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Preliminary communication

The effectiveness of installing physical barriers for preventing railway suicides and accidents: Evidence from Japan

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ABSTRACT

Background: Installing physical barriers, such as platform screen doors (PSDs), on train platforms is considered to be one of the most effective measures to prevent railway suicide. However, there is little evidence on the effectiveness of such barriers. In particular, the effectiveness of half-height, as opposed to full-height, PSDs has never been assessed.
Methods: Using suicide and accident data between 2004 and 2014 provided by a major railway company in the Tokyo metropolitan area, this study examines whether the installation of half-height PSDs has contributed to the reduction of the incidents of fatal and non-fatal railway suicide. In addition, the study tests whether the installation of PSDs has resulted in the reduction of unintentional falls onto railway tracks.
Results: Our estimation using a Poisson regression model showed that the introduction of PSDs resulted in a decrease in the number of suicides by 76% (CI: 33–93%). Yet, the installation of PSDs has not completely prevented suicide, as there were cases in which passengers climbed them over. As for unintentional accidents, no fall accidents occurred at stations with PSDs.
Limitations: Our data come only from one train operator, and thus the generalizability of our results may be limited. We do not fully examine potential substitution effects.
Conclusion: Platform screen doors are effective in reducing the number of railway suicides. However, half-height PSDs are less effective than the full-height PSDs in preventing intentional entry to the train tracks. Installation of PSDs is an extremely effective method to prevent fall accidents.

1. Introduction

Suicide is a large public health problem. More than 800,000 people die from suicide every year, which amounts to one suicide every 40 s worldwide, according to the report by World Health Organization (World Health Organization, 2014). Suicide not only affects the families and friends of the decedents; it can also have a far-reaching impact on others. In particular, railway suicide can have an extremely huge impact on the general public. Railway suicide, which occurs at public facilities used by many, causes delays and disruptions of train schedules and can put a tremendous psychological burden on those who witness an incident. For example, in the Tokyo metropolitan area, where most commuters use trains and subways, the estimated number of passengers affected by one fatal incident of railway suicide can be as high as 83,000, disrupting normal operation for as long as 142 min (see below for data source). Railway suicide is also known to traumatize train conductors who witness such incidents (Cothereau et al., 2004; Farmer et al., 1992; Kim et al., 2013; Limosin et al., 2006; Weiss and Farrell, 2006; Yum et al., 2006). It can even physically harm passengers on the platform, as was the case in Tokyo in 2011 when four bystanders were injured by a woman whose body bounced back to the platform after she jumped in front of a running train.

Installing physical barriers, such as platform screen doors (PSDs), on train platforms is considered to be one of the most effective measures to prevent railway suicide (Ladwig et al., 2009; Law and Yip, 2011; Mishara, 2007). These doors open only when trains stop at stations, thereby limiting access to the platform by individuals who enter train tracks for the purpose of ending their lives. Because these doors can also prevent unintentional accidents, the installation of PSDs[1] has become popular among railway operators in many places, including Copenhagen, Guangzhou, London, Taiwan, Paris, and Hong Kong. In Japan, the government has urged train operators to install PSDs as a safety measure, especially at stations that serve more than 100,000 passengers per day (235 stations as of 2013).

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[1] PSDs: platform screen doors.

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However, there is surprisingly little evidence on the effectiveness of such barriers for suicide prevention. To our knowledge, the only case that has been studied is the railway system in Hong Kong where one of the train operators (MTR Corporation) has started the installation of full-height (i.e. ceiling-to-floor) PSDs on three lines (TWL, KTL, and ISL) in 2002. According to two related studies, the number of suicides at stations with PSDs decreased after the installation of the doors, while the number of incidents remained unchanged at stations without PSDs (Law et al., 2009; Law and Yip, 2011).

The present study examines PSDs in Japan in order to provide further evidence on the effectiveness of PSDs as a method of suicide prevention. Japan presents a unique case because most of its train operators employ half-height, as opposed to full-height, PSDs whose effectiveness has yet to be studied. The half-height PSDs in Japan are chest-height, and in theory can be climbed over by an adult. In contrast, the full-height PSDs, such as the ones used in Hong Kong, extend from the ceiling to the floor of the platform. Thus, entry to train tracks is completely blocked. Given the prevalence of half-height PSDs in many parts of the world, evaluating their effectiveness constitutes an important research agenda. This study examines whether the installation of half-height PSDs has contributed to the reduction of the incidents of fatal and non-fatal railway suicide. In addition, the study tests whether the installation of PSDs has resulted in the reduction of unintentional falls onto railway tracks.

2. Methods

Data on suicide and accidents are obtained from a major railway company in the Tokyo metropolitan area. Following the request from the railway company, the name of the company will remain anonymous. In order to avoid the identification of the company, the number of lines in the company's train network will also remain undisclosed.

The railway company maintains a database that records all incidents of accidents and suicides (both fatal and non-fatal) that occurred on its railway system. The information recorded in the database includes the date and time of incidents, station name/location, train number, detailed description of incidents, the estimated number of passengers affected by the incident, and the number of trains that were delayed and canceled as a result of the incident. The data on suicides cover the period of April 2004 to March 2014, while the data on unintentional accidents cover the period of April 2005 to March 2014. The company removed information that can lead to the identification of victims from the data before releasing them to us. The installation date of PSDs for each station was also made available by the train company. Because the suicide and accident data are anonymous data collected by the railway company, no ethics approval was necessary.

Incidents of suicide were determined as such only when the motives for entering train tracks became evident based on the investigation by the police or by victims' own account. Both fatal and non-fatal incidents of suicide are included in our analysis. As for accidents, included in the analysis are fall accidents that involved passengers falling onto the track area. The most common fall accidents were by drunken passengers who constituted 80% of all cases, followed by falls due to inattention (13%), sickness (6%), and collisions with other passengers (1%). Because the focus of this study is PSDs installed at stations, only incidents of suicides and accidents that occurred at stations are included in the analysis.

All stations of the network, except for the ones on the newest line that started operating in 2008 (8.7% of all stations), were included in the analysis. We excluded these new stations because their accident and suicide records were available only for a subset of years. Only one suicide occurred between 2008 and 2013 at these excluded stations. All of the stations on this line have half-height PSDs. After the exclusion of those stations, the number of stations included in the analysis was 168. We used monthly data for our analysis, and our unit of observation was the station-month. The total number of station-month observations totaled 20,160 (=168 stations $*$ 120 months).

The dependent variables were the number of suicides and accidents per station-month. The average number of suicides and accidents per station-month was 0.007 (s.d.=0.084) and 0.079 (s.d.=0.299), respectively. The minimum number was 0, while the maximum was 1 for suicide and 3 for accidents. The station with the largest number of suicides had a total of 7 suicides during the study period. The station with the largest number of accidents had a total of 74. The total number of suicides and accidents during our study period was 144 and 1821, respectively.

The main independent variable was a dummy variable valued at 1 if the station had PSDs installed in a particular month. The railway company installed its first PSDs in 1991 when they opened a new line. Because the company could design these new stations with PSDs in mind, it installed full-height PSDs at these stations. The train operator has gradually retrofitted existing stations with half-height PSDs since then. At the beginning of our study period in April 2004, 19 of the 168 stations in our study had PSDs installed, and 52 stations were subsequently retrofitted with half-height PSDs at different timings. As of March 2014, 71 stations (42.76% of 168 stations) have PSDs. Among them, 73.24% has half-height PSDs and the rest has full-height PSDs.

The height of half-height PSDs is 1.3 m (51 in.; the doors are 1.2 m), which is not impossible for an adult to climb over. The half-height PSDs that the company installed do not have an alarm system that alerts train conductors or staff when somebody tries to climb over them when the train is not at the station.

3. Results

We first report the average number of suicides and fall accidents per year by the availability of PSDs. Table 1 shows the total number of suicides and accidents in each year at stations with and without PSDs. It is evident that the number of suicides is much larger at stations without PSDs than those with PSDs. Yet, the installation of PSDs has not completely prevented suicide. In total, 7 suicides were observed at stations with PSDs. In contrast, no fall accidents occurred at stations with PSDs, while an average of 185 accidents per year occurred at stations without PSDs.

Next, we used a Poisson regression model based on a difference-in-differences (DID) approach. We regressed the number of suicides on an indicator variable, which equals 1 if the station had PSDs in a particular station-month observation. We did not estimate the effect of PSDs on the number of accidents because PSDs succeeded in the complete prevention of accidents.

In addition, in order to take into account the differences among stations (e.g., the number of passengers, the presence of express trains), we included station-specific dummy variables in the model. By including these dummies, we were able to separate the effect of PSDs on suicide from the effect of station-specific time-invariant unobserved factors. In addition, this method allowed us to estimate a temporal difference in the mean number of suicides before and after the installation of PSDs.

Second, in order to take into account the effects of time-varying factors (e.g., macroeconomic conditions) that can also affect the frequency of railway suicide, the model included year-month-specific dummy variables (fixed effects). By including the year-month fixed effects, the effect of such time-varying common factors was taken