels most of the way autonomously, deciding for itself how to navigate the route. It is adapted to cope with various types of urban infrastructure, including kerbs, uneven pavements and even snow (Fig. 6). However, at certain moments, it is supported by a remote operator – for example, when crossing pedestrian crossings (Fig. 6). The robot delivers products within a distance of up to 3 km from the premises and has found its application in several cities in Poland, including Gdynia and Warsaw (Roboty polskiego startupu..., 2023).

Similar devices are also in use in some European countries and the United States, but their use is limited by regulations permitting such vehicles or the lack of regulations prohibiting their use. In terms of safety, this is another type of device that travels mainly on pavements or cycle paths, providing that national or local regulations allow it (Singh, Bhattacharyya, 2024).



Fig. 6. A robot delivering food from Oggy Bakery in the Chwarzno-Wiczlino district of Gdynia and a sign placed at a pedestrian crossing (in 2024) informing pedestrians that a robot may appear at the crossing.

Source: author Jakub Ubych – Councillor of the City of Gdynia (left photo) and own collection (right photo).

For now, their use is limited to selected locations and short distances from the premises, and the solution is still in the testing phase, also in terms of the safety of other road users, e.g. potential collisions with cyclists on cycle paths or with cars at pedestrian crossings. However, it should be noted that with the development of autonomous vehicle technology, new challenges and threats are also emerging. The most significant ones include the limited ability of autonomous systems to respond correctly in non-standard traffic situations, the risk of misinterpreting signals from other road users, and vulnerability to technical failures or cyber-attacks. In addition, the lack of developed and uniform legal regulations regarding liability for possible accidents involving autonomous vehicles poses a serious challenge to their widespread implementation. In recent months (in 2024), a special sign resembling a road sign (although not formally one) has appeared in Gdynia, placed at a pedestrian crossing (Fig. 6) whose purpose is to warn drivers of the possibility of a robot appearing at the crossing. The placement of the sign was agreed with the city authorities, but it has nevertheless sparked some discussion on the district's internet forums about the legality and effectiveness of such a solution.

Finally, it is also worth briefly mentioning the aspect of transport safety that has arisen in connection with the Covid-19 pandemic, namely the problem of epidemic safety in urban transport during health threats. Public transport has become particularly vulnerable to the risks posed by infectious disease epidemics, and the need to maintain social distancing and avoid crowded spaces does not encourage the use of this form of travel. This situation creates additional difficulties for public transport operators, with organisational and technical issues affecting safe travel, and economic repercussions also being significant.

Even before the pandemic, bicycles, scooters and other micro-vehicles had become the preferred mode of transport in many cities around the world. During the epidemic, these vehicles can be a good alternative to public transport in the city, because, like private cars, they reduce the likelihood of spreading the infection. Although cars have many advantages in such circumstances, an excess of private vehicles in cities leads to traffic congestion and has a negative impact on the environment. On the other hand, the use of micro-mobility vehicles depends on the season and weather conditions, and they are not popular among older people (Janczewski, Janczewska, 2020a).

However, the growing popularity of micro-mobility results in increasing competition between pedestrians, micro-mobility users and car drivers for space to move around the city, generating potential

conflicts. The demand for individual means of transport in cities, observed during the coronavirus pandemic, has led to temporary changes in the use of space, consisting in the reduction of bicycle traffic by annexing part of the road for temporary bicycle lanes. Perhaps temporary modifications to road space will begin to be used regularly over time. This could be an effective solution for the holiday period, when car traffic in the city slightly decreases, but conditions are favourable for travelling on electric scooters or bicycles, and demand for such means of transport increases (Mroczek-Czetwertyńska, 2025).

### **3. Perception of threats arising from the development of micro-mobility transport**

The development of micro-mobility forms of transport in the context of urban residents' safety and health risks is a new topic, particularly in Poland, mainly due to the shorter period of operation of these forms of transport compared to other countries, especially within sharing systems. In particular, there is a lack of information on the frequency of collisions and accidents caused by users of micro-mobility devices or in which they are involved, as well as on the injuries sustained by the victims. Often, these incidents are not reported anywhere, and even if they are recorded, they are not available in the public statistics system. The availability of such data directly from commercial companies managing shared vehicle systems is also limited or completely impossible. In addition, there is a particular lack of information on the subjective perception of the development of the micromobility transport system in cities, including the assessment of infrastructure, vehicle availability and parking options in urban areas, as well as the sense of safety among different users of this space.

In order to gain insights into the development of micromobility transport within urban environments – both from users of such modes of transport and from individuals who do not utilise them but share the same urban spaces – an original pilot survey was conducted in Gdańsk, Warsaw, and Berlin. The principal objective of the study was to examine the extent to which the expansion of micromobility influences the safety and health of individuals in contemporary cities. The survey was conducted in two Polish cities – Gdańsk and Warsaw – and in Berlin, which was selected as a reference location owing to its well-established tradition of micromobility, particularly in the domain of bicycle transport. The principal distinctions among the analysed urban centres related to the timeline of implementing public bicycle systems (Berlin – 2004, Warsaw – 2012,

Gdańsk – 2019), the emergence of shared micromobility service providers – primarily operators of electric scooters – and the corresponding development of urban infrastructure designed to accommodate such forms of transport.

The field research was undertaken in two phases: the first one took place between late summer and early autumn of 2020 in Gdańsk, while the second one was conducted during the spring and summer of 2021 in Gdańsk, Warsaw, and Berlin. This division into two research periods resulted from temporary restrictions introduced in Poland and other countries in response to the COVID-19 pandemic, which included limitations on mobility, particularly across national borders. The research was conducted in various parts of the mentioned cities, including areas around transport hubs, stations, office centres, parks and their surroundings, tourist attractions, and university campuses and buildings. These locations were chosen in order to reach a diverse group of respondents, including students, tourists and residents of all ages. However, the COVID-19 pandemic imposed certain restrictions on the field research, particularly in Berlin, where restrictions were in place on staying in enclosed spaces such as railway stations and shopping centres.

In the end, a greater number of surveys were completed in Gdańsk than initially anticipated (293 instead of 200). This outcome was achieved through the division of the research into two phases and the flexible adjustment of its implementation to the prevailing pandemic conditions. In Warsaw (104 surveys) and Berlin (78 surveys), the number of collected questionnaires was lower than originally planned; however, it remained adequate for the objectives of the pilot study. In Berlin, the research process was further complicated by sanitary restrictions in force at the time, including limited access to public spaces and the requirement to present valid test results or vaccination certificates. These factors hindered respondent recruitment and extended the duration of individual survey sessions.

The survey conducted in Gdańsk was dominated by men, who accounted for 64% of the respondents (187 people), while women accounted for 35% (104 people). The situation was different in Warsaw, where the majority of the participants were women – 62% (64 people), and men accounted for 38% (39 people). In Berlin, on the other hand, there was an almost equal participation of both sexes: women accounted for 46% of respondents (36 people) and men for 50% (39 people). It should be noted that the percentages do not add up to 100% because the question about gender allowed for a possibility to refuse to answer, which did not result in the participant being excluded from the survey.

The differences between cities in terms of the gender ratio of participants may result from the specific nature of the research conducted in each city – in Gdańsk, part of the research was conducted remotely, and, due to the subject matter, it may have attracted more attention from men. In Warsaw, on the other hand, the study was conducted entirely face-to-face, and the overrepresentation of women may be related to a generally greater openness to participating in social research than just an interest in its subject matter. In Berlin, the research was also conducted in person in the field and, due to more restrictive pandemic restrictions, was a major challenge in itself, hence the smaller sample size than in other cities, but at the same time, it was easier to control the share of participants in terms of gender criteria. Due to the pilot nature of the project and the difficult conditions accompanying its implementation, this criterion was not of key importance. The study was not supposed to be representative – its main purpose was to gather the opinions of both micromobility vehicle users and pedestrians using selected common spaces covered by the analysis.

Across all three cities, the largest proportion of respondents belonged to the 30–44 age group (Gdańsk – 57%, Warsaw – 44%, Berlin – 40%), followed by those aged 18–29 (Gdańsk – 30%, Warsaw – 32%, Berlin – 31%). These results align with the expected demographic profile of the study; nevertheless, respondents from other age categories also constituted a notable share of the sample, particularly in Berlin and Warsaw (29% and 24%, respectively). Importantly, the survey encompassed both users of micromobility vehicles and pedestrians who utilise urban spaces. The participants' educational profile reveals a predominance of individuals with higher education (Gdańsk – 84%, Warsaw – 75%, Berlin – 68%). In the case of Gdańsk, this may partially be attributed to the inclusion of an online survey component within the field research, which required access to digital devices (computer, tablet, or smartphone) and a basic level of digital literacy.

The results of the study revealed clear differences in the assessment of micromobility development, including the adaptation of urban infrastructure and the perceived level of safety in public spaces, between respondents from Berlin and participants from Gdańsk and Warsaw. The greatest differences in the respondents' opinions concerned the frequency of use of micromobility vehicles – in Berlin, these vehicles are more often used as a daily means of transport (32% of respondents, compared to 26% in Gdańsk and 12% in Warsaw), and most often it is a private bicycle (67% of respondents use it frequently) and rented

scooters (16% use them frequently), while in Gdańsk, with a slightly lower frequency of use of micro-mobility vehicles, private bicycles also dominate (69% of responses), but users also often use their own scooters (16%) and shared scooters (15%). In Warsaw, the use of micro-mobility vehicles is more complex – private bicycles still predominate (57%), but users regularly indicated other options, such as city bikes (15%), personal scooters (15%) and shared scooters (14%), with respondents using them several times a week or several times a month, rather than on a daily basis.

The percentage of respondents who do not use this type of personal transport at all also significantly varied between the surveyed cities – from 19% in Gdańsk, through 22% in Berlin, to 31% in Warsaw. The figure for Warsaw may seem surprisingly high, given the availability of city bikes and other shared vehicles in the city, but the higher participation of older age groups in the survey and the availability of diverse urban transport options should be taken into account. Respondents from Warsaw were also more critical of the city's suitability for micro-mobility vehicles than those from Berlin (especially when comparing the two capitals, excluding Gdańsk), which may also have contributed to the more frequent use of public transport or private cars than micro-mobility vehicles.

When analysing issues directly related to the safety of using urban space – both by pedestrians and users of micro-mobility vehicles – significant differences between the surveyed cities are noticeable. Respondents from Berlin reported a significantly higher level of safety than participants from Warsaw and Gdańsk – 63% of micro-mobility vehicle users and 77% of pedestrians positively rated safety in urban spaces. In Warsaw, 68% of the surveyed pedestrians declared that they feel definitely or rather safe when walking on pavements, while only 47% of respondents expressed similar feelings as users of micro-vehicles. In Gdańsk, 66% of pedestrians rated safety on pavements as high, while among micro-mobility vehicle users, this percentage was 60%.

It should be added here that in the question about the sense of safety as users of personal transport devices, respondents could choose the answer 'not applicable/I do not use vehicles', which means that some respondents did not assess this aspect. With regard to only those respondents who have experience as users of micro-mobility vehicles, the safety rating is slightly higher – in Berlin 72%, in Gdańsk 71%, and in Warsaw 61% of users feel safe in urban spaces. In both respects, Warsaw residents reported the lowest sense of safety among the surveyed cities.

In the opinion of most respondents, the level of safety in urban areas did not significantly change in the year preceding the survey, despite a noticeable increase in the volume of micro-mobility traffic on pavements. This phenomenon was most often reported by survey participants from Gdańsk (80%), which can be linked to the launch of municipal shared electric scooter, moped and bicycle systems in 2019. In Warsaw and Berlin, the percentage of respondents indicating an increase in the number of micro-mobility vehicles on pavements was lower, although still significant – 61% and 59%, respectively. At the same time, a smaller percentage of respondents in these cities felt that their sense of safety as pedestrians had deteriorated (Warsaw – 17%, Berlin – 23%), while in Gdańsk as many as 32% of respondents expressed this opinion, which may be directly related to the dynamic introduction of shared vehicle systems into the urban space (Fig. 7 and Fig. 8). It is also worth noting that in all three analysed cities, changes in the use of both public and private transport were recorded during the period under review, resulting from the restrictions and effects of the COVID-19 pandemic. This circumstance may have influenced to some extent the respondents' subjective feelings about safety and the perceived traffic intensity in public spaces.

From the standpoint of evaluating the overall suitability of urban spaces for micromobility vehicles – an aspect closely linked to user safety – participants rated Berlin's transport infrastructure the highest (62%). Warsaw (46%) and Gdańsk (44%) received noticeably lower, though still moderately positive, assessments. Despite the generally favourable perceptions of spatial suitability, respondents expressed greater criticism regarding the technical condition of vehicles available through sharing systems, which may also have implications for user safety. Only 45% of the respondents in Berlin, 40% in Warsaw, and 37% in Gdańsk described the condition of these vehicles as good. It is also noteworthy that a considerable share of participants were unable to assess this aspect – 42% in Gdańsk, 35% in Berlin, and 33% in Warsaw. The lowest-rated element concerned the availability of parking spaces (including informal or unmarked ones) for micromobility vehicles, which was deemed satisfactory by merely 28% of the respondents in Berlin and Warsaw, and 24% in Gdańsk.

Although the respondents observed an increase in pedestrian traffic on pavements, only participants from Berlin expressed a clear preference for prohibiting the use of micromobility vehicles in these areas – 87% of respondents supported such a restriction. This stance corresponds with Berlin participants' more favourable evaluations of micromobility infrastructure and the overall suitability of urban space for this mode of

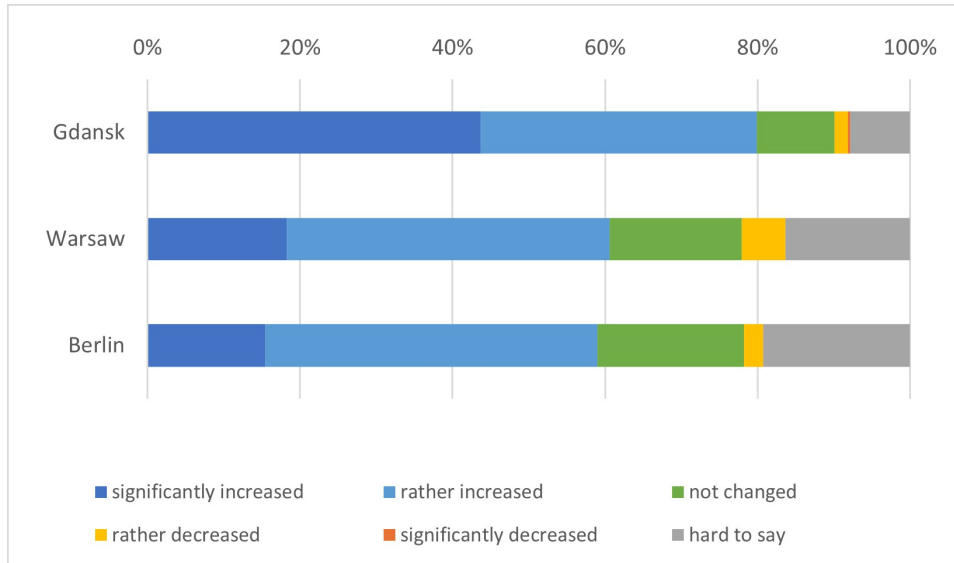


Fig. 7. Changes in the intensity of micro-mobility vehicle traffic on pavements in the 12 months prior to the survey.

Source: own elaboration.

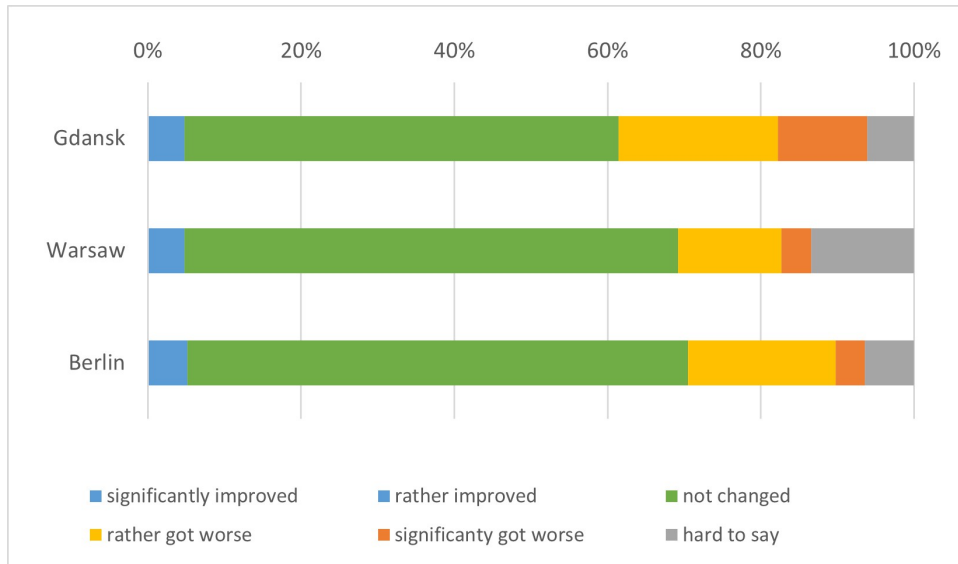


Fig. 8. Changes in the sense of safety on pavements from the perspective of pedestrians in the 12 months prior to the survey.

Source: own elaboration.

transport, despite concurrent concerns regarding the limited availability of parking spaces. In contrast, significantly lower levels of support for introducing a similar ban were reported among respondents from Gdańsk (54%) and Warsaw (43%).

Respondents were also invited to share their views on the necessity of introducing modifications to urban transport infrastructure. The most pressing need identified was the development of dedicated lanes for micromobility vehicles, indicated by 33% of the respondents in Gdańsk, 32% in Warsaw, and 30% in Berlin. The second priority, as perceived by the participants, was the expansion of parking facilities for personal transport vehicles. In Berlin, this measure was regarded as equally important as the development of road infrastructure for micromobility

(30% of the respondents), whereas in Gdańsk and Warsaw, support for this initiative was lower – 21% and 17%, respectively. Other notable proposals included the installation of motion sensors at pedestrian crossings and level crossings to enhance the mobility of micromobility users (particularly in Berlin and Gdańsk), as well as the introduction of speed limits for such vehicles, which was most strongly supported by respondents in Warsaw.

The survey questionnaire also included questions related to the pandemic and its impact on the use of personal vehicles as an alternative form of transport during infectious disease outbreaks – here, the opinions of the respondents from all three cities were similar, with the majority of the respondents perceiving this form of intra-city mobility as a good

substitute for public transport during epidemic threats. In addition, the respondents from Warsaw treat the use of these vehicles as an important supplement to everyday public transport.

#### 4. Conclusions

The results of the study reveal clear differences in perceived safety depending on the surveyed city, which can be linked to different levels of transport and micro-mobility infrastructure development. The highest sense of safety was recorded in Berlin, where the survey participants were less likely to point to an increase in the volume of micromobility traffic on pavements and more likely to support a ban on micromobility in pedestrian areas. These attitudes may result from a more advanced level of infrastructure development in the city, enabling more effective separation of pedestrian and vehicular traffic.

In Warsaw and Gdańsk, safety ratings were noticeably lower. In Gdańsk, pedestrians most often pointed to a deterioration in their sense of safety and an intensification of micromobility traffic on pavements, which may be a consequence of the dynamic development of shared scooter and bicycle systems in recent years. In Warsaw, on the other hand, despite a higher motorisation rate, pedestrians were less likely to report a decline in safety, while users of micro-mobility vehicles were more likely to perceive riding on the streets as high risk.

The varying perceptions of safety in the surveyed cities point to growing challenges associated with the development of micromobility and the introduction of modern transport technologies, including autonomous vehicles. The dynamic transformation of modes of transport in urban areas, coupled with limited

infrastructure adaptation, generates potential risks to residents' health and safety. In particular, the sharing of space by pedestrians, users of micro-mobility vehicles and traditional means of transport is proving problematic, leading to an increased risk of collisions, spatial conflicts and congestion on existing transport routes.

An additional challenge is the lack of comprehensive legal regulations and technical standards that would clearly define the rules for the use of micro-mobility and autonomous vehicles in cities. As a result, there is a phenomenon of 'spatial competition' between different forms of transport, which may result in a deterioration in the residents' quality of life, increased traffic stress and the risk of accidents.

In this context, the obtained research results may constitute a valuable starting point for in-depth qualitative analyses of mobility culture, user behaviour and ways of sharing common spaces. They also constitute important diagnostic material for local authorities and urban planners, enabling the development of more sustainable, safe and health-friendly urban transport development strategies. The integration of micromobility and autonomous technologies into the existing transport system should be carried out in a controlled manner and based on empirical data, taking into account safety aspects and the needs of all city users.

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