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Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 69 (2023) 647–654

Transportation Research Procedia

www.elsevier.com/locate/procedia

AIIT 3rd International Conference on Transport Infrastructure and Systems (TIS ROMA 2022), 15th-16th September 2022, Rome, Italy

Monitoring speed variation and pedestrian crossing distraction in Enna (Sicily) during different pandemic phases

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Abstract

The growing phenomenon of teleworking and the recent covid-19 pandemic have caused the volumes of pedestrians who routinely cross the city to change since March 2020. This change may have resulted in further damage to the health of pedestrians due to limited activity. Some recent studies point to slight changes in walking speed and stride length compared to changes in the number of steps, these changes were consistently seen during the state of emergency, they showed that people tried to walk faster in their outdoor walking. For the safety of pedestrians, it is necessary to analyse not only the change in speed when crossing but also the potential factors influencing it. These factors include user-related variables (gender, age, weight) and variables related to potential distractors such as smartphone use or walking in groups. The results of measurements made during the pandemic period (4 different phases) in pedestrian traffic in the zebra crossing area are also presented. The research was conducted in a zebra crossing area located in a small town in Sicily (Enna) frequently used by workers, students and elderly people. The results showed that during the first and second pandemic phases (May to October 2021) there were significant changes in the way of moving and the speed of pedestrians at crossings. The same crossings were also examined in the late autumn of 2021 (third and fourth pandemic phases) and the data show further changes in pedestrian behaviour. The data collected can help to improve safety in the area of pedestrian crossings through infrastructural actions or educational programmes and campaigns, especially among vulnerable groups of pedestrians.

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2352-1465
10.1016/j.trpro.2023.02.219

Keywords: pedestrian distractions, crossing behaviour, walking speed.

1. Introduction

Walking outdoors is one of the most popular activities in the world, but the recent pandemic has changed people's lifestyles. The ability to walk is the key element of mobility that enables the continuation of independent living in ageing (Rantakokko et al.,2013). Difficulties associated with walking shorter distances represent a critical level below which independent mobility may be threatened (Hirvensalo et al.,2000Mänty et al. ,2007; Hardy et al.,2011). Walking performance is determined by an interplay of neuromuscular, cardiorespiratory, and sensory functions, all of which decline in ageing (Rantanen ,213). Habitual physical activity can help slow the decline of walking determinants and maintain walking ability and independence (Karavirta et al.,2022). In particular, behavioural restrictions have affected people's physical activity. In recent years, portable health monitoring technology has made it possible to monitor activity levels such as steps taken per day and heart rate (Natarajan et al.,2020). Some scientific reports have been based on such data (Fitbit Staff 2020; Tison et al.,2020) , others on online questionnaires (Srivastav et al.,2021) or observations of recorded videos. Research has confirmed that the amount of activity of individuals/week has decreased in terms of the number of steps taken, as in previous reports. It appeared that the walking pattern of individuals changed, as if to compensate for their inactivity. The greatest changes in walking speed and stride length were recorded during the state of emergency. This work focused on a literature review of the distractions that pedestrians experience when crossing and the variations in speed according to certain socio-demographic factors such as gender and age of the pedestrian. Speed variation has highlighted some aspects related to road safety and public spaces, but also brought to light some variations in habits which in turn may have social and health implications. The analysis of a case study highlighted the trends of speed variation in the same crossing in an urban context considering the different pandemic phases. Walking speed, or gait speed, is the habitual pace at which we walk when performing daily activities. Walking speed has an inverse proportionality with age. Slow speed is a constant risk factor for disability, cognitive impairment, institutionalisation, falls and death (Middleton et al.,2015; Hackett et al.,2018). Advancing age produces a loss of mobility causing a range of negative effects including reduced physical activity, obesity and reduced strength and balance; and may contribute to chronic diseases such as diabetes (Filgueira et al.,2021). A loss of mobility can also lead to social isolation, putting us at risk of mental health problems such as depression and cognitive decline. These results highlight the need to rethink the planning of certain urban spaces such as intersections and to disseminate careful public health messaging regarding respecting social distance and promoting walking and physical activity for the general improvement of public health (Christofaro et al,2021).

2. Literature review

Examining the changing traffic safety environment can provide insights into where to look for opportunities to implement countermeasures. In the first half of 2021, European data highlighted an increase in journeys but not yet at the levels seen before March 2020. Given the observed decrease in accident rates in 2021 compared to 2020 and external projections of increases in pedestrian fatalities, there is a need to improve data to understand potential changes in pedestrian safety, particularly in areas where pedestrians walk. Changes in drug and alcohol sales and other reported behavioural changes also warrant continued exploration. In particular, increases in alcohol and marijuana sales, while indirect measures of road safety risk, are indicators of social changes that may have implications for road safety (Katrakazas et al.,2020;Alhajyaseen et al.,2021) . Several studies have analysed the results of restrictions on mobility choices. A study in Germany analysed the overall mobility of the population, derived from mobile phone data, and observed a proportionality with stricter government interventions. Furthermore, in cities with increasing bicycle traffic, government interventions were found to reinforce the positive impact of the pandemic on cycling (Möllers et al.,2021). In Spain through the use of mobile phone data it was found that mobility levels before COVID-19 were slightly higher in areas of lower deprivation. The period of economic hibernation led to a very strong decline in mobility, especially in areas of low deprivation. These differences weakened during the reopening, and mobility levels were similar by deprivation once the freeze was completely lifted (Glodeanu et al.,2021). Several studies carried out in Italy, particularly in Sicily, have shown a clear reduction in the use of public transport (mostly buses) due to the emerging fear of infection on board and the associated state of anxiety and stress (Campisi ert al.,2021; Basbas et al.,2021a; Basbas et al.,2021b). The mobile device location data analysed in New York City showed that the average

miles travelled on the main traffic mode per person per day, the percentage of business trips have a positive effect on people involved in accidents(Zhang et al.,2021). On the contrary, unemployment rate and inflation rate have negative effects on people involved in accidents. In addition, the research pointed out that different levels of control policies during the COVID-19 epidemic were associated with safety awareness, driving and travel behaviour, and thus have an indirect influence on accident frequency. In Japan, the changes in walking speed and stride length were small compared to those in the number of steps (Obuchi et al.,2021). Such changes were consistently seen during the state of emergency, suggesting that people tried to walk faster in their outdoor walking. This change in walking behaviour may have protected further health deterioration due to restricted activity. The COVID-19 pandemic has resulted in a reshaping of the demand for safe and physically remote walking, cycling and outdoor commerce spaces. A range of actions have been implemented of both a temporary and a permanent nature such as carving out space on the roadway for uses other than cars, putting up pedestrian signs, reducing speed limits and subsidising bicycle sharing schemes. Several studies have analysed the above processes and their implications for future efforts to design and implement pedestrian and cycling infrastructures pedestrian and cycling infrastructures, and the ways in which transport professions might evolve in response to lessons learned during and after the pandemic (Combs et al.,2021; Campisi et al.,2022). Among the restrictive measures adopted is social distancing to mitigate disease transmission. The use of social distancing corresponds to a significant increase in an internal flow length scale, i.e. the radius within which pedestrians repel each other (Kramer et al.,2021). Through the simulation of two-dimensional pedestrian dynamics modelling pedestrian counter-flows under confinement. The results revealed significant dependence of the average speed on the independent variables (the pedestrian density and the degree of social distancing). A study conducted by (Echeverría-Huarte et al.,2021) have pointed to a correlation between pedestrian density, walking speed and prescribed safety distance, indicating useful density ranges (approximately 6 m2 per pedestrian) to ensure an interpersonal distance of 1 m). Such data are useful for establishing density restrictions in urban and architectural spaces based on scientific evidence. Through the use of spatio-temporal models of pedestrian mobility and by developing a variation of the pedestrian level of service measure, research has estimated the pandemic pedestrian level of service (P-PLOS), i.e. introduced a dynamic view of pavement capacities according to interpersonal distance recommendations during the pandemic, making it possible to know where and when it is necessary to take tactical urban planning measures to maintain or improve the level of service, as well as where it is necessary to take measures to reduce pedestrian flow (Talavera-Garcia et al.,2021). A study conducted through social clustering (Li & Xu,2021) pointed out that social restrictions led to differences in flow patterns and increased social distance. Unlike previous studies that distinguished different points of interest by functional category this research provided a new perspective to differentiate clusters using pedestrian flow patterns considering reopening policies by region and period. Generally in urban spaces and roads the COVID-19 pandemic has generally reduced the numbers of collision accidents, and their fatalities and injuries, despite the relative increase in the severity of injuries and fatalities. This is related to the decrease in mobility with often empty lanes, the reduction in crowding and the increase in speed (Yasin et al.,2021). Variation of pedestrian speeds as well as density and level of service are often parameters that are obtained from the use of microsimulation tools and allow a comparison of possible scenarios. The evolving size and frequency of mass events and the study of crowd disasters by simulating pedestrian flows have become important areas of research. Various modelling approaches such as Newtonian force-centred approaches are not yet fully consistent with empirical observations and are sometimes difficult to calibrate. A study conducted by (Moussaïd et al.,2011) predicted the emergence of self-organising phenomena such as the spontaneous formation of one-way lanes or stop-and-go waves, making it possible to achieve a more realistic modelling of collective social behaviour, in particular of human crowds and biological swarms. In order to address the critical issues induced by the restrictions and thus the pandemic and to improve advanced urban planning activities, several actions are being directed towards the study of walkability and the improvement of infrastructure to support walkability. Planning efforts include the development of strategies and design elements that improve the accessibility, comfort and safety of the urban walking environment, while also considering the needs of vulnerable road users (i.e. pedestrianisation of urban areas, barrier-free streets, public spaces for outdoor activities). According to the General Theory of Walkability (Speck, 2018), the essential elements for assessing the level of walkability of urban environments with particular reference to :

- Presence of services within walking distance;
- Level of comfort and safety experienced by pedestrians;
- Attractiveness of urban areas in terms of architectural design and social context.

As highlighted by the 2030 Agenda for Sustainable Development Goals (SDGs) adopted by the United Nations in 2016, there are several goals directly related to making walking a primary mode of travel as well as a first and last mile solution to connect to public transport. Walking provides direct access to any urban opportunity, and accessibility is the defining element that cuts across all other urban disciplines. Walking, therefore, ensures the social participation provided by a system of public spaces, primarily streets, squares and parks. Several potential distractors generally cause pedestrians to alter their walking or crossing speed at traffic light intersections (Truong et al.,2019; Liu et al.,2021, Campisi et al.,2022b). Several factors contribute to the presence of the aforementioned distractors such as age, gender and/or income. A study conducted by (Deluka-Tibljaš et al.,2022) suggest more detailed analysis of the impact of distractors and of COVID–19 pandemic non-mobility, as well as an analysis of possible infrastructural solutions to increase children's road traffic safety, is suggested. The present work focused on the observation of a pedestrian traffic light intersection near a primary and secondary school in the city centre of Enna. The intersection analysed has been studied over the years to measure pedestrian and driver safety by comparing different scenarios with different flows (Ištoka Otković et al.,2021) or specific traffic-light duration (Collotta et al.,2014; Pau et al ,2018). Through the use of videocamera it was possible to record weekly data in different pandemic phases and it was possible to reconstruct the pedestrian speed trend, the composition and density in one of the arms of the intersection obtaining a comparison of the results and allowing to define some strategies to obtain the best results.

2. Methodology

A survey campaign through the use of video cameras was carried out at urban location of Enna city in the centre of Sicily (Italy) during the period 08March 2021-December2021. The monitored area is characterised a 4 arms intersection and by 4 crossings on either side of the intersection, one of which is the most crowded and was the subject of this study with traffic light regulation near offices and schools. Through the use of video cameras, 4 weeks of pedestrian flows were recorded for both directions (A-B and B-A). The 4 weeks monitored correspond respectively to

- the first week of May 2021 (1st week),
- the first week of July 2021 (2nd week),
- the first week of October 2021 (3rd week),
- the first week of December 2021 (4th week).

The peak day monitored is Tuesday of each week as this is the day when there is both an open-air market and other activities near the urban traffic light intersection.

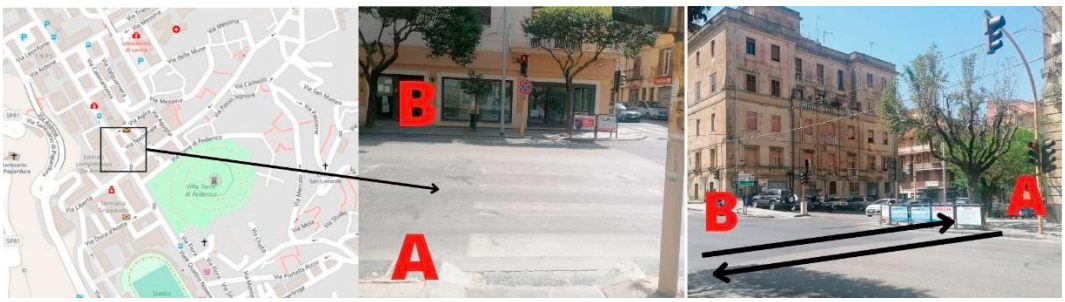

Fig. 1. Analysed pedestrian crossing and relative urban area (maps source: https://www.openstreetmap.org/#map=17/37.56296/14.27247)

Although various restrictions related to work and school activities were defined during the four weeks, the pedestrian flow in the area remained almost constant in total value. The research defined the trends of pedestrians who respectively crossed the pedestrian area during the 4 weeks in the two directions considering 4 actions namely :

- walking without any active device (smartphone, tablet or similar)
- crossing while talking on the phone

- crossing while wearing headphones
- crossing while chatting

3. Results

With regard to the analysed pedestrian traffic volumes, reference can be made to Table 1

Table 1. Pedestrian volume registered on analysed area

Pedestrian Volume (ped/h)	1st week	2nd week	3rd week	4th week
direction A_B	117	120	121	127
direction B_A	103	105	104	106
total	220	225	225	233
Pedestrian crossing length: 14m and width of approximately 4 m; pedestrian green time =40 sec and pedestrian red time =39 sec				

4 different groups of people were analysed according to age by observing the images taken i.e. children up to 8-10 years old, young people up to 18-25 years old, adults up to 55 years old and the elderly i.e. people over 55 . Therefore, the distributions in the figures below were recorded for walking (a) and crossing while talking on the phone (b), respectively.

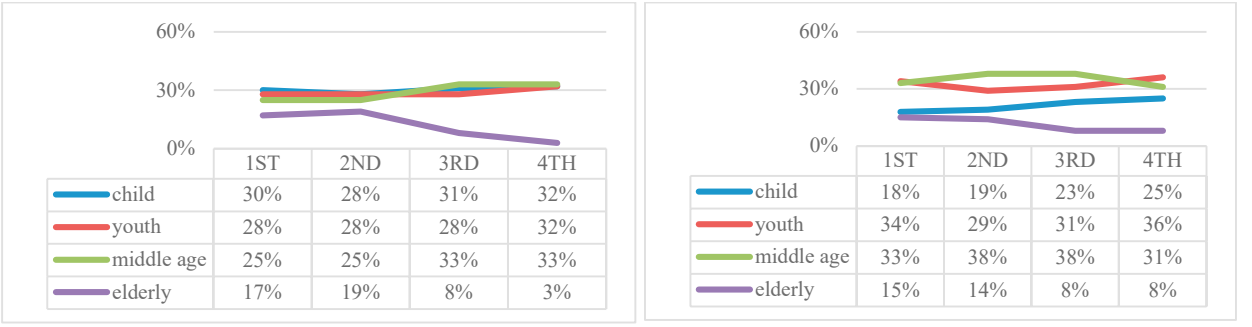

Fig. 2. (a) walking trend; (b) talking trend during pedestrian ,crossing phase

There was a reduction in the number of seniors and young people in weeks 3 and 4 due to the increase in online teaching compared to face-to-face teaching. Decreasing trend of elderly people during week 3 should be justified by the increase of positives in the city. Considering the combined action of crossing and talking on the phone in the right-hand graph of figure 2 it can be seen that young people and adults are most likely to cross while talking, a slightly increasing trend was recorded among children while a deflection for the elderly. With regard to crossing while wearing headphones and chatting, it is possible to analyse the trends on the left-hand graph for wearing headphones and the right-hand graph for chatting in Figure 3 respectively

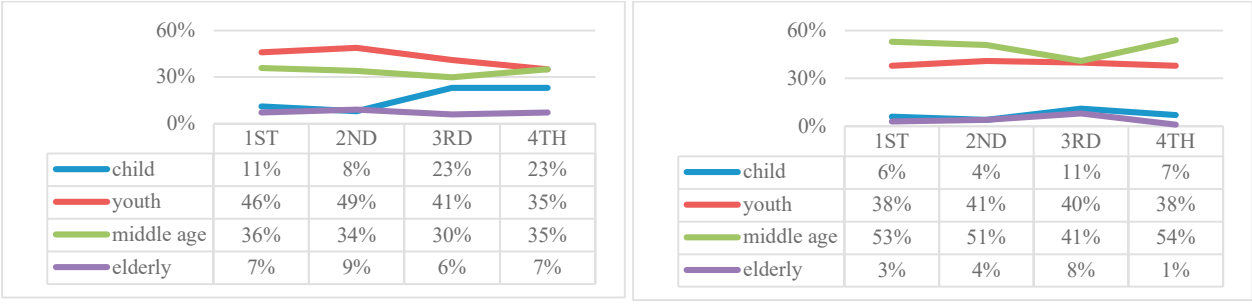

Fig. 3. (a) wearing headphones trend; (b) chatting during pedestrian crossing phase

According to the use of the traffic signal, pedestrians can be classified into 2 categories: pedestrians crossing the road during the green signal (regular users); pedestrians crossing during the red signal (trainers) . With regard to the trend of speed variation per walk, the trend with the lowest values for the population group characterised by children with values between 0.87 and 0.9, while the highest trends were recorded by young people with speeds between 1.28 and 1.36. Several works in the literature report that the average speed of the elderly is 0.92 metres per second while a person with a normal step is about 1.2 m/s.

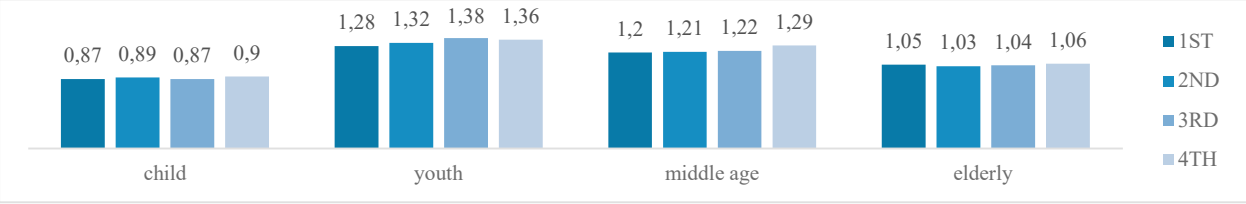

Fig. 4. Walking speed variation (m/s) during pedestrian crossing phase

With regard to crossing also related to talking activities, young people still have the highest speed trends.
The lowest trends are connected with both children and the elderly for issues related to the perception of the environment and psychophysical conditions.

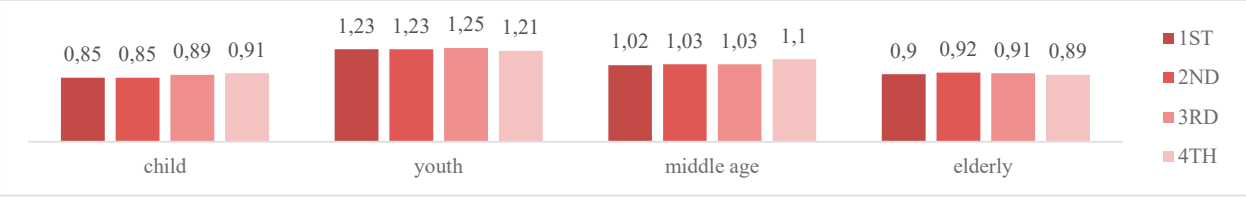

Fig. 5. Speed variation (m/s) talking during pedestrian crossing phase

Speed trends decrease as users cross the road while wearing headphones or similar, and a reduction to around 0.79-0.8 m/s is noted for children and a trend of 0.89-0.69 for the elderly. An even smaller speed trend for the elderly could also result from the presence of masks limiting vocal sound. The phenomenon is linked to figure 6 below

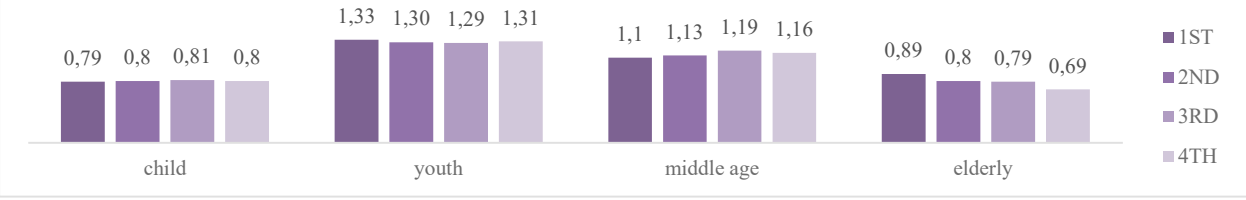

Fig. 6. Speed variation (m/s) wearing headphones trend during pedestrian crossing phase

Finally, speed trends are reduced overall as users cross and chat at the same time. This is because it implies a greater

visual focus on the screen than on the surroundings like described on figure 7

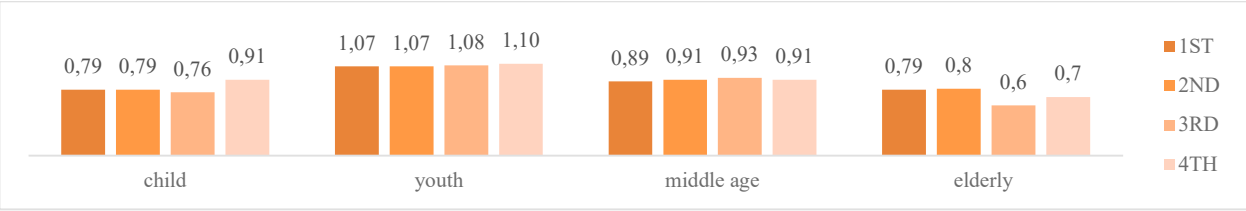

Fig. 7. Speed variation (m/s) chatting during pedestrian crossing phase

4. Discussion and conclusions

The urban analysis of the monitored crossing showed substantial uniformity in the volumes of pedestrians crossing. What was recorded as different was the composition, i.e. the percentage of pedestrians of different ages. The third week monitored corresponding to the implementation of increased restrictions adopted at local and national level and also a noticeable increase in the number of admissions tested positive for COVID-19 especially for the elderly class, which led to a drastic reduction in the percentage of elderly people walking in the city and the area examined. In addition, the activities that pedestrians generally commit during pedestrian crossings were monitored, and a considerable gap between the 4 classes was noted, especially with regard to the issue of chatting while crossing the road. It was estimated that this compared to the other activities that lead to a possible reduction in safety was the one that led to the greatest reduction in speed, especially in children and the elderly. The monitoring provided a greater change in walking speed for young people with a reduction in speed of 0,44m/s versus a reduction of 0,2m/s for children's walking versus only 0,07m/s for adults and 0,01m/s for the elderly It can be observed that all the trends relating to the three activities carried out at the same time as crossing the road show almost similar trends between the elderly and children and between adults and young people. In general, in terms of speed, there is a decrease for elderly people crossing the road while chatting (down to 0, 6m/s) or wearing headphones or the like (0.69m/s). There is not only a general reduction in speed, but also a substantial reduction in the number of activities carried out at the same time. These trends are probably due to the different psycho-physical and perceptive conditions of the surrounding environment and the greater difficulty for the elderly and children to perform several activities at the same time. The results provide a basis for further research related to the field of road crossing safety, improving the urban planning of crossings and their surroundings

Acknowledgements

The authors would like to acknowledge that this research was supported by the project “Transport infrastructure in the function of sustainable mobility” (uniri-tehnic-18-143—1289) supported by the University of Rijeka, Croatia.

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