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OBJECTIVE APPROACH IN INVESTIGATING IMPLICATION OF ROAD VEHICLE TYRE SAFETY KNOWLEDGE ON COMPLIANCE

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Abstract. Standard effectual directive on tyre safety management operations on its own is nothing without appropriate compliance and application. Deliberate oversight and neglect of safety precautionary measures may result in an accident and eventually be classified as an unforeseen event. This study on safety knowledge and its implication for on-road vehicle tyre safety compliance was conducted among one hundred and thirteen private vehicle owners in Abeokuta, Nigeria. Data collection for this study was done using subjective and physical measurement procedures. The analysis of data obtained showed that sixty-eight participants (60.2%) of the participants had a fair knowledge of road vehicle tyre safety, followed by those that had good knowledge 39 (34.5%). No participant had poor or excellent knowledge. Overall operational tyre safety and compliance with the specifics for tyre standard condition showed that 1 (0.9%) of the assessed vehicles were of very high safe and appropriate compliance status. Forty-three (38.1%) of the assessed vehicles owned and used by the participants were of very low operational tyre safety and practices. This was followed by average safe and appropriate practice 39 (34.5%). Pearson's chi-square test analysis was used to check if there is an association between tyre safety knowledge and safe and appropriate compliance status variables gave $\chi^2 = 1.135$ and $p = 0.769$. This implies that there is no statistically significant association between the two variables.

Keywords: *tyre, safety, knowledge, vehicle, compliance, on-road.*

Rezumat. Directiva standard privind operațiunile de management al siguranței anvelopelor nu valorează nimic fără respectarea și aplicarea corespunzătoare. Supravegherea deliberată și neglijarea măsurilor de precauție de siguranță pot duce la accident și, în cele din urmă, pot fi clasificate ca un eveniment neprevăzut. Acest studiu analizează cunoștințele privind siguranța și implicațiile sale pentru conformitatea anvelopelor vehiculelor rutiere. Studiul a fost realizat în rândul a o sută treisprezece proprietari de vehicule private din Abeokuta, Nigeria. Pentru colectarea datelor s-au folosit proceduri de măsurare subiective și fizice.

Analiza datelor obținute a arătat că șaizeci și opt (60,2%) dintre participanți aveau cunoștințe corecte despre siguranța anvelopelor vehiculelor rutiere, urmați de cei care aveau cunoștințe bune 39 (34,5%). Niciun participant nu avea cunoștințe slabe sau excelente. Siguranța operațională generală a anvelopelor și conformitatea cu specificațiile pentru starea standard a anvelopelor au arătat că 1 (0,9%) dintre vehiculele evaluate avea o stare de conformitate foarte sigură și adecvată. Patruzeci și trei (38,1%) dintre vehiculele evaluate utilizate de participanți au avut o siguranță și practici operaționale foarte scăzute pentru anvelope. Aceasta a fost urmată de o practică medie sigură și adecvată – 39 participanți (34,5%). Testul Pearson a fost utilizată pentru a verifica dacă există o asociere între cunoștințele privind siguranța anvelopelor și variabilele de stare de conformitate sigure și adecvate - $\chi^2 = 1,135$ și $p = 0,769$. S-a constatat, că nu există o asociere semnificativă statistic între cele două variabile.

Cuvinte cheie: *anvelopă, siguranță, cunoștințe, vehicul, conformitate, pe drum.*

1. Introduction

The road accident phenomenon is apparently a complicated and remarkable development due to its diverse resultant effects on lives and property. The associated physical, economic and social problem calls for concern. The frequency and intensity of road traffic crashes are better explained in the witnessed 1.2 million lives it claims yearly and an additional 20 - 50 million non-fatal injury cases [1]. Nigeria alone records 10,050 road accident death cases yearly, with an average of 27 death cases per day [2, 3]. Afolabi and Gbadamosi [4] traced the significance of morbidity and mortality cases from road traffic crashes to population growth flight as well as an increased level of motorization. However, the record of road traffic accidents in the developing countries where vehicles are relatively few is proportionately upsurging but surprising declining in the industrialized nations [5]. From this perspective, Iteke et al. [6] linked the continued amplifying morbidity and mortality cases in road traffic accident records in most developing countries especially in the sub-Saharan Africa region to inconsequential and avoidable causation root factors. That is to say, most road traffic crashes are predictable and perhaps preventable [7].

Road vehicles and their operations play a significant role in road traffic accidents [4]. The features representing road vehicles in road traffic crashes includes defective tyres, faulty braking system, dysfunctional steering system, etc. these factors are directly or indirectly connected to the functions tyres offer in an on-road vehicle which includes acceleration, cornering, braking, and steerability. However, defective operation of any of these systems or components arising from poor maintenance of the vehicle influences the ride comfort and safety [8]. Safe vehicle actions and activities are very crucial in road traffic crashes morbidity and mortality reduction. Vehicle maintenance for safety and ride comfort involves assiduousness management of every component or system involved in vehicle controlling and maneuvering function. This involves compliance with the equipped tire pressure monitoring system specifics for vehicle tyre air pressure, plying speed on different road surfaces whether wet or dry as well as an electronic stability control system [8].

The necessity for accuracy in tyre pressure inflation and wheel alignment is a ride comfort and safety necessity to tyres flexing and heat during wheel rotation [8]. Most assuredly maintenance of appropriate tyre contact patch pattern and effective function in accelerating, steering, braking or cornering is only within its service life and proper inflation. Accordingly, the service life of vehicle tyres should effectively deal with tyre/road interface

interactions at the molecular level as well as the loading and unloading energy absorption of the vehicles [9, 10]. To maintain good tyre road grip, avoid aquaplaning on a wet road, vehicle instability, tyre blowout, and long braking distance, the specifics for tyre condition standard which includes tread depth, tyre age, and inflation pressure must be observed.

Understanding of the accident preventive measures as regards effectual and appropriate tyre safety management operations on its own is nothing without application. Deliberate oversight and neglect of safety precautionary measures may result in an accident and eventually be classified as an unforeseen event [11]. Subjective factors or variables are perchance independent of their actual performance [12]. Azodo and Ismaila [13] observed that awareness depending on its level may or may not translate to appropriate practices. Though subjective procedures for data collection from record raise bias response issues, conscious perception explanations vulnerability and publicly verifiable as a major concern [12, 14, 15]. However, individuals' inner states, potential knowledge and introspective reports about conscious experiences are reliable on the subjects and can only be assessed using a subjective approach [16]. On the other hand, utilizing objective design measures only because of its valid evidence relevant facts, logical implications and viewpoints, and humanitarian purposes in data collection precludes the existence of oblivious perception [17, 18]. That is to say, the adoption of an objective research technique in a study deal with an accepted standard which includes valid evidence relevant facts, logical implications and viewpoints and human purposes of that issue. If relevant valid evidence is denied, an objective approach is impossible. This study, therefore, adopted subjective and objective procedures in investigating the implication of road vehicle tyre safety knowledge on compliance among Nigerians.

2. Materials and Methods

This was a cross-sectional study of safety knowledge and its implication for on-road vehicle tyre safety compliance conducted among private vehicle owners in Abeokuta, Nigeria. Purposive multi-stage random sampling was used in the selection of participants. Subjective and physical measurement approaches were used for data collection in this study. The questionnaire (subjective approach) comprises demographic information (highest educational qualification, occupation and driving experience) whereas the categories of information assessed for knowledge of established operational road traffic safety standards were appropriate size of vehicle tyres, specified tyre inflation pressure, tyres expiry date and roadworthiness tread depth (Table 1). The variables on correct tyre safety rules developed based on the conceptual basis of the study after due consultation with related works of literature and established operational road traffic safety standards were assessed using a self-administered questionnaire. The same formed the guide for the evaluation of operational tyre safety and compliance among the participants. The responses of the participants to the variable were classified as either correct or incorrect. The scaling mean-point of each participant's responses was computed to 100% and presented as 70 – 100 for "Excellence" 60 – 69 for "Very Good", 50 – 59 for "Good", 40 – 49 for "Fair", and 0 – 39 for "Poor" knowledge.

Analysis of the operational tyre safety and compliance with the specifics for tyre standard condition which includes tread depth, tyre age, and inflation pressure was carried out on each participant's vehicle. The physical measurement was conducted before sunrise and also before the owners used the vehicle with regards to the arrangement priory made with the vehicle owners.

Table 1

Applicable road vehicle operational tyre safety standards [19-23]

Road vehicle tyre safety	Road vehicle operational tyre safety specifics
Appropriate tyre inflation pressure	25% below and above the manufacturer's recommended inflation pressure
Inflation pressure specifications guide and size designation recommended by the tyre/vehicle manufacturer.	Driver's door ledge, the fuel tank cover, the manufacturers' car manual or online search using the vehicles model for specified standard inflation pressure.
Shelf life of tyre from date of manufacture (DOM)	Four years
Legal minimum tread depth	1.6 mm
Instructed guide to tyre purchase	Tread depth, DOM and cracks or damage
Factors necessitating change of vehicle tyre	Worn out, expired, bad cut,bulges, punctures, impacts, cracks, and failing often

The scoring scheme associated with systematic observations made through physical measurement was analyzed as appropriate and inappropriate compliance status. This was conducted for the four tyres in each of the assessed vehicles. The level of safe and appropriate practice compliance for each of the assessed vehicles was computed to 100% and evaluated using the scaling range as follows "Very high safe and appropriate practice" = 70 – 100, "High safe and appropriate practice" = 60 – 69, "Average safe and appropriate practice" = 50 – 59, "Low safe and appropriate practice" = 40 – 49 and "Very low safe and appropriate practice" = 0 – 39. The data obtained were subjected to descriptive statistics in the form of frequencies and percentages.

Statistical Package for the Social Sciences (SPSS) software version 16.0 (Chicago, IL, USA) was used for descriptive statistical analysis on the data collected. The measure of the safety knowledge and its implication on operation compliance level regarding the tyre safety was conducted using the Pearson chi-square test at a p-value of 0.05 for significance level.

3. Results and Discussions

The response rate for the one hundred and twenty questionnaires distributed to the private vehicle owners in Abeokuta, Nigeria, was (113/120) 94%. Participants' distribution according to gender showed 60 (53.1%) female and 53 (46.9%) male. The highest educational training among the participants was tertiary education 93 (82.3%) probably owing to the presence of three institutions of higher learning in the study area, Federal College of Education, Oselle, Moshood Abiola Polytechnic, Ojere and Federal University of Agriculture, Abeokuta (Figure 1). The distribution of the participants by occupation showed that most of the participants were civil servants 33 (29.2%), followed by entrepreneurs 22 (19.47%) with the applicants having the minimum number of participants as 4 (3.54%) (Figure 2). Participants' years of present vehicle ownership and driving experience with it are presented in figure 3.

Accidents are a naturally unforeseen event or occurrence that results in death, injury, or property damage but when they happen one can't really say they are unanticipated [24].

However, caution can only be effectively taken and acted upon if appropriate awareness of associated danger is in place [11].

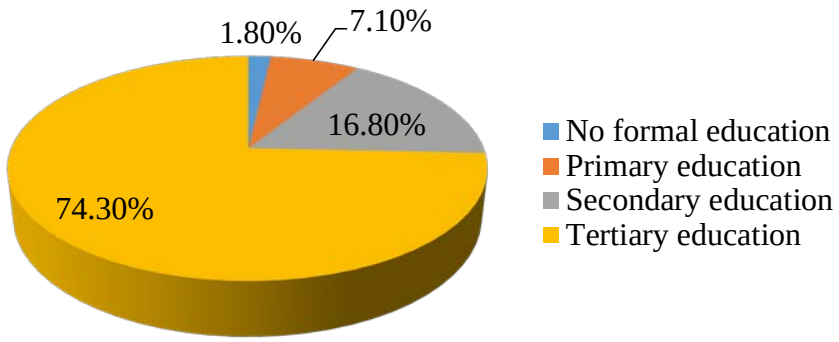

Figure 1. Highest educational training of participants.

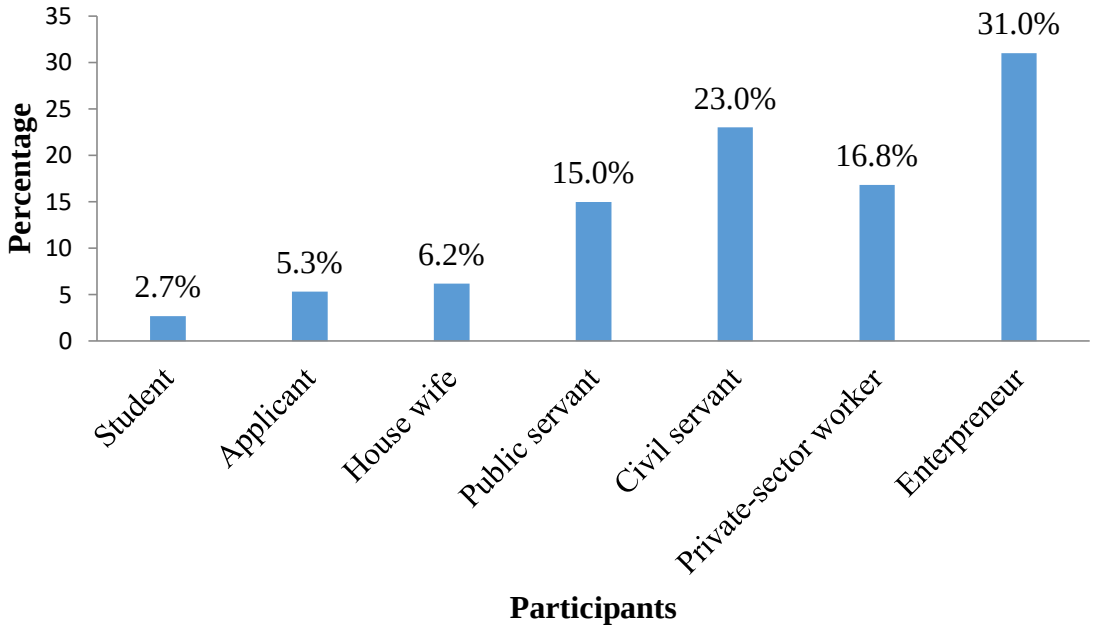

Figure 2. Occupation of participants.

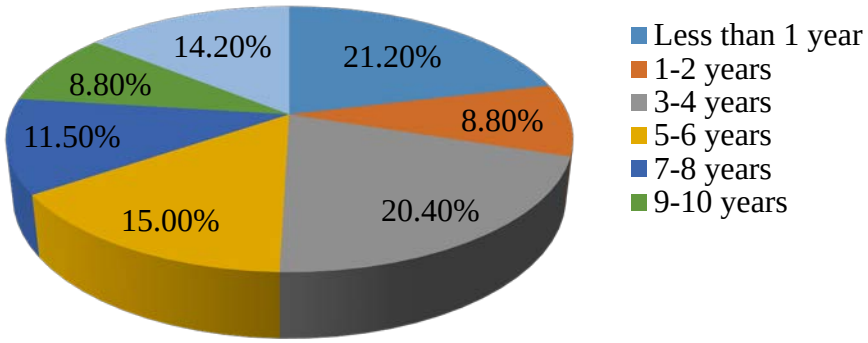

Figure 3. Participants years of driving experience.

Lack of awareness can result in a number of unsafe acts towards tyre safety practices. The safety knowledge and its implication on on-road vehicle tyre safety compliance conducted in this study cut across the lifespan of tyres, tyre pressure, tyre tread wear, and tyre sizes. Table 2 gives the response of the study participants for various levels of knowledge on on-road vehicle tyre safety. Considering that the shelf life of a tyre whether used or not is

four years from the DOM [22]. Sixty-two (54.9%) of the participants had correct knowledge on tyre DOM for expiry date check out of which thirteen (11.5%) of the participants had correct knowledge about the shelf life of tyre from DOM with ninety-three (82.29%) having incorrect knowledge.

Every vehicle has its own tyre inflation pressure specification according to the vehicle manufacturer. It is important to note here that two different models of vehicles may have the same tyre inflation pressure values but this should not be taken for general value. The structural damage scope covered in this study includes tyre inflation pressure (used for under-inflation, over-inflation, and appropriate inflation determination) and tyre wear. Sixty-eight (60.2%) of the participants had correct appropriate tyre inflation pressure knowledge for their vehicle nonetheless the 74 (65.5%) that had correct knowledge of the location where inflation pressure specifications guide for their vehicle by the manufacturers of the vehicles is found (Table 2). Ten (8.85%) of the participants' informed knowledge of appropriate tyre pressure was from the right source (Table 2). Knowledge of the designation location for the recommended tyre size by vehicle manufacturer had 74 (65.5%) correct responses from the participants. The knowledge eight-seven (77.0%) of the participants had about the appropriate size of their vehicle tyre was correct. Fifty-one (45.1%) had correct knowledge instructed guide to tyre purchase whereas on factors necessitating a change of vehicle tyre 74 (65.49%) had correct knowledge (Table 2).

Table 2

Appropriate knowledge on on-road vehicle tyre safety

Assessed variables on knowledge of road vehicle tyre safety	Participants responses for road vehicle operational tyre safety	
	Correct n (%)	Incorrect n (%)
Appropriate tyre inflation pressure for owner's vehicle	68 (60.2)	44 (38.9)
The location where inflation pressure specifications guide for the vehicles manufacturers is found	74 (65.5)	38 (33.6)
Shelf life of tyre from DOM	13 (11.5)	93 (82.29)
Legal minimum road worthiness tread depth	50 (44.2)	63 (55.8)
The designation location for the recommended tyre size by vehicle manufacturer.	74 (65.5)	38 (33.6)
Instructed guide to tyre purchase	51 (45.1)	62 (54.9)
Factors necessitating change of vehicle tyre	74 (65.49)	39 (34.51)
Informed knowledge of correct tyre pressure	10 (8.85)	98 (86.73)
Tyre DOM for expiry date check	62 (54.9)	51 (45.1)
Appropriate size of tyre for owner's vehicle	87 (77.0)	26 (23.0)

Overall safety knowledge of on-road vehicle tyre safety on the various variables assessed in the questionnaire by the participants showed that no participant had poor and excellent knowledge of road vehicle tyre safety. Sixty-eight (60.2%) of the participants had a fair knowledge of on-road vehicle tyre safety, followed by those that had good knowledge 39 (34.5%). Only 6 (5.3%) of the participants had very good knowledge (Table 3).

In a normal and appropriate operation condition, tyres smooth roll and durable functions are imperative for acceleration, cornering, braking, and stability owing to the high-quality composite and expertly-engineered chassis component that is specifically adapted to vehicles to match a variety of different suspension systems and respond accurately for proper traction needed.

Table 3

Overall knowledge road vehicle tyre safety per participant vehicle owner

Levels of road vehicle tyre safety	Frequency (n)	Percentage (%)
Poor knowledge	0	0.0
Fair knowledge	68	60.2
Good knowledge	39	34.5
Very good knowledge	6	5.3
Excellent knowledge	0	0.0
Total	113	100.0

Table-4 shows the analysis of the operational tyre safety and compliance with the specifics of the tyre condition standard which includes tyre size, tread depth, tyre age, and inflation pressure carried out on each participant's vehicle. The assessment was carried out on each of the four tyres; the front right, front left, back right, and back left as well as for the vehicle as a unit. From the standard for tyre roadworthiness in Nigeria [22], tyres have a 4-year validity period from their DOM which means that beyond a four years duration of from its DOM used or not, the such tyre has high accident risk potential, therefore should be avoided. Purchase of new expired tyres is susceptible to road accident risk. The shelf life of tyres in the vehicles showed that only 33 (29.20) of the participant vehicles were road worthy.

Tyre inflation pressure measured when compared with the specification stipulated by the manufacturers either driver's door ledge, the fuel tank cover, the manufacturers' car manual or online search using the model of the vehicle for specified standard inflation pressure with considered accuracy of ±0.05 observed 6 (4.42%) of the participant vehicles had appropriate tyre inflation pressure. In practice, the road contact patch pattern of tyres needs to be maintained through appropriate operational safety standards for it to uphold its shape and perform effectively in load carrying function and stability. In addition, incorrect tyre pressure also increases the potential for hydroplaning (aquaplaning) and much longer stopping distances.

Reithmaier and Salzinger [25] opined that excessive wear of tyres significantly contributes to road traffic accident due to the rolling resistance and friction between the road and tyre. The tyres of the assessed vehicles witnessed a much uneven wear due to inappropriate inflation pressure 33 (29.20%) of the participant vehicles recorded even tyre pressure.

The rolling resistance of tyres mainly depends on how the tread of the tyres touch the road surface. Tread depth is very important in maintaining straight line headway of the loaded tyre, especially at a constant speed. On the basis of hydroplaning potential and stopping distances, it is expected that tyre replacement for safe driving of used vehicle tyre should be at the tread depth of 1.6 mm as the chance of worn out tyre to cause an accident is high especially on the wet road [22, 26]. ROSPA [26] added that increases in stopping distance become significant when the tyre is worn past 3mm. The legal minimum tread depth of 1.6 mm notwithstanding, Hardy and Fenner (2015) reported that tyre tread depth of 3 mm performs 25% better than those at 1.6mm. In this study, the roadworthiness of road vehicle tyres (total compliance of the four tyres) was analyzed on the basis of legal minimum tread depth of 1.6 mm and 3.0 mm for dry and wet road conditions respectively (across 75% of the

tyre). Legal minimum roadworthiness tread depth for wet road conditions analyzed at the depth of 3.0 mm showed that 55 (48.7%) of the assessed vehicles were roadworthy as they had appropriate depth cut. When the legal minimum roadworthiness tread depth for dry road conditions was assessed at the depth of 1.6 mm, it showed that 85 (75.2%) participants' vehicles were of appropriate tread depth.

All the four tyres in a vehicle should be of appropriate sizes, speed rating and construction (radial or cross ply). Of the factors assessed, the same tyre size recommended by the tyre/vehicle manufacturer had the most appropriate safety compliance with a proportion of 105 (92.9%) of the assessed vehicle owned by the participants. This observation is in line with Reithmaier and Salzinger's [25] study.

Table 4

Analysis of the operational tyre safety and compliance with the specifics for tyre condition standard

Assessed variables	Appropriate operational status of tyre from physical measurement data analysis				
	Front right n (%)	**Front left n (%)**	**Back right n (%)**	**Back left n (%)**	**The assessed vehicle n (%)**
Tyre inflation pressure	26 (23.01)	25 (22.12)	25 (22.12)	17 (15.04)	6 (4.42)
Shelf life of tyre	44 (38.9)	46 (40.7)	63 (55.8)	53 (46.9)	33 (29.20)
Even wear of tyre tread	31 (27.4)	33 (29.2)	29 (25.7)	23 (20.4)	13 (11.50)
Legal minimum road worthiness tread depth for wet road condition	89 (78.8)	88 (77.9)	86 (76.1)	78 (69.0)	55 (48.7)
Legal minimum road worthiness tread depth for dry road condition	98 (86.7)	104 (92.0)	101 (89.4)	103 (91.2)	85 (75.2)
The same tyre size recommended by the tyre/vehicle manufacturer.	113 (100)	109 (96.46)	112 (99.12)	111 (98.23)	105 (92.9)

A vehicle is made up of many component parts and systems. A default of any of the component parts and systems, a tyre, for example, may affect the proper functioning of the vehicle. Overall operational tyre safety and compliance with the specifics of the tyre condition standard for each assessed vehicle showed that no assessed vehicle was of very high safe and appropriate compliance status. Forty-three (38.1%) of the assessed vehicles owned and used by the participants' were of very low safe and appropriate operational tyre safety and practices. This was followed by high safe and appropriate practices 39 (34.5%) (Table 5).

Pearson's chi-square test used to analyse data obtained to check if there is an association between tyre safety knowledge and safe and appropriate compliance status variables giving $\chi^2 = 1.135$ and $p = 0.769$ which is greater than 0.05.

This implies that statistically there is no significant association between knowledge of road vehicle tyre safety and operational tyre safety and compliance with the specifics for tyre condition standard among the participants (Table 6).

Table 5

Operational tyre safety and compliance with the specifics for tyre condition standard per assessed vehicle

Levels of safe and appropriate practice compliance	Frequency (n)	Percentage (%)
Very low safe and appropriate practice	43	38.1
Low safe and appropriate practice	30	26.5
Average safe and appropriate practice	39	34.5
High safe and appropriate practice	0	0.0
Very high safe and appropriate practice	1	0.9
Total	113	100.0

Phi and Cramer's used to test the level of association of knowledge of road vehicle tyre safety and operational tyre safety and compliance with the specifics for tyre condition standards showed that the level of association between the two variables was weak (Table 7).

Table 6

Chi-Square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.135[a]	3	0.769
Likelihood Ratio	1.130	3	0.770
Linear-by-Linear Association	0.096	1	0.756
No of Valid Cases	113		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.43.

Table 7

The table of symmetric measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	0.100	0.769
	Cramer's V	0.100	0.769
	Contingency Coefficient	0.100	0.769
No of Valid Cases		113	

Conclusions

For a vehicle to serve its intended purpose which is to convey materials, goods, and people safely to their intended destinations, precautionary action must be judiciously observed and implemented. The safety aspect of road transportation and its operation is very important as it is closely related to human lives. This experimental research that assessed the effect of awareness and cautionary information on safe and appropriate tyre safety management operations among private vehicle owners in Abeokuta, metropolis, Nigeria on the established operational road traffic safety standards which includes vehicle tyres sizes, specified tyre inflation pressure, tyres expiry date and roadworthiness tread depth observed

that there was an association between the safety knowledge and its implication on-road vehicle tyre safety but it is not statistically significant. This calls for proactive awareness of tyre safety among vehicle owners.

Conflicts of Interest: The authors declare no conflict of interest.

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