

## ORIGINAL ARTICLE

## Is Our Child Safe on the Escalator?

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## ABSTRACT

**Introduction:** This study aimed to explore the behaviour of Malaysian children aged 5 and less when traveling on the escalator. **Methods:** An observational study was conducted at six randomly selected shopping malls in the Kinta District of Perak State in Malaysia. Sample size of 258 caregiver-child pairs was calculated. Children and their caregivers were observed for unsafe behaviours by using a checklist consisting of 15 unsafe behaviours (e.g.: child sitting on escalator, travelling facing opposite direction, playing with the emergency stop button, not following caregivers' instruction). The checklist was constructed from accredited escalator guidelines adapted from five different countries. A child was considered unsafe if there was at least one of the unsafe events observed. The proportion of child using escalator in an unsafe manner was analysed using IBM® SPSS® Statistics. **Results:** Of the 258 child-caregiver pairs observed, 149 (57.8%) children and 162 (63.8%) caregivers demonstrated at least one unsafe behaviour when using the escalator. 'Not following caregiver's instructions' (28.7%) was the most common unsafe behaviour among children while the most common unsafe behaviour among caregivers was 'not holding their child's hand when using the escalator' (41.7%). Four children used the escalator unattended. **Conclusion:** More than half of the children and their caregivers had used escalators in an unsafe manner and this required attention from the Public Health Department and the Department of Occupational Safety and Health to prevent unwanted injuries, especially among children.

**Keywords:** Escalator safety, Children, Caregiver, Unsafe behaviour

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## INTRODUCTION

Escalator-related injuries are common as there are 30 killed and 17,000 seriously injured annually in the United States (1). Children belong to the predominant group at risk of escalator-related injuries. There are an estimated 2,000 children getting injured annually in the United States (2). The average age of children in these escalator-related injuries events was six years old (3). The cases of escalator-related injuries among children doubled from the year 2012 to 2016 in Singapore (4). In Malaysia, there were 31 cases within the year 2011 to 2015, of which 97% involved young children (5).

Ninety-two percent of the escalated-related injuries were attributed to the user's unsafe behaviour, reported by Lim E., 2018 (6). Commonly reported unsafe behaviours include pram and stroller usage (11.7% of 248 events) (7), the wear of rubber shoes (76.5% of 17 cases) (7), unsupervised child play (8), failure to hold the handrail and running on the escalator (6).

The Occupational Safety and Health Act 1994 (Act 914) stated that it is the responsibilities of escalator owners to ensure the escalators are safe for use. The responsibilities were further specified in guidelines on the safe use of lifts and escalators 2010 by the Malaysian Department of Occupational Safety and Health (DOSH) (9). This includes the requirement to display sufficient safety signage and proper function of emergency stop button. Besides the owners' responsibilities, the Malaysian DOSH emphasized that users should shoulder part of the responsibility in ensuring safe use of escalator. Users should adhere to the safety precautions in order to minimise the accidental events (9). Nevertheless, escalator-related injury among Malaysian children remains a common occurrence. The latest incident was of a four-year-old boy losing half of his foot from being trapped in between the metal panel and the steps (10).

Escalator-related injuries in children may result in permanent physical disabilities. Among the 26 children involved in escalator-related accidents in New York, 50% required surgical intervention, 46.2% suffered severe injuries to the extremities, 46% sustained permanent cosmetic deformities, and 15.4% had significant functional losses (3). In Malaysia, deaths and permanent physical disabilities accounted for 14% of

the 85 elevator- and escalator-related injuries. One of the leading causes of these accidents was the wrongful use of the elevator and escalator (11).

Two recent escalator-related deaths involving children were reported in this country (12,13). One of the potential factors may be caused by parents behaviour when using the escalator with their children. The first case: a seven-year-old girl fell to her death when playing on the escalator due to the lack of her parents' full supervision (12). Another mortality case of a six-year-old girl occurred when her mother was talking over the mobile phone and was unaware of her daughter climbing over the escalator, slipping and falling off to the basement (12).

Given the severity of this problem and the impact of potentially permanent physical disabilities on the children resulting from escalator-related injuries, this study aimed to observe behaviour of caregivers and children aged 5 years and less taking the escalator at the shopping malls in Malaysia.

## MATERIALS AND METHODS

### Study design and study site selection

This observational study was conducted between November 2016 and February 2017 at the Kinta district of Perak State in Malaysia. The shopping malls were opted as the study site because more than half of the escalator-related injuries occurred in shopping malls (4). In this study, shopping malls which are only equipped with inclined or curved traveller, or without a pair of up-and-down escalators were excluded. By considering resources constraint (limited number of data collectors), the researchers decided to exclude malls only equipped with escalators of one direction. The reasons for excluding curved traveller include the structure is different from the escalator, and therefore the safety instructions to use curved traveller are also different (13). The users' behaviour would be different when using these two different types of machines. For example, users are not allowed to take stroller on the escalator whereas it is allowed on the curved traveller. Six out of 12 eligible shopping malls were selected based on the random numbers generated by EpiCalc 2000 Version 1.02.

Data collection was scheduled during weekends as an assumption that most of the caregivers would bring their children to shopping malls on weekends was made.

Permissions to conduct the study at the selected sites were obtained from the shopping mall managements prior to data collection. This study involved observation of children and caregivers with no interview or collection of unique identifiers. Ethical approval for informed consent waiver was obtained from the Medical Research Ethics Committee (MREC) Ministry of Health Malaysia (NMRR-

16-2191-33056). In the event if a child was found to have a highly dangerous behaviour on the escalator, the researcher would take the necessary action to intervene.

### Sample Size Calculation

The proportion of 97% of the children involved in the escalator-related injuries in Malaysia was adapted for sample size estimation (14). Confidence level of 95% and precision level of 2% were set in the sample size calculator for single proportion (EpiCalc 2000, v1.01), and the minimal sample size calculated was 280.

Every selected shopping mall was sampled in equal proportion ( $n=48$ ) and 24 samples were required to be collected from each up- and down-escalator.

### Sampling Method

Simple random sampling method was employed in data collection. A random number was generated using a mobile application known as Random Number Generator© version 1.2.3 by UX Apps installed in the researchers' mobile phones. The random number was then used to select a child from every eligible cohort of 10 consecutive children observed. An eligible child for this study was defined as a child who was (i) with height less than 110 cm, (ii) riding the escalator at the main entrance of the shopping mall, or (iii) in the safety zone of the escalator. The area of safety zone is measured by twice the width of the handrails and the length is eight inches outward from the escalator newel end (15).

Estimates of the children's age were made based on their height at or below the level of escalator handrail. The average height of a 5-year-old Malaysian child is  $107.90 \pm 6.72$  cm for boy and  $107.26 \pm 6.94$  for girl (16) which is within the standard height of the escalator handrail, ranging from 90 to 110 cm (9). Any child whose height is similar to or below standard would be estimated being less than 6 years of age.

A few possible conditions of the children at the escalator were anticipated by researchers; hence, sample selection had been further sub-defined. Each eligible child was observed as a single sample. If more than one eligible child is present in the family, the shortest one was observed by assuming that the shortest one was the youngest child in the family. If a group of children riding the escalator without supervision of parents/caregivers, each child will be considered as an individual sample. If more than one caregiver was present, researchers choose only the one that is nearest to the child or holding the child's hand. Infants carried by caregivers and child nearby or at the escalator other than the main entrance one was excluded.

### Tools development

A 15-item checklist assessing escalator safety features, caregiver and child's unsafe behaviour on escalator was developed based on the established escalator safety

guidelines available from different countries (Malaysia Department of Occupational Safety and Health, 2010; Canada Safety Authority, 2014; United Kingdom Safety Assessment Federation, 2011; Hong Kong Electrical and Mechanical Services Department, 2016; and Singapore OTIS Elevator Ltd, 2016).

Unsafe behaviour is defined as any act by a user disregarding the "safety rules, standards, procedures, instructions, and specific criteria in the system" (17,18). In this study, unsafe behaviours on escalator among caregivers and children were defined by at least one event of these following criteria adapted from the escalator safety guidelines: i) caregiver not holding child's hand; ii) child not following caregiver instruction including refusing to hold caregiver's hand; iii) caregiver/child not holding handrail; iv) caregiver travelling with more than one child; v) travelling in opposite direction to escalator movement; vi) carrying bags or other objects on the outside of the handrail; vii) placement of package on the moving steps, handrail, deck board or landing plate; viii) travelling with stroller, trolley or wheelchair on the escalator; ix) playing, running or sitting on or within the escalator safety zone; x) loose clothing that brushing against the escalator steps; xi) not standing within the yellow line of the escalator steps; xii) playing with the escalator emergency button; xiii) vandalising the parts and panels of the escalator; xiv) extending any parts of the body out of the escalator; xv) stopping when getting off the escalator; xvi) using improper shoes.

Basic escalator safety features, such as escalator warning signage, safety features including emergency button not blocked by other objects, were also included into the checklist for assessment.

### Inter-rater reliability testing

To standardize observations among 6 researchers, 3 simulated scenario videos comprising of unsafe behaviours listed in the checklist were selected (19). Individually, each of the 6 researchers were asked to observe and record the unsafe behaviours of caregivers and children into the checklist after watching the videos. Results were entered into SPSS version 20 for inter-rater reliability test and almost perfect agreement was achieved among the researchers (Fleiss' Kappa=0.933).

Additionally, researchers were trained to identify the type of caregiver. Types of caregiver include presumed both parents, presumed mother, presumed father, presumed grandparents, uncertain caregiver (nanny/maid). The context of presumption of types of caregiver were based on reasonable ground (physical characteristic / interaction / physical contact), or evidence (child addressing the caregivers).

### Techniques for Data Collection

For each of the selected mall, both up-and-down-escalators were considered as one pair of escalators

and observed for data collection. The average estimated escalator travelling time is approximately 20-35 seconds, and it was found to be difficult for a researcher to observe and record both the caregiver and the child's behaviour at the same time. Hence, two researchers were positioned at the escalator entry points for data collection; one of them observed caregivers' socio-demographic characteristics and behaviour when using the escalator, while the other one observed the child's behaviour. A pair of caregiver and child was considered as one sample.

The third pair of researchers was positioned at the exit-point of escalator to distribute leaflets about safe use of escalator to all the caregivers to create awareness about escalator safety. This applied to both up and down direction of the escalators.

### Data analysis

The primary outcome of the study was to determine the proportion of children with unsafe behaviour on or around escalator in shopping mall. The observation was considered unsafe if there was at least one of the checklists' events was marked as 'yes'. Categorical data analysed were presented in frequency and percentage.

## RESULTS

### Response rate

Of 280 observations performed, 258 observations were included for analysis while another 22 samples excluded were due to incomplete recording in the checklist. Approximately equal number of observations were collected from upward escalators 115 (47.9%) and downward escalators 125 (52.1%).

### Sociodemographic of study population

The most common type of caregivers observed with the children were presumed to be both parents (108; 41.9%), followed by presumed to be mother (74; 28.7%) and presumed to be father (58; 22.5%). Ethnicity of caregivers comprised of 45.7% Malay, 34.9% Chinese and 17.1% Indian. There were 4 children that took the escalator alone, and hence, 4 caregivers' socio-demographic data were not available. A maximum of 5 children were travelling with the caregivers on escalator was observed in one of the observations.

About equal proportion of boys (122; 47.3%) and girls (116; 45.0%) were observed among our study population. However, presumptions were made on the gender of 20 (7.7%) children which appeared unclear to the data collector, 15 of them were presumed as boys and 5 as girls.

### Unsafe Activities Observed among the Children

Slightly more than half of the children [149 (57.8%)] were noted having at least one unsafe behaviour when taking escalator. A total of 14 (5.4%) children were

walking/running at or near escalator unattended by their caregivers, including 4 (1.6%) children were alone all the time during the observation. There were events where the children were alone near the escalator but were accompanied by caregivers while riding on the escalator.

**Table I: Unsafe Activities Observed among the Children**

| Variables  | n=258,<br>n (%) |
|--|-----------------|
| Child not following caregiver instructions (e.g. refuse to hold parents' hands, running away from parents) | 74 (28.7)       |
| Touching the escalator parts   | 46 (17.8)       |
| Facing the opposite direction of travel  | 38 (14.7)       |
| Stepping on the escalator using improper shoes (soft-rubber shoes)   | 33 (12.8)       |
| Loose clothing that brushing against steps   | 28 (10.9)       |
| Child sitting on the escalator step  | 23 (8.9)        |
| Stop when getting off the escalator  | 20 (7.8)        |
| Leaning /riding /climbing over the sides handrails   | 18 (7.0)        |
| Not standing in between the yellow stripes and away from the skirting                                      | 14 (5.4)        |
| Carrying bag / other objects on the outside of handrail  | 13 (5.0)        |
| Vandalising the obstruction guards   | 10 (3.9)        |
| Extending any parts of the body out of the escalator   | 8 (3.1)         |
| Playing with the emergency stop button   | 0 (0.0)         |
| Placement of package on the moving steps, handrail, deck board or landing plate                            | 0 (0.0)         |
| Other unsafe behavior children   | 0 (0.0)         |

The specific types of unsafe behaviours' of children include children not following caregivers' instruction [74 (28.7%)], touching the step (moving parts), comb, skirt guard panel or handrail inlet [46 (17.8%)], travelling on the opposite direction of escalator [38 (14.7%)], wearing improper shoes [33 (12.8%)], and had loose clothing that brushed against the steps [28 (10.9%)] (Table I).

**Unsafe Behaviour Observed among the Caregivers**

About two-third [162 (63.8%)] of the caregivers were found to be practising at least one unsafe behaviour. The most common unsafe behaviour noted among caregivers was that they did not hold their child's hand when taking escalator [106 (41.7%)], using phone or tablet while travelling on escalator [78 (30.7%)], caregivers holding stroller / trolley / similar item on escalator [49 (19.3%)] and wearing loose clothing brushing against steps of escalator [32 (12.6%)] (Table II).

**Number of Unsafe Behaviours**

The number of unsafe behaviours was further analysed according to the episode of unsafe events among caregivers and children (Table III). Caregiver traveling with more than one child [83 (64.3%)] were significantly associated with more episode of unsafe behaviours among the children as compared to caregiver with one child [62 (49.6%)] (p=0.018).

**Adequacy of Basic Safety Features of Escalators**

All 6 shopping malls had adequately upheld five safety

**Table II: Unsafe Behaviour Observed among the Caregivers**

| Variables   | n=254,<br>n (%) |
|---|-----------------|
| Not holding the child's hand  | 106 (41.7)      |
| Using hand phone or tablet while taking escalator   | 78 (30.7)       |
| Holding stroller / baby carriages / pushing trolley / hand trolley / similar items on escalator | 49 (19.3)       |
| Loose clothing that brushing against steps  | 32 (12.6)       |
| Stepping on the escalator using improper shoes (soft-rubber shoes)                              | 27 (10.6)       |
| Carrying handbags / bag / other objects on the outside of hand-rail                             | 27 (10.6)       |
| Facing the opposite direction of travel   | 20 (7.9)        |
| Touching the step (moving parts), comb, skirt guard panel or handrail inlet                     | 15 (5.9)        |
| Leaning /riding over the sides handrails  | 12 (4.7)        |
| Extending any parts of the body out of the escalator  | 8 (3.1)         |
| Sitting on the escalator step   | 6 (2.4)         |
| Stop when getting off the escalator   | 6 (2.4)         |
| NOT Standing in between the yellow stripes and away from the skirting                           | 6 (2.4)         |
| Placement of package on the moving steps, handrail, deck board or landing plate                 | 5 (2.0)         |

**Table III: Number of Unsafe Behaviours Observed among Caregivers and Children**

| Number of unsafe behaviours | Caregiver<br>n=254, n (%) | Children<br>n=258, n (%) |
|-----------------------------|---------------------------|--------------------------|
| 0                           | 92 (36.2)                 | 109 (42.2)               |
| 1                           | 41 (16.1)                 | 55 (21.3)                |
| 2                           | 54 (21.3)                 | 51 (19.8)                |
| 3                           | 34 (13.4)                 | 17 (6.6)                 |
| >3                          | 33 (13.0)                 | 26 (10.1)                |

**Table IV: Escalator Safety Features**

| Escalator safety features  | Paired<br>escalator,<br>n=6<br>n (%) |
|--|--------------------------------------|
| Warning signage display  | 6 (100.0)                            |
| Entry and exit of the escalator are not blocked by advertisements or objects | 6 (100.0)                            |
| Warning signage NOT blocked by advertising objects or others objects         | 6 (100.0)                            |
| Emergency stop button visible  | 6 (100.0)                            |
| Emergency stop button NOT blocked by other objects                           | 6 (100.0)                            |

features of escalator (Table IV).

**DISCUSSION**

User behaviours are one of the significant contributors to accidents on the escalator (20). Despite having displayed warning sign and safety precautions for the use of escalator, users not adhering the safety guideline and thus contributing to accidents were commonly reported. Children are prone to escalator-related accident and it may be attributed to the lack of adherence of safety

instructions among the parents or caregivers who did not ensure their children's safety on the escalator or used the escalator in an unsafe manner (20). Fifty percent of the children involved in the escalator-related injuries resulted from not holding hand of their caregivers (3). Intentional or unintentional non-adherence to safety precautions among caregivers should be addressed. Besides, lack of parental awareness or distractive environment in a shopping mall could be equal factors in causing lack of supervision (21). Users' unsafe behaviours while using the escalator should be tackled by reiterating the importance of observing the safety rules through awareness activities while long term plan would be inculcating the children the practise of safe behaviour through educational approach (20). Studying caregivers and their children's unsafe behaviour without their knowing would provide policy makers such as DOSH an accurate data about the severity of this problem as unsafe behaviour will not only pose significant injury risk to themselves, but also to other users.

There are rules and restrictions that should be considered by the shopping mall management and the Malaysian DOSH. These strategies include prohibiting toddlers or pre-schoolers to use or go near the escalators alone; building children safety gates around the entrance of escalators; and having a security guard at the escalator. Parental and children awareness on escalator accidents and safety measures could be improved through social media and school education (22).

Despite the fact that not all elevators have been hazard-proof, a study suggested that elevator is one of the safety features imperative for escalator and caregivers travelled with young children should be alerted about this option by displaying standardized precautionary signage that direct user for the location of an elevator (22). Audio message to alert the passenger about the availability of elevator and to enhance the awareness of safe use of escalator should be played at or near escalator (2,22,23). Our findings indicated that caregivers with more than a child was significantly associated with more incidents of unsafe behaviours. This finding corresponds to other reports and these families should be taking the elevator instead. The potential challenges of taking elevator would still be the inaccessibility to nearby elevators and the long waiting time with a crowd (2,4,23,24).

In this study, more than one-tenth of the children were wearing improper shoes to travel on the escalator. Rubber clogs have been reported to be the reasons for crush injuries and amputations. The mechanism for these injuries is most likely due to the broad toe-box design giving false perception on the safe distance to stand away from the escalator steps. The smaller feet also expose children to the risks of slipping through the gaps or into the comb plate (7). We recommend that rubber clogs should be banned from travelling with escalator.

The use of hazardous items such as stroller, baby carriages, and trolley among the parents were observed in this study. Warning signage prohibiting these items might have been overlooked or not followed (24). We recommend that barricades should be mandated and installed at the entrance of the escalators to prevent hazardous items from travelling on the escalators.

Majority of the caregivers used mobile phone while riding the escalator with their children. This behaviour is a potential distraction that could lead to accidents. Warning signage should include the prohibition of this unsafe behaviour (20). Such unsafe practice has yet to be banned in this country. It is suggested that any kind of mobile device usage on the escalator should be prohibited among the riders and this warning should be included in the warning signage.

### **Strengths and Limitations**

A list of potential unsafe behaviours was generated for the purpose of conducting a real-time physical observation. Studying unsafe behaviours at the escalators discreetly could minimise response bias that is found in self-reported survey methods (25).

Children were sampled based on the estimation of their height. Other potential sampling bias include how a parents might be chosen over the other by the researcher as he or she was showing some unsafe behaviours. The demographic characteristics of the subjects such as age, gender, and ethnicity were not collected and could be considered in future study. Similarly, interrater variability could be reduced through the use of CCTV or videotaping and assessment by two researchers independently.

It is recognised that there was no linkage of cause and effect to ascertain that unsafe behaviour causes higher risk of injuries. It is also possible that the structure, speed, space, height of the escalator may be potential factors in causing escalator-related injuries reported (22). Future studies are therefore needed to include critical analysis and audit of all the injuries that have been reported, in order to determine the real solutions.

### **Implications for practice**

Caregivers' unsafe behaviour is not the sole factor contributing to the event of escalator-related injuries among children; nevertheless, they are at the most immediate position to protect their children from injuries or to provide instant help to the children should any accident occur. Hence, it is important for caregivers to observe safety measures at the first place in order to ensure their children's safety is assured. However, caregivers themselves were found to contribute to high number of unsafe events which could possibly expose their children to risk of escalator related injuries. Theoretically, since caregivers are the one who set

example for their children, they should be even more aware about safety behaviours at escalators. Their ignorance could have given their children an impression that such unsafe behaviours were accepted behaviours. Another possibility for explaining this finding is that caregivers could be unaware about unsafe behaviours other than those stated at warning signage, and therefore awareness programme should be created in the shopping mall. Additionally, information displayed by warning signage could be insufficient to alert caregiver, children or user about riding escalator in the proper manner. Precautionary information that alert the users should be revised and updated by DOSH.

## CONCLUSION

Most young children and their carers use the escalator in unsafe manner. It is important to ensure that action should be taken to reduce unsafe behaviour of escalator users as one of the important measures to keep our children safe and prevent injuries. The relevant authorities, including public health department and Department of Occupational safety and Health, should continue promoting safe use of escalator among parent and children in a national awareness program.

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