Investigating Pedestrian Safety-Related Behavior in Developing Countries; Egypt as a Case Study

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Abstract

Objectives: A good understanding of pedestrian behavior and their road safety culture is a key for improving traffic safety in the developing countries. The primary aim of this study is to apply a pedestrian behavior questionnaire in Egypt to investigate pedestrian behaviors in developing countries.
Methods: Exploratory Factor Analysis (EFA) was applied to assess the behavioral factors that express pedestrian behaviors. T-test and ANOVA were conducted to explore the significant differences across gender, age groups and education level. Furthermore, regression analysis was conducted to investigate how the examined variables are associated with behavioral factors.
Results: The current study showed that Egyptian pedestrian behaviors consist of four factors: transgressions (violations and errors), lapses, aggressive behaviors, and positive behaviors. The results displayed that in Egypt, males reported a higher level of transgressions and aggressive behaviors than females. All pedestrian behaviors varied by age, pedestrians (< 40 years) reported higher violations, younger pedestrians (< 25 years) reported more frequent lapses and aggressive behaviors, and positive behaviors were more reported by people older than 40 years in comparison with younger participants.
Conclusion: This study added a validation for applying the Pedestrian Behavior Scale (PBS) to explore the pedestrian behavior in Egypt and to understand the socio-demographic variables that affect the pedestrian behaviors. The findings can be used by infrastructure agencies to enhance educational road safety programs and enact appropriate laws, which could reduce the number of pedestrian-related crashes.

Keywords: Pedestrians Behavior Scale (PBS); Exploratory Factory Analysis (EFA); Regression Analysis.

1. Introduction

Traffic crashes are a worldwide public health issue, especially for the vulnerable road users. Approximately, there are 1.35 million fatalities and more than 50 million injuries around the world every year. Children and young adults are found to be more prevalent in these statistics, with traffic accidents being the leading cause of death worldwide. Pedestrian deaths accounted for 40% of traffic deaths in Africa (WHO, 2018) (1).
Although the importance of studying pedestrian behavior, attitude, and perception regarding road safety, few research have been conducted in developing countries, and specifically Egypt, on this topic. Egypt is one of the largest developing country in the Middle East, with a population of over 100 million people growing at a rate of 2.7 percent per year and over 11 million registered vehicles. The average number of traffic accidents over the last five years has been 11,800, resulting in more than 4200 deaths and 14,800 injuries, most of them are vulnerable road users. Crash investigations showed that human errors are responsible for more than 75 percent of road accidents (CAPMAS, 2019) (2).
The objective of this study was to build on previous worldwide researches of pedestrian behavior questionnaires and validate a questionnaire for an Egyptian pedestrian population and to investigate the pedestrian behaviors across the demographic variables. In this research, a short version of the Pedestrian Behavior Scale (PBS) was used to collect the data. This data analyzed using Exploratory Factor Analysis (EFA), Analysis of Variances

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(ANOVA) and Linear Regression models. Finally, policy recommendations were provided based on the discussion of the results.

To improve explanation of the pedestrian behavior, Grani'e et al. (2013) constructed and validated the Pedestrian Behavior Scale (PBS), a self-report scale that evaluates injury risk behaviors in pedestrians of all ages. The Pedestrian Behavior Scale (PBS) was developed based on six validated questionnaires: the Moyano Diaz (1997) pedestrian behavior scale (3), the Driver Behavior Questionnaire (DBQ) (4,5). Aggressive Driver Behaviors Scale and Positive Driver Behaviors Scale (6), the Adolescent Road User Behavior Questionnaire (ARBQ) (7), and Grani´e's road user behavior perception scale (8). Table 1 shows the definitions of different types of pedestrian behaviors (9).

Table 1: Definitions of different types of pedestrian behaviors. Source: Deb et al. (2017)

Pedestrian Behavior	Definition	Example	Reference
Violation	Deliberate deviation from social rules without intention to cause injury or damage.	Not using nearby pedestrian crosswalk to cross	Reason et al. (1990)
Error	Deficiency in knowledge of traffic rules and/or in the inferential processes involved in making a decision	Crossing diagonally to save time	Reason et al. (1990)
Lapse	Unintentional deviation from practices related to a lack of concentration on the task; forgetfulness.	Forgetting to look around for vehicles before crossing	Reason et al. (1990)
Aggressive Behavior	A tendency to misinterpret other road users' behavior resulting in the intention to annoy or endanger.	Getting angry with another user and insulting him	Lawton et al. (1997)
Positive Behavior	Behavior that seeks to avoid violation or error and/or seeks to ensure traffic rule compliance.	Not crossing diagonally or letting other road users go first	Ozkan and Lajunen (2005)

Several prior studies were applied the (PBS). Following its early validation by Grani'e et al. (2013), Nordfjrn and Simsekoglu (2013) also used it to explore the role of local cultures variables and behavior toward safety on self-reported risky pedestrian behavior among Turkish urban pedestrians. In Esfahan, Iran, 32 items from the PBS were used to deal with the pedestrian behavior (10). In 2016, modified (PBS) had been verified in Serbia and China (11,12). Deb et al. (2017) verified a short questionnaire, which was frequently utilized in the Americas in later years (13). Ruiz et al. (2020) validated the short questionnaire developed by Deb et al. (2017) on a Mexican population (14). The PBS has been applied in various parts of the world, including the United Kingdom, Africa (Kenya), Southeast Asia (Bangladesh and Thailand), and the Western Pacific (China and Vietnam) (15–20).

2. Methodology

The Pedestrian Behavior Questionnaire used in this study was developed from Grani'e's et al (2013) original 47 items (PBS). This survey is a self-report device for measuring pedestrian behaviors across the country when using the roadway. The replies were given on a 5-point Likert scale (from 1 = never to 5 = always). As stated in the introduction, this questionnaire addresses five categories of behavior: Violations, Errors, Lapses, Positive Behaviors, and Aggressive Behaviors. The original (PBS) was reduced to 19 items of pedestrian behaviors, 18 items from the (PBS) and one item related to one of the most repeated behaviors in Egypt, "While crossing the road, I use hand signals to inform the driver of my decision to stop or cross the road", to determine which category it belonged to. The questionnaire also included questions to collect socio-demographic data; gender, age and education level. About 567 participants over 16 years old responded to the questionnaire and completed the form. The gender ratio in the sample was fairly balanced, with 60% males and 40% females. To reflect adolescence, young adulthood, and adult, age was separated into three groups: 16–24 (54 %), 25–39 (39 %), and 40 and above (8 %). In terms of education, the sample is divided between those with a university degree (74%), and those with post-graduate education, which accounts for 26%.

Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) with Varimax rotation method was conducted with 19 items to identify the most appropriate factor structure for pedestrian behaviors in Egypt. Kasier-Meyer-Olkin (KMO) measure of sampling adequacy was greater than 0.80 and Bartlett's test of sphericity was significant, showing that factor analysis may be appropriate for the analysis of the dataset. The number of factors to keep was calculated through eigenvalue analysis (21). Following factor extraction, Cronbach's Alpha was applied to check the internal consistency of the items loaded into each factor. To investigate the variations in behavioral factors across socio-demographic groups; t-test, ANOVA and linear regression models were used. Gender, age groups and education level were entered as independent variables to investigate their influence to the pedestrian behavior as a dependent variable. Some statistics were conducted to interpret the outcomes: R^2, p-value and variance inflation factor (VIF) to ensure that multicollinearity issue had no considerable effect. IBM SPSS v.25 was used to analyze the data.

3. Analysis and Results

Means and standard deviations for the PBS items for the most reported behavior in each category in order from the highest to the lowest frequent are presented in Table 2. Principal Component Analysis (PCA) was applied to investigate the factorial structure of the Egyptian pedestrian behavior questionnaire. The results revealed justifiable factor loading values for items, which confirm the validation of the questionnaire items. The data best fit into four factors (Transgressions; violations and errors, lapses, aggressive behaviors, and positive behaviors), with a total variance of 50.01%. To assess internal reliability, Cronbach's alpha scores were measured for Lapses (0.80), Transgressions (0.75), Aggressive Behaviors (0.63), and Positive Behaviors (0.52). The PCA results are presented in Table 3. The usual cut-off number is 0.7 (22,23). Some researchers regard alpha values between 0.6 and 0.7 to be acceptable (12,24–26). According to Nunnally (1978), a result between 0.50 and 0.60 is appropriate in the initial stages of study.

Tabel 2: Means and standard deviations of pedestrian behavior items.

Items	Behavior	M	SD
I thank a driver who stops to let me cross	P1	4.39	1.00
I cross even if vehicles are coming because I think they will stop for me.	E1	2.26	1.33
I cross while talking on my cell phone or listening to music on my headphones.	V1	2.23	1.25
I cross without looking when following other people who are crossing	L1	2.20	1.32
I get angry with another road users (pedestrian, driver, cyclist, etc.), and I yell at them.	A1	2.19	1.28

P: Positive behavior A: Aggressive behavior V: Violation E: Error L: Lapses

Tabel 3: Principle Component Analysis (PCA) results.

Items (how often do you …)	Lapse	Transgression	Aggressive	Positive
I thank a driver who stops to let me cross.	0.694			
When I am accompanied by other pedestrians, I walk in single file on narrow sidewalks so as not to bother the pedestrians I meet.	0.693			
I let a car go by, even if I have the right-of-way, if there is no other vehicle behind it.	0.665			
While crossing the road, I use hand signals to inform the driver of my decision to stop or cross the road.	0.647			
I cross even if vehicles are coming because I think they will stop for me.	0.613			
I cross while talking on my cell phone or listening to music on my headphones.		0.709		
I cross even though obstacles (parked vehicles, buildings, trees, trash bins, etc.) obstruct visibility.		0.709		
I cross without looking when following other people who are crossing		0.608		
I get angry with another road users (pedestrian, driver, cyclist, etc.), and I yell at them.		0.572		
I avoid using pedestrian bridges or underpasses for convenience, even if one is located nearby.		0.548		
I cross the street even though the pedestrian light is red.		0.484		
I walk on the roadway when I could walk on the sidewalk.			0.728	
I walk in a way that forces other pedestrians to let me through.			0.709	
I have run into a pedestrian or an obstacle while walking because I am not paying attention.			0.624	
I realize that I have crossed several streets and intersections without paying attention to traffic.			0.437	
I cross very slowly to annoy a driver.				0.675
I forget to look before crossing because I am thinking about something else.				0.659
I cross without looking because I am talking with someone.				0.652
I get angry with another road user (pedestrian, driver, cyclist, etc.), and I make a hand gesture.				0.539
% of variance explained	15.71%	13.46%	11.90%	8.94%
Cronbach’s alpha	0.80	0.75	0.63	0.52

The investigation of pedestrian behavior responses through t-test and ANOVA has been conducted. The results revealed that aggressive behaviors and transgressions had a significant difference across gender. Males reported more transgressions and aggressive behaviors than females. Moreover, Pedestrian behaviors differed between age groups. Positive behaviors, aggressive behaviors, transgressions, and lapses all showed a significant age impact. The Bonferroni post hoc test showed that older pedestrians (over the age of 40) reported more positive behaviors than those under the age of 40. Adolescents (under the age of 25) exhibited higher aggressive behavior than those above the age of 25. Adults (over 40 years) committed fewer transgressions than pedestrians under the age of 40. Teenagers (under the age of 25) reported greater lapses than those over the age of 25. Positive behaviors, violations, and lapses all had a significant education impact. People with post-graduate education reported more positive behaviors than those with only a university level. Pedestrians with only a university degree performed more violations than the second group, as well as more repeated lapses. Linear regression models have been created that includes the three variables to study their effect together on the behavior of pedestrians. The results showed that the variables that had a significant effect in the t-test and ANOVA remained with significant effect in the regression models for all behavior except for transgressions and aggressive behaviors. It has been found that in aggressive behavior model, gender continued as the only one with a significant effect and Education for transgressions behavior. Linear regression results are presented in Table 4.

Table 4: Linear regression models.

$R^2 = 0.014$; $F = 2.687$, $p = 0.046$			
Positive behaviors	β	P	VIF
Gender (Ref : male)	-0.054	0.207	1.055
Age Group (Ref : under 25 years)	0.075	**0.083**	1.074
Education (Ref : University degree)	0.073	**0.079**	1.023

$R^2 = 0.046$; $F = 9.102$, $p = 0.000$			
Aggressive behaviors	β	P	VIF
Gender (Ref : male)	-0.194	**0.000**	1.055
Age Group (Ref : under 25 years)	-0.48	0.263	1.074
Education (Ref : University degree)	-0.045	0.284	1.023

$R^2 = 0.017$; $F = 3.207$, $p = 0.023$			
Transgressions	β	P	VIF
Gender (Ref : male)	-0.069	0.107	1.055
Age Group (Ref : under 25 years)	-0.051	0.243	1.074
Education (Ref : University degree)	-0.084	**0.047**	1.023

$R^2 = 0.031$; $F = 7.007$, $p = 0.000$			
Lapses	β	P	VIF
Gender (Ref : male)	-0.039	0.365	1.055
Age Group (Ref : under 25 years)	-0.125	**0.004**	1.074
Education (Ref : University degree)	-0.115	**0.006**	1.023

4. Discussion

4.1. Validity of the Questionnaire

According to the Exploratory Factor Analysis (EFA), principal component analysis based on Eigen value greater than one with orthogonal varimax rotation was carried out. The Egyptian version of this questionnaire had the best fitting in four pedestrian behavior factors. These were transgressions, lapses, positive behaviors and aggressive behaviors, explained through 19 items. Cronbach's alpha results showed high internal reliability (> 0.6), but not for the positive behavior (0.52). Interestingly, low internal consistency for the positive behavior factor had been found in previous studies (9,22,23). This inconsistency suggests that a modification of the positive behavior scale is necessary. The researchers anticipate that additional positive behavior items will need to be included and validated. Most of the questions in the positive behavior scale express pedestrian's positive behavior toward other road-users. Inclusion of pedestrian's positive behavior toward traffic rules at crosswalks may improve the internal consistency of that subscale as well as enhance the internal reliability. It had been found that most of the findings verified the applicability of this PBQ for the Egyptian population, with only minor revisions required.

4.2. Culture and Pedestrian's Behaviors

The four-factor structure of this study which combines violations and errors in transgressions suggests that Egyptians do not differentiate between legal rules and rules of safety, which was a similar pattern described in prior studies in France (22) and China (12). Yildirim (2007) in Turkey also discovered a four-factor model in their sample , but with the combination of the lapses and errors, which showed that their Turkish sample could not distinguish between them, both of which had an unintended origin (24).

Different social, cultural, and physical environments cause different behaviors (15,25). Given the poor quality of the infrastructure, the absence of enforceable laws and penalties for dangerous pedestrian behavior in Egypt, this could be an explanation for the formation of the four-factor model with the formation of the transgression scale.
Furthermore, in many places of Egypt, facilities of pedestrians are poorly planned and insufficient, which is likely to encourage traffic violations. As a result, Egyptian pedestrians may be unaware of the negative implications of their actions or may feel they have no choice except to conduct into unsafe activity. This is essential to investigate because pedestrians who often break the law may display these patterns in all situations (5), but dangerous behaviors caused by errors and lapses are not anticipated in all conditions (11). This finding leads to a better knowledge of Egyptian pedestrian behavior and explains how infrastructure, in combination with the lack of law enforcement, may impact Egyptian pedestrian behavior.
Similar to other research (9,11,22,25), positive behaviors had the higher means, whereas aggressive behaviors and lapses had the lowest. This shows that Egyptian pedestrians in most of the time attempt positive behavior. On the other hand, certain risky actions are frequent and increase the chance of an accident. One of the most common of these transgressions is “I cross while talking on my cell phone or listening to music on my headphones”. These comprehensions are important for road safety agencies and authorities in policy implications for enhancing pedestrian safety.

4.3. Pedestrian Behaviors across demographic variables

The results showed that in Egypt, males reported a higher level of engagement in all types of behaviors than females. The comparison by gender showed that males reported more transgressions and aggressive behaviors than females. This gender difference is consistent with worldwide findings (9,11,15,22). Similarly, significant behavior different patterns through gender have been discovered in other types of transportation. For example, among drivers (26), motorcyclists, and bicyclists (27,28). Thus, this might be due to a gender difference in which females are more careful, conservative, and obedient road users than men. Furthermore, similar to Grani'e et al. (2013), males in the current research also reported more aggressive behavior than females. This result may also be attributed to cultural and sociological concerns in Egypt, since females may interact less, particularly when arguing with strangers on the street.
The results showed that all pedestrian behaviors varied by age. Pedestrians under the age of 40 reported higher violations, which is consistent with prior research (9,22,29). This finding may be attributed to the increased energy, youthful spirit, and lack of experience that might lead younger pedestrians to display more risk-taking and less cautious behaviors. In line with Deb et al.’s (2017) findings, younger pedestrians (< 25 years) reported more frequent lapses compared to other aged pedestrians. Young people in Egypt are under a lot of stress as a result of the country's economic issues. This psychological conflict, along with relatively low patience and regulations on attitude compared with older people, can lead to distraction and lack of concentration. Also the same result occurred with the aggressive behavior. A large number of Positive behaviors were reported in people older than 40 years in comparison with younger participants, which is similar to the study of Anti´c et al. (2016). This outcome might be clarified because older persons having better interactions with others around them as a result of their experience and their different reasons for walking.
The results reveal that all pedestrian behaviors, except aggression, differed across education level. Pedestrians with a university education recorded more transgressions and lapses in attitude than those with a postgraduate education. People with a postgraduate education reported more positive acts than those with a lower education.

5. Conclusions

This research provides a basic framework for investigating pedestrian behaviors in Egypt according to four categories: Transgressions, lapses, aggressive behaviors and positive behaviors. The four-factor model structure was concluded using Exploratory Factor Analysis (EFA), which shows that Egyptians do not distinguish between legal and safety requirements. Each of these four different subscales had been evaluated and confirmed to be valid, except for positive behaviors, which requires further assessment. It is recommended to investigate the validity of the long version of the pedestrian behavior scale (PBS), so with more number of items in each factor, the internal reliability may be improved.
In general, aggressive behaviors and lapses had the lowest means, whereas positive behaviors had the highest scores. This shows that most of the time, Egyptian pedestrians make an effort to be positive. Males reported high scores in all types of behaviors than females. This conclusion could also be explained by cultural and sociological factors in Egypt, as females are less likely to interact with strangers on the street. Younger pedestrians reported higher violations, lapses and aggressive behaviors compared with older pedestrians who reported more positive behaviors. This finding may be attributed to the increased energy, low patience and lack of experience that might lead younger pedestrians to display more risk-taking and less cautious behaviors.
Considering the poorly designed infrastructure, the shortage of regulations and fines for pedestrian behaviors, the poorly planned and inappropriate pedestrian facilities, traffic violations and unsafe behaviors are expected to

increase. Therefore, Frequent risky behaviors must be investigated by road safety agencies and authorities in terms of policy implications for improving pedestrian safety.

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