



Analysis of illegal pedestrian crossing behavior on a major divided arterial road



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ARTICLE INFO

Article history:

Received 10 May 2016

Received in revised form 22 October 2017

Accepted 18 January 2018

Keywords:

Jaywalking
Vehicle conflicts
Pedestrian safety
Crash risk
Behavior

ABSTRACT

Pedestrians' illegal mid-block crossing increases the chances of a crash compared to crossing at marked or signalized crosswalks. Therefore, it is necessary to have an accurate understanding of this type of behavior to be able to prevent it. This paper presents the results from a comprehensive study undertaken to gain insight into illegal pedestrian crossing behavior on a high-speed six-lane divided arterial road that runs through a high-density urban area. Pedestrian behavior data were collected during the different stages of illegal crossing including before crossing, during crossing, and after crossing to determine the effect of hindrances, vehicles, and other pedestrians on the crossing behavior. The results showed that the illegal crossing behavior is mostly undertaken by male pedestrians. Over one-third of all pedestrians crossed in the presence of a vehicle on the road. Out of this group, almost one-third crossed using a rolling gap. The waiting time before crossing was affected by the group size, crossing point (curb or median), and the presence of other pedestrians on the opposite side of the road. Most of the pedestrians crossed the road during their first attempt and used the shortest path to cross. The crossing time was affected by gender, age, mobile phone use, type of clothing, crossing in a group, crossing point, path of crossing, and presence of a vehicle. The decision to cross was based on the presence of vehicles in the middle or far lanes for most pedestrians. Overall, the presence of a vehicle, as well as other pedestrians and hindrances, altered the illegal crossing behavior of pedestrians.

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1. Introduction

Pedestrians are an integral element of the transport system and are at a greater risk of being involved in a crash compared to other road users. Pedestrians crossing the road using unsafe means are more exposed to the risk of crashes compared to those walking on sidewalks. Furthermore, crossing at unmarked mid-block sections increases the chances of a crash compared to crossing on a marked or signalized crosswalk. In a marked crossing, (predictable situation) pedestrians have a well-designated space to use for crossing, equipped with signs to alert drivers to be prepared and reduce their speed. At these crossings, most drivers will give way to pedestrians, minimizing the chances of a conflict. On the other hand, (ambiguous situation) while crossing at an undesigned mid-block section, the space for crossing is not known to the driver or the

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pedestrian. In many cases, the driver is not aware at all that a pedestrian will cross in that section. Even if a driver sights a pedestrian, the priority is not set; not knowing who will yield to the other creates a state of confusion.

Furthermore, the crossing maneuver is largely dependent on the pedestrian's assessment and perception of the surrounding condition. If the pedestrian underestimates the risk, then there is a greater chance of a pedestrian-vehicle interaction. [Zhuang and Wu \(2011\)](#) found that pedestrians are more tense while crossing an unmarked roadway compared to a marked roadway. The installation of a marked crosswalk on the road gives the pedestrian a sense of safety, which makes them more confident while crossing. Past studies found that the waiting time was less and the crossing speed slower at a marked mid-block crosswalk compared to an unmarked crossing ([Havard & Willis, 2012](#)).

Previous research comprehensively analyzed pedestrian safety in urban areas, but limited studies were found in the area of analyzing pedestrian crossing behaviors. Studies focused on pedestrian behavior at signalized intersections ([Brosseau, Zangenehpour, Saunier, & Miranda-Moreno, 2013](#); [Lipovac, Vujanic, Maric, & Nesic, 2012](#)), unsignalized marked crosswalks ([Hamed, 2001](#); [Havard & Willis, 2012](#)), or signalized marked crosswalks ([Rosenbloom, 2009](#)) but few studies investigated illegal crossing behavior ([Havard & Willis, 2012](#); [Zhuang & Wu, 2011](#)).

Zhou et al. examined pedestrians' intentions of illegal crossing using a self-reported questionnaire survey in Dalian, China ([Zhou, Romero, & Qin, 2016](#)). The pedestrians showed a negative attitude towards illegal crossings and reported that the presence of other pedestrians, especially friends and family, would have an influence on their intention to cross illegally. The self-reported responses do not reflect the actual crossing behaviors, so observational surveys are more appropriate to study the crossing behaviors ([Papadimitriou, Yannis, & Golias, 2009](#)).

Sinclair and Zuidgeest studied the factors that affect the crossing decisions of pedestrians on freeways in regard to selecting illegal crossing or footbridges in Cape Town, South Africa ([Sinclair & Zuidgeest, 2016](#)). The pedestrians crossing at grade did not underestimate the risk from high-speed vehicles but still chose to make an unsafe crossing to save walking distance and time and avoid being a victim of crime. The pedestrians' intentions to cross roads in various circumstances were analyzed using the theory of planned behavior, and it was found that demographic subgroups divided by age, gender, or driving status differ significantly and perceive risks differently and thus require separate attention in road safety programs ([Holland & Hill, 2007](#)).

[Zhuang and Wu \(2011\)](#) found that almost half of the pedestrians had some distractors while crossing. These distractors included mobile phone use, talking, eating, smoking, and carrying bags, all of which had small effects on the crossing behavior. For pedestrian crossings, on divided and undivided roads, pedestrians were found to behave differently while crossing from curb to median and from median to curb ([Hamed, 2001](#); [Havard & Willis, 2012](#)). This illegal crossing behavior was not evaluated in detail before, but it was highlighted that the crossing is done in two stages ([Cherry, Donlon, Yan, Moore, & Xiong, 2012](#)) on a six-lane road without a median.

While the behavior of pedestrians at some facilities has been researched, almost no studies have investigated the illegal behavior of pedestrians along high-speed major divided arterial roads in high-density areas. The main objective of this study is to understand pedestrians' illegal crossing behavior on a major six-lane divided arterial section in a densely populated neighborhood using field observations from Doha, Qatar. Illegal crossings in these types of facilities are riskier, as the flow of vehicles is continuous and pedestrians are required to process the traffic conditions in multiple lanes before stepping into the road. In addition, the driving at higher vehicle speeds on urban roads puts restrictions on the vehicle and pedestrian yielding behaviors. Furthermore, on divided roads, the process of crossing is repeated twice in a short period of time since each pedestrian has to cross from the curb and then cross again from the median. The study attempts to determine the effects of hindrances and the presence of vehicles and other pedestrians on the illegal crossing behavior and investigates different variables that were not explored in previous research during the different stages of crossing (before crossing, during crossing, and after crossing), as explained in the next section. Furthermore, this study is considered the first in Qatar and the Arabian Gulf region, which is a region with unique culture and weather conditions.

2. Methodology

2.1. Study site

This study was conducted in Qatar, where almost one-third of fatalities are pedestrian-related ([QNTSC, 2013](#)). This high proportion of pedestrian fatalities is higher than those in many countries around the world such as the United Kingdom (21.8%), the United States (12.8%), and Australia (12%) and close to the rates for other countries in the Arabian Gulf region such as the United Arab Emirates (28.7%) and Oman (23.4%) ([WHO, 2016](#)).

This study uses observations recorded from a mid-block section on a busy road in downtown Doha. The studied road is a major six-lane divided arterial with many banks and businesses on both sides. The data were collected on two typical weekdays, for twelve consecutive hours each day, using four video cameras, during the month of March, when the prevailing climate conditions are pleasant in Doha. The positions of the cameras were chosen to get a complete view of both sides of the entire section with some overlaps along the length of the road.

This section is of approximately 368.50 m in length between the crosswalks (390 m center to center) of two signalized intersections equipped with pedestrian signals. The width of the road is 12 m in each direction (3 lanes at 3.65 m each

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