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ORIGINAL ARTICLE

Development of Electric Vehicle Accidents Attitude Scale in Cognitive, Affective and Behavioral Dimensions: A Reliability and Validity Study

Elektrikli Araç Kazaları Tutum Ölçeğinin Bilişsel, Duygusal ve Davranışsal Boyutlarda Geliştirilmesi: Bir Güvenilirlik ve Geçerlilik Çalışması

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ABSTRACT

Background/ Objective: The knowledge, attitudes, and behaviors of healthcare professionals are directly related to mortality and morbidity due to road traffic crashes. It has become important to investigate the causes of various injuries in electric vehicle accidents. These issues are indirectly the responsibility of forensic medicine. This study aimed to develop an Electric Vehicle Accidents Attitude Scale (EVAAS) regarding cognitive, affective, and behavioral dimensions to determine the attitudes of healthcare professionals toward electric vehicle accidents.
Materials and Methods: The sample group of the study consisted of 386 physicians and other health professionals, working in the emergency services and 112 units (emergency health services in Türkiye) of hospitals in Türkiye. The Delphi technique was performed in the development of EVAAS, and validity/reliability analyses were conducted after a focus group study and a pilot application.
Results: The 26-item EVAAS scale was grouped into three-dimensional factors (cognitive, affective, and behavioral), which explained 65.257% of the total variance. Cronbach's alpha coefficient for EVAAS was 0.859, retest reliability was 0.781, and the test-retest reliability was calculated as 0.766.
Conclusion: A valid and reliable EVAAS scale consisting of 26 items in three dimensions (cognitive, affective, and behavioral) was developed in the study.

Keywords: Attitude scale, Electric vehicle accidents, Emergency medicine, Forensic medicine, Health care professionals

ÖZ

Arka Plan/Amaç: Sağlık çalışanlarının bilgi, tutum ve davranışları, doğrudan karayolu trafik kazalarından kaynaklanan mortalite ve morbidite ile ilişkilidir. Elektrikli araç kazalarında çeşitli yaralanmaların nedenlerini araştırmak önemli hale gelmiştir. Bu konular dolaylı olarak adli tıbbın sorumluluğundadır. Bu çalışmanın amacı, sağlık çalışanlarının elektrikli araç kazalarına yönelik tutumlarını belirlemek için bilişsel, duygusal ve davranışsal boyutlara ilişkin bir Elektrikli Araç Kazaları Tutum Ölçeği (EAKTÖ) geliştirmektir.
Materyal ve Yöntem: Çalışmanın örneklem grubu, Türkiye'deki hastanelerin acil servislerinde ve 112 birimlerinde (Türkiye'deki acil sağlık hizmetleri) çalışan 386 hekim ve diğer sağlık çalışanından oluşmuştur. EAKTÖ'nün geliştirilmesinde Delphi tekniği uygulanmış ve odak grup çalışması ve pilot uygulama sonrasında geçerlilik/güvenilirlik analizleri yapılmıştır.
Bulgular: 26 maddelik EAKTÖ üç boyutlu faktörlere (bilişsel, duygusal ve davranışsal) ayrıldı ve toplam varyansın %65,257'sini açıkladı. EAKTÖ için Cronbach alfa katsayısı 0,859, tekrar test güvenilirliği 0,781 ve test-tekrar test güvenilirliği 0,766 olarak hesaplandı.
Sonuç: Çalışmada bilişsel, duygusal ve davranışsal olmak üzere üç boyutta 26 maddeden oluşan geçerli ve güvenilir bir EAKTÖ ölçeği geliştirildi.

Anahtar kelimeler: Acil tıp, adli tıp, Elektrikli araç kazaları, tutum ölçeği, sağlık çalışanları

Introduction

One of the most important factors related to public health is road traffic accidents. The knowledge, attitudes, and behaviors of health professionals are important dimensions affecting the mortality and morbidity caused by accidents. This issue directly and/or indirectly concerns forensic medicine specialists, who play an important role in the assessment of injuries and the determination of the cause of death (1). The majority of clinical forensic practice involves cases of injury and death related to road traffic accidents. Determining the cause of death when investigating the nature and severity of traffic accident injuries and determining whether death occurred as a result of a traffic accident are among the responsibilities of forensic medicine specialists (2). Although forensic medical specialists are not involved in the initial stages of the process, emergency medical services are among the first responders at the scene of an accident. Accurate and rapid first medical response is one of the most important factors in reducing the mortality rate in road traffic accidents (3). The training status (professional training) and the attitudes of the emergency medical response team toward the types of accidents play a key role in the effectiveness of the first medical response.

In recent years, the frequency of electric vehicles (EVs) in traffic has been increasing day by day with the

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rapid development of new technology (3). Although EVs are similar to other fossil fuel vehicles in terms of driving and mobility, they have significant technical differences. In particular, the batteries that store energy can cause injuries and fatalities that do not occur in other traffic accidents. The most important of these are spontaneous and unquenchable fires (4), skin and tissue burns (5), blast injuries from explosions (6), poisoning from the release of toxic gases (7), and injuries from electric current (8). Spontaneous combustion of electric vehicles and the inability to extinguish fires have been in the news recently. The cognitive, affective, and behavioral attitudes of first responders to an incident regarding the knowledge, recognition, and management of these injuries are critical to providing an accurate, rapid, and effective response to the incident and to ensuring occupational health and safety. It is possible that both the early recognition and emergency intervention with the injury and the protection of the emergency healthcare professionals from injury, experience, and emotional and behavioral basis about these accidents will contribute to reducing the number of deaths and injuries.

Attitudes, including cognitive, affective, and behavioral dimensions, are defined as the tendency to have a positive or negative learned response to an event, situation, institution, or person (9). The cognitive parameter of an attitude consists of an individual's beliefs, knowledge, and thoughts about the object of the attitude. The affective parameter consists of the individual's feelings and evaluations about the attitude object, and the behavioral parameter consists of the individual's behavior toward a situation (10). Therefore, attitude scales have been developed in various fields to enable individuals to clearly express their opinions in a broad framework.

In recent years, many studies on electric vehicle accidents have taken their place in the literature. However, most of the studies are technical and aim to increase the efficiency of the vehicles and to identify risks. In terms of attitudes, there are no studies on attitudes towards accidents, except for studies on electric vehicle preference. The establishment of an attitude scale for the teams dealing with accidents involving these vehicles, which present many different risks, will undoubtedly contribute to remedying this deficiency.

In the framework of the above information, this research aims to develop an Electric Vehicle Accidents Attitude Scale (EVAAS) in cognitive, affective, and behavioral dimensions to determine the attitudes of healthcare professionals towards electric vehicle accidents. The EVAAS will be a significant contribution to the literature on the subject, as no such scale for the same purpose has been found in the literature.

Materials and Methods

The study used a survey, which is one of the data collection techniques including EVAAS. The Delphi technique was used to develop the attitude scale. The Delphi technique was developed by two researchers, Norman Dalkey and Olaf Helmer, in the 1950s in the USA. According to Dalkey and Helmer (11), the main purpose of using this technique is to obtain the most reliable consensus from a group of expert opinions through an intensive series of questionnaires in such a way that controlled feedback can be obtained. In short, the Delphi technique is used to obtain the common views of a group of independent and uninformed experts through a rational and written approach, and thus to plan programs, develop policies, predict events and trends, and develop standards.

Within the framework of the above information, a comprehensive literature review was first carried out for the study, and three dimensions (subscale, factor), namely cognitive, affective, and behavioral, were taken into consideration, as in the attitude scales used in many studies (12-15). The procedure regarding the stages of the Delphi technique used in the study is as follows:

Statement of the problem: To determine the cognitive, affective, and behavioral attitudes of healthcare workers regarding electric vehicle accidents,

Selection of panel members: Twenty professionals with a certain level of knowledge, experience, research, and training on the subject were selected as panelists. Accordingly, 10 panelists consisting of three forensic specialists, two emergency physicians, two paramedics, one emergency medical technician, one psychologist, and one biostatistician were selected as panelists.

The first Delphi survey (Round I): The dimensions (cognitive, emotional, behavioral) defined by the problem of the study were sent to the panelists and a pool of 60 items was created by asking the panelists to write "items that can measure the attitudes of health care workers towards electric vehicle accidents". At

the end of this round, 48 items were included in the pool by combining similar suggestions.

The second Delphi survey (Round II): The 48 items ranked under the identified factors were then presented to the panel members again and given a 3-point scale for the appropriateness of the items (appropriate, partially appropriate, and not appropriate). The data obtained at the end of the round were analyzed to generate median, interquartile, and range (q3-q1) statistics. As a result of the analysis, the pool was reduced to 40 items.

The third Delphi Survey (Round III): The medians, quartiles, and ranges calculated for the item pool were sent to the panelists, and three options (appropriate, partially appropriate, not appropriate) were again presented to reach a consensus on which items should be included in the pool. The 32-item EVAAS was constructed as a result of the Delphi rounds within the framework of the data obtained.

In the following process, the comprehensibility of the 32 items in EVAAS was reduced to 29 items by removing three items as a result of a focus group study consisting of 15 health professionals (paramedics, emergency medical technicians, forensic specialists, and emergency medicine specialists). In addition, the final scale was reduced to 27 items by removing 2 items as a result of the validity and reliability analysis of the data obtained with a pilot study of 30 people. A total of 27 items (12 items for the cognitive dimension, eight items for the affective dimension, and seven items for the behavioral dimension) were presented to the health workers. Each item of the EVAAS was subjected to a 5-point Likert-type rating, scored as 1=strongly agree, 2=agree, 3=neutral, 4=disagree, 5=strongly disagree.

The population of this study consists of physicians, paramedics, emergency medical technicians, and ambulance drivers working in 112 units (Emergency Health Service in Türkiye) and emergency departments of public state and university hospitals in Turkey. Due to constraints such as time, cost, and distance, the convenience sampling method, which was preferred by the participants in this study (16), was used for selection. The study used the n=s2.Za2/d2 formula (17), which is recommended for large populations and quantitative research, to calculate the minimum sample size. Accordingly, using the data obtained as a result of the pilot study with 30 participants, standard deviation s = 1, effect size d = 0.1, and Z0.05 = 1.96 (for significance level a= 0.05), the minimum sample size was calculated as 384. In this framework, 391 health workers from 16 provinces in different regions of Turkey formed the sample group (17, 18).

Exploratory factor analysis (EFA) with varimax rotation was used in the study to determine the construct validity of the 27-item EVAAS. Reliability and internal consistency statistics of the scale and subscales (factors and dimensions) were measured by corrected item-total correlation, Cronbach's alpha when items were deleted, and Cronbach's alpha coefficient. The correlation between the two variables was calculated for test-retest reliability. In addition, a confirmatory factor analysis (CFA) was applied to the data obtained with different samples of 291 people to test the factor structure. LISREL 8.71 was used for CFA, and SPSS 21.0 for Windows (SPSS, Inc., Chicago) was used to analyze other data in the study.

The study was approved by the Ethics Committee for Non-Interventional Clinical Research of xxx University, decision number 2023/26.

Results

The results of the exploratory factor analysis (EFA) and reliability analysis of EVAAS, including three dimensions (cognitive, affective, and behavioral), are shown in Table 1. According to the factor analysis results, Bartlett's test of sphericity and Kaiser-Meyer-Olkin measure of sampling adequacy verify the factorability of the data (Bartlett's test of sphericity= 4383.103; $p<0.001$ and KMO=0.808). The 26-item EVAAS was grouped into three dimensions or factors (cognitive, affective, and behavioral), which explained 65.257% of the total variance.

The cognitive dimension, consisting of 11 items and explaining 29.432% of the total variance, constituted the first factor of the scale, followed by the affective/emotional (22.444%) and behavioral (13.381%) dimensions. The factor loadings of all items were found to be above 0.40, except for the 10th item (factor loading is 0.342) in the cognitive dimension. Cronbach's alpha coefficients for reliability analysis were calculated as 0.821 for the cognitive dimension, 0.853 for the affective/emotional dimension, and 0.831 for the behavioral dimension. As a result of the confirmatory factor analysis (CFA) applied in the study, the coefficient of the 10th item in the cognitive dimension was found to be quite low (0.17). However, the CFA goodness of fit indices (RMSEA, NFI, SRMR, AGFI, and $\chi 2/DF$) were at acceptable levels. Under

Table 1. Results of Exploratory Factor Analysis (EFA) and Reliability Analysis for EVAAS

	Factors and Items	Factor Loading	Corrected Item-Total Correlation	Cronbach's Alpha (α) if Item Deleted	Cronbach's Alpha (α)
F1: Cognitive dimension -Eigenvalues (% of Variance) = 5.896 (29.432)					
1	Accident types and risks in traffic accidents vary depending on vehicle fuel types.	0.800	0.428	0.860	0.821
2	I don't think electric vehicle accidents are different from other traffic accidents. (R)	0.650	0.418	0.862	
3	I have sufficient knowledge about the working system of electric vehicles (battery, current, voltage, etc.).	0.732	0.583	0.852	
4	I recognize that a vehicle involved in an accident is electric by its make, model, logo, etc.	0.609	0.493	0.857	
5	I have sufficient knowledge about the electrical components of electric vehicles (batteries, wiring points, etc.).	0.861	0.661	0.849	
6	I have sufficient knowledge about electric vehicle accidents and risk factors.	0.834	0.686	0.847	
7	I know the precautions to be taken against electric vehicle accidents.	0.819	0.628	0.850	
8	Battery-caused fires in electric vehicle accidents are very difficult to extinguish.	0.612	0.584	0.852	
9	I know that toxic gases (methane, cyanide, carbon monoxide, carbon monoxide hydrogen fluoride, etc.) originating from batteries cause poisoning in electric vehicle accidents.	0.644	0.689	0.845	
10	Battery-induced explosive injuries can develop in electric vehicle accidents.	0.342	0.421	0.827	
11	Battery-induced electric shock or thermal injuries can occur in electric vehicle accidents.	0.841	0.673	0.847	
12	Standard equipment for the response to electric vehicle accidents needs to be developed.	0.568	0.591	0.851	
F2: Affective dimension-Eigenvalues (% of Variance) = 4.496 (22.444)					
13	I feel psychologically prepared for electric vehicle accidents.	0.807	0.759	0.833	0.853
14	The knowledge I have about electric vehicle accidents gives me peace of mind.	0.772	0.664	0.840	
15	I have the necessary attention and concentration when faced with the high risks of electric vehicle accidents.	0.845	0.716	0.836	
16	Electric vehicle accidents generally scare me. (R)	0.800	0.445	0.866	
17	I hesitate to intervene in electric vehicle accidents. (R)	0.819	0.424	0.862	
18	My lack of knowledge about electric vehicle accidents disturbs me. (R)	0.805	0.504	0.857	
19	Non-extinguishable fires in electric vehicle accidents scare me. (R)	0.781	0.575	0.852	
20	I am concerned about battery-induced explosions, toxic gas, and thermal injuries in electric vehicle accidents. (R)	0.698	0.430	0.860	
F3: Behavioral dimension -Eigenvalues (% of Variance) =2.681 (13.381)					
21	I pay attention to the fuel type of the vehicle when responding to those injured in traffic accidents.	0.637	0.481	0.857	0.831*
22	I attend training meetings on electric vehicle accidents and injuries.	0.585	0.656	0.847	
23	I do not intervene in electric vehicle accidents before the rescue team-fire brigade arrives.	0.650	0.492	0.857	
24	I use protective equipment (gloves, shoes, etc.) when responding to electric vehicle accidents due to electric shock and thermal injuries.	0.731	0.590	0.846	
25	I use a gas mask when responding to electric vehicle accidents to avoid any possible toxic gas releases from batteries.	0.661	0.431	0.862	
26	I take precautions for myself or the injured when responding to electric vehicle accidents.	0.613	0.547	0.849	
27	Since electric vehicles operate quietly and are difficult to detect, I approach the vehicle from the side in case it moves suddenly in an accident.	0.548	0.513	0.850	
	General scale Explanation rate of total variance = % 65.257				

Note: The 10th item in the cognitive dimension was excluded from the evaluation due to its negative effect on total variance and Cronbach's alpha.

the EFA and CFA results, it was decided to remove the 10th item in the cognitive dimension from the scale.

Table 2. Test, Retest, and Test-Retest Reliability

Reliability	Value
Test reliability	Cronbach's Alpha (a)=0.859
Retest reliability	Cronbach's Alpha (a)=0.781
Test-retest reliability	Correlation (r)=0.766

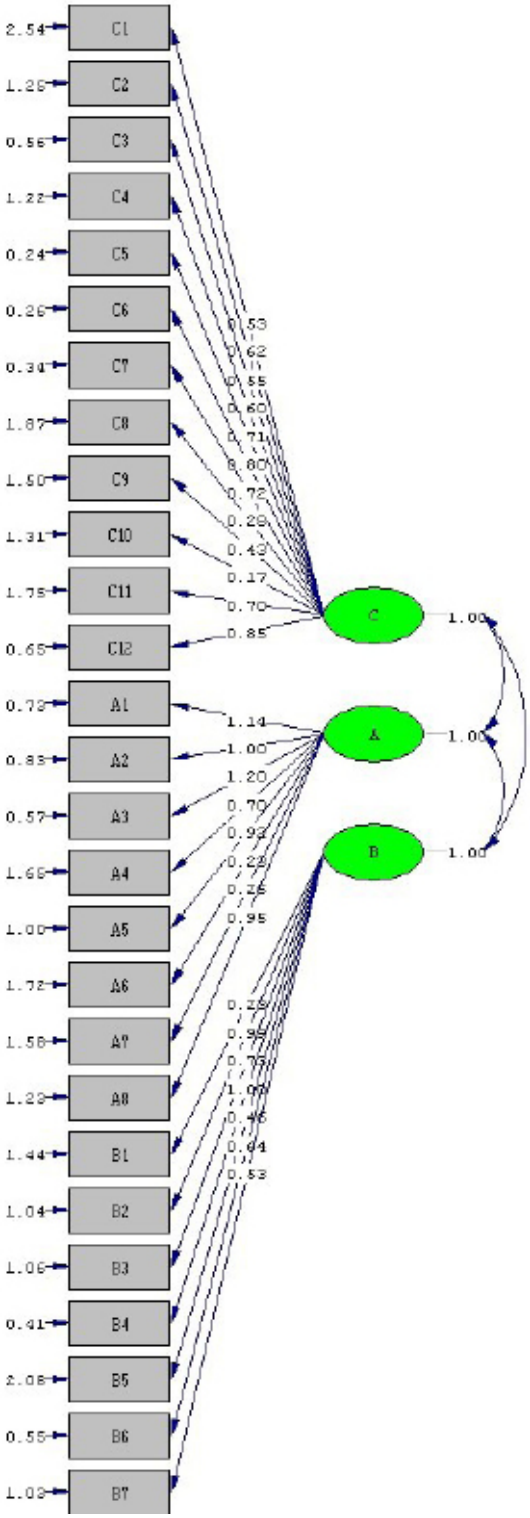

Table 3. Model fit indices of the scale

Fit Indexes	Good Fit	Acceptable Fit	Model	Results
RMSEA	0<RMSEA<0.05	0.05<RMSEA<0.08	0.08	Acceptable
NFI	0.95≤NFI≤1	0.90≤NFI≤0.95	0.90	Acceptable
SRMR	0≤SRMR≤0.05	0.05≤SRMR≤0.10	0.09	Acceptable
AGFI	0.90≤GFI≤1	0.85≤AGFI≤0.90	0.86	Acceptable
χ2/DF	<3	<5	3.42	Acceptable

AGFI: Adjusted goodness of fit index, DF: Degree free, NFI: Normal fit index, RMSEA: Root-mean-square error of approximation, SRMR: Standardized root mean square residual, χ2: Chi-square

Discussion

In the study, following the focus group study and pilot application processes as proposed and recommended in the literature for scaling, a scale consisting of 26 items in the cognitive, affective, and behavioral dimensions was developed using the Delphi technique to determine the attitudes of healthcare professionals towards electric vehicle (EV) accidents. A new scale (EVAAS) consisting of 26 items dealing with three dimensions (cognitive, affective, behavioral) was developed in the study after relevant literature, the Delphi technique, focus group study, and pilot application processes to determine the attitudes of healthcare workers towards electric vehicle (EV) accidents. This scale structure was based on the ABCs of attitudes (affective, behavioral, and cognitive) [10]. The 8-item affective dimension consists of items measuring an individual's emotional outlook (emotion, happiness, fear, anxiety, etc.). The 7-item behavioral dimension includes items related to behavioral responses to electric vehicle accidents. The 11-item cognitive dimension includes items that express individuals' opinions as well as some basic information. According to the EFA results, 26 items in the three dimensions explained about two-thirds of the total variance in the study. The Cronbach's alpha coefficients of the scale and subscales were above the critical value of 0.70 (19). The EFA, CFA, Cronbach's alpha and adjusted item-total correlation results confirmed the validity and reliability of the EVAAS without removing any items (20). Considering the number of injuries and deaths associated with road traffic crashes, they are among the most significant public health problems. While millions of people are reported to die annually, many more are injured and disabled (21-23). In addition, road traffic crashes result in loss of time + loss of work intensity for many professional groups involved in medical first aid,

treatment and rehabilitation, and the ensuing legal processes. Traffic crashes primarily affect firefighters, search and rescue personnel, emergency medical technicians, traffic police officers, vehicle assistance officers, hospital emergency personnel, and other medical specialists and health care professionals. Medical examiners are responsible for providing forensic reports on basic issues such as the severity of victims' injuries and determining the cause of death in fatal cases. Secondarily, the workload of judicial officials (prosecutors, judges, lawyers, etc.) is affected. The fact that the number of deaths and injuries can be prevented shows the importance of efforts to prevent and reduce traffic accidents. The fact that fossil fuel vehicles (gasoline, diesel, and LPG) have been on the road for a long time and that society has learned the characteristics of the vehicles suggests that attitudinal evaluations of vehicles will be futile. However, when we look at electric vehicles, which are a new technology product both in terms of their different operating systems and the risks they pose, the importance of attitudes in responding to these vehicle accidents becomes apparent.

Determining the attitudes of healthcare workers toward EV accidents is valuable in several ways. First and foremost, it will ensure that healthcare workers can approach victims appropriately and that their positive and negative perceptions of these vehicles do not lead to delays in intervention or even incorrect early intervention. In addition, responders who do not have sufficient knowledge about the risks of EVs can be prevented from having occupational injuries. In addition, delayed or incorrect intervention can lead to medical malpractice claims. Determining the attitudes of healthcare workers will contribute to the processes that may develop in the coming years.

Other attitudinal assessments have been examined, and in the study conducted by Kaya et al. in 2017, it was found that as the level of encountering risk factors and knowledge of healthcare workers increased, their awareness of screening increased, and the rate of regular cancer screening was high in this group (24). This study shows that the behaviors of people who have achieved cognitive competence are properly manifested. Similarly, the study "Nursing students' knowledge, willingness, and attitudes toward first aid behavior as bystanders in traffic accident trauma: A cross-sectional survey," conducted by Pei et al. in 2019, claims that first aid behavior was stronger in traffic accidents that occurred immediately after first aid training (25). Both studies show the importance of training, especially in ensuring the correct development of behavior in healthcare professionals. In the review of Demiralp's 2023 study, which examined nurses' attitudes toward CBRN incidents, the importance of training long before accidents or attacks was mentioned (26). All of these studies have shown the need for appropriate and adequate training to achieve the desired behaviors, and the need for training has been determined by studies using attitude scales.

Conclusion

EVs are becoming more and more common, and the number of accidents is increasing with this increase. Different approaches, materials, and mental equipment are required in emergency intervention due to their potential to cause non-extinguishable fires, explosions, and poisoning, which are different from the classical fossil-fuelled vehicles. Our study will be an important contribution to reveal the awareness of emergency health workers towards these accidents and to provide the necessary educational and managerial solutions.

Although the EVAAS scale is designed for healthcare professionals, it can be applied to firefighters, traffic police, vehicle assistance technicians, and especially to EV users and passengers with minor modifications. Thus, the study will make a significant contribution to determining the educational status of the risk group on the subject of safety measures regarding EV accidents and to develop awareness and subsequently reduce possible deaths, occupational accidents, and injuries.

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