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Testing Effectiveness of Community Co-Created Interventions in Preventing Road Traffic Accidents of Motorcyclists in Goma City, Democratic Republic of Congo

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Abstract:

- ***Introduction:***

Globally, approximately 1.35 million people die annually on the world's roads. And between 20 and 50 million people sustain injuries often resulting in prolonged hospital stays or permanent disability. More than 90% of these road traffic deaths occur in low- and middle-income countries. This can be attributed to the increased use of commercial motorbikes by young people for transportation in Sub-Saharan Africa. Motorcyclists face a significantly higher risk of road accidents, being over eight times more likely to be involved in an accident compared to car drivers. WHO data published in 2020 indicated that the Democratic Republic of Congo (DRC) had 30,256 road traffic deaths, accounting for 4.60% of total road traffic fatalities. These fatalities contribute significantly to the nation's economic losses due to medical expenses and lost productivity.

- ***Objective:***

To determine the effectiveness of co-created road traffic interventions in preventing road traffic accidents of motorcyclists in Goma City, DRC.

- ***Methodology:***

The study used a quasi-experimental design with a random sampling technique to reach 150 motorcyclists (75 per study group) using questionnaires and interview guides. A baseline study was conducted to explore the behavioural factors that influence road traffic accidents in Goma city and thereafter, stakeholders were included in a workshop to co-develop a behavioural change model to help prevent road traffic accidents. The intervention was rolled out and afterwards an endline survey was done to establish its effectiveness. The study was anchored on the theories of planned behaviour and socio-cognitive theory.

- ***Results***

The study revealed that 148(98.7%) motorcyclists put on helmets as the safety measures but majority of motorcyclist 85(56.7%) had no protective. Also, having helmets were not associated with traffic road accident ($\chi 2$=1.2779; P-value=0. 258). Driving past stop signs was associated with road accident ($\chi 2$=9.1408; P-value=0.05. Driving under the influence of alcohol caused traffic road accident ($\chi 2$=8.7465; P-value=0.033). Drowsiness was significantly associated with traffic road accident ($\chi 2$=7.3251; P-value=0.002).

- ***Conclusions***

The co-developed model anchored the theories of planned behaviour and socio-cognitive theory attained statistically significant effects in reducing motorcycle accidents.

- ***Recommendations***

The research findings will be used to inform evidence-based decisions on reduction of motorcycle accidents in Goma City and similar settings.

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I. INTRODUCTION

Road traffic crashes (RTCs) burden varies globally, from 22.8% in China to 62% in Vietnam [1]. The crashes are a major public health problem, especially in developing countries, where many people are injured or die as a result of their involvement in accidents [1]. Based on WHO road safety statistics of 2018, 1.35 million people die on roads across the globe annually, in addition, 20 to 50 million people are injured and require to stay in hospital for extended period or become permanently disabled [3]

A huge number of young people aged between 5 to 29 years who have the greatest potential, die as a result of road traffic crashes [3]. The number of the motorcyclists is estimated at 770 million worldwide and the main activities they are engaged in are transportation, sports, mobility, and economic pursuits [4]. In China, both the overall case fatality rate (CFR) and human damage (HD) related to road accidents increased by 19.0% and 63% respectively. In the period from 2000 to 2016, the CFR of freight vehicles increased from 20% to 33%, 5% higher than average [5]. In India, 50% of cities experience a high fatality risk, and road traffic deaths are expected to exceed 25,000 by 2025 [6].

Many families are driven deeper into poverty by the loss of a family breadwinner, funeral costs, the expenses of prolonged medical care and rehabilitation or through the earnings lost while caring for someone who is injured or disable [5]. Road traffic injuries also place a strain on the healthcare services in relation to financial resources, bed occupation, and the demand placed on health professionals. For instance, in Kenya patients from road traffic injury represent between 45-60% of all admissions in surgical wards [7].

The Democratic Republic of Congo has a National Road Prevention Commission, with a mission to propose to the Government a concerted road safety policy and to ensure coordination of all sectorial actions with a view to better safety on the entire national road network. According to the latest WHO data published in 2020, DRC reached 30,256 or 4.60% of total road traffic deaths ranking 25th in the world and eighth among the leading cause of death [3] and is responsible for a large portion of the country's economic losses due to medical costs, vehicle damage, and lost productivity. Study has established that a total of 708 road traffic accidents were recorded by the road traffic police in the city of Goma [8] prompting a response from the local government to implement various interventions to improve road safety including; installation of speed bumps, traffic signals, increased enforcement of traffic laws and increased public awareness campaigns.

- *The Conceptual framework*

This framework shows how the variables interact with each other. The dependent variable motorcycle accidents, is dependent on the behavioural factors and co-developed behaviour change model with stakeholders. The intervening variables are local traffic policies and law enforcement, infrastructure and road conditions, weather and environmental factors, and cultural norms. Confounding factors are those variables that can distort the observed relationship between the exposure and outcome variable but not part of the causal pathway.

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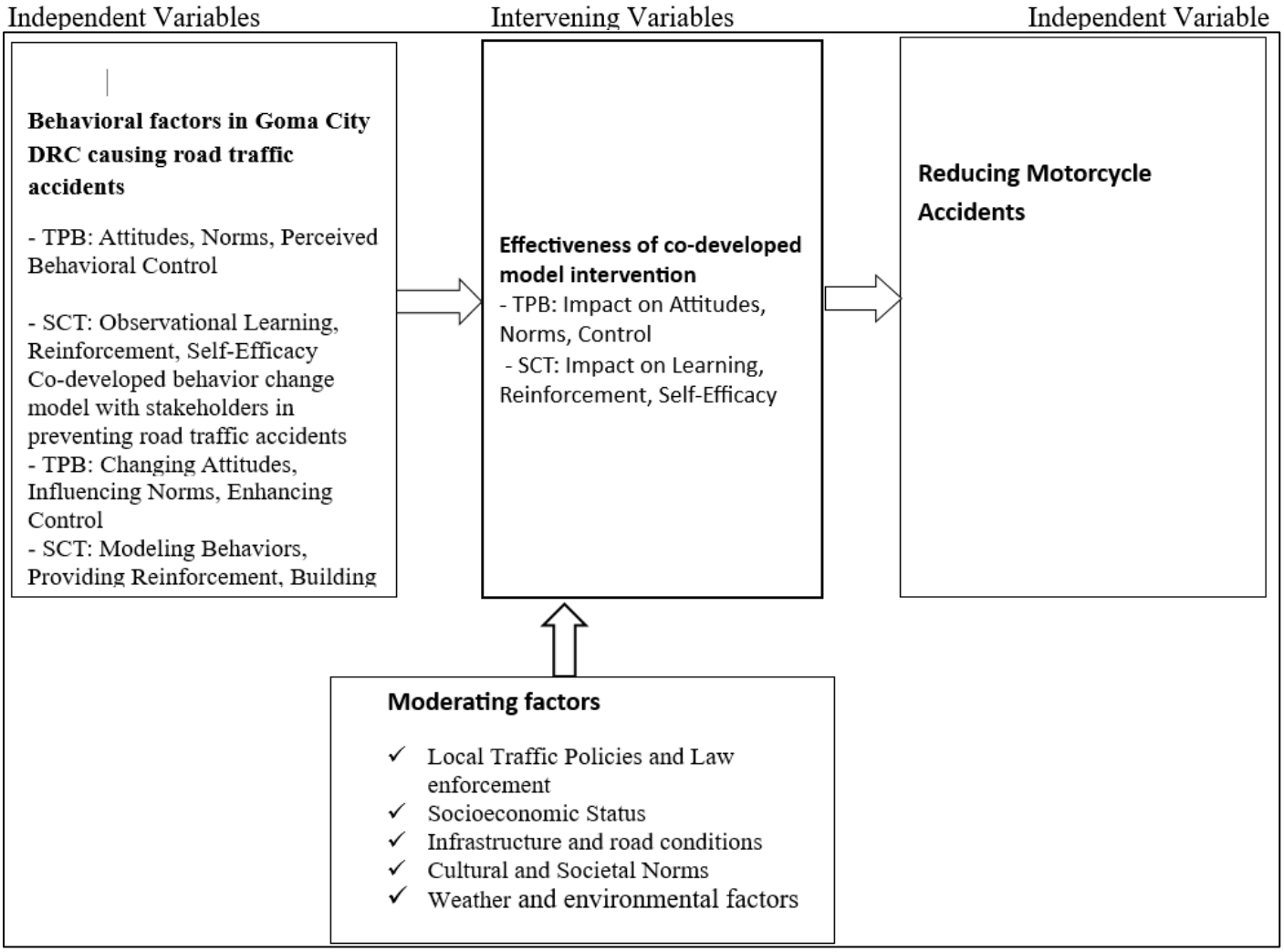

Fig 1 Independent Variable, Intervening Variable, Independent

II. MATERIALS AND METHODS

➢ *Study Area;*

This research was carried out in the city of Goma located in the east of the Democratic of Congo, and the capital of North Kivu province extending over an area of 66.45 km^2

➢ *Study Design-*

The study was guided by a pre-post design, where data on road traffic accidents involving motorcyclists was collected before (baseline data collection) and after (endline data collection) the implementation of co-created intervention. The study adopted both quantitative and qualitative approaches to data collection and analysis and presentation. The treatment group consisted of areas where the interventions are introduced, while the comparison group comprised areas without the interventions but with similar baseline characteristics. The intervention phase was conducted for a month and the effectiveness of the model was tested after 6 months from the datasets collected of the different timepoints so as to establish impacts of the intervention. The study was conducted in five phases over a period of eight months. A phased approach was adopted for practical, logistical and operational efficiency.

➢ *The target population and Sample size calculation;*

The target population for this study primarily encompasses motorcyclists and stakeholders of Goma City, DR Congo. The determination of the sample size was done by using the formula by Demidenko [9]. The study recruited a total 150 respondents from the motorcyclists (75 for each of the groups).

➢ *Inclusion and Exclusion Criteria*

- *Inclusion Criteria*

✓ *Stakeholders:*

- Directly involved in Road safety: either from the ministry of transport and communication, a community leader, a leader from the motorcyclist associations located in Goma or a member of the law enforcement team.
- Consented and willing to participate in the study.
- Above or equal to the legal age in DRC (18 years and above).
- For illiterate participants, provide information about the study verbally and obtain verbal consent and a thumbprint as their signature in the presence of an impartial witness.

✓ *Motorcyclists:*

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- Should be a motorcyclist operating in Goma City.
- Consented and willing to participate in the study.
- Above or equal to the legal age in DRC (18 years and above).
- For illiterate participants, provide information about the study verbally and obtain verbal consent and a thumbprint as their signature in the presence of an impartial witness.

- *Exclusion Criteria*

- Motorcyclists who will have operated in Goma City for less than 6 months.
- Motorcyclists who are not registered in any of the motorcyclist associations.
- Residents who had major disabling medical conditions at the time of the study hence were unable to cooperate

✓ *Procedure and Methods*

After obtaining the research consent, primary and secondary data were collected using both qualitative and quantitative data methods. The data collection process was undertaken in two weeks

✓ *Ethical Approval*

Approval to carry out this study was obtained from School of Graduate Studies, Great Lakes University of Kisumu and also clearance from Great Lakes University of Kisumu Ethics also clearance from Goma province DRC. Further Voluntary and informed consent of the respondents was sought after explaining the aim of the study.

✓ *Statistical Analyses*

The primary outcome of the study is motorcyclist road traffic accidents in relation to the various interventions being introduced in the study arms. Other study outcomes include the behavioral factors like driving when fatigued, overconfidence while driving, not using safety gear, and aggressive driving behavior. Quantitative data was analyzed SPSS Statistics 19.0. The descriptive statistics was depicted as percentages. For inferential statistics, cross tabulation with chi-square test was used to establish the existence of statistically significant difference between the independent variables; socio-demographic, socio-economic, and health systems factors with the dependent variables namely the reduction of motorcycle accidents. Baseline and endline data were collected from both the intervention and control sites from the motorcyclists attached in the various associations. A difference-in-difference analysis approach was used to determine the net change in the outcome between the intervention and control arms at baseline and endline. Results have been presented in tables.

III. RESULTS

➢ *Demographic Characteristics of the Participants*

The median age of the motorcyclists participated in the study in Goma city was (median= 33, IQR=11) and their median monthly income salary in CDF was (median=300000, IQR=4200) while the majority of them attained secondary level of education 105(70%), 25(16.7%) attained primary level of education, 15(10%) attained college or higher education level and 5(3.3%) were not able to attained formal education level.

The majority of motorcyclists 131(87.3%) had more than 6 months experience in driving motorcycle, 13(8.7%) had 3 months to 6 months experience while 6(4%) had experience in driving motorcycle for a period less than 3 months. On issues of training Highway Code, 100(66.7%) motorcyclists had trained on Highway Code while 50(33.3%) motorcyclists had not trained.

Majority of the motorcyclists 136 (90.7%) had registered their motorcycles but 14(9.3%) had not been able to register their motorcycles. The majority of motorcyclists 102(72%) did not have driving license while 42(28%) had their license. In terms of traffic road accidents, 58(38.7%) had been involved in traffic road accident in the past 6 months while 92(61.3%) had not been involved in traffic road accidents as shown in Table1

Table 1 The Demographic Characteristics of the Study Participants in Goma City

Variable name	Median (IQR)	Frequency(n)	Percentage (%)
Age (Years)	33 (8.25)		
Monthly Income (CDF)	300000 (42000)		
Education level			
Colleges or higher		15	10
Primary		25	16.67
Secondary		105	70
No formal education		5	3.33
Period Riding a motorcycle			
3months to 6 months		13	8.67
Less than 3 months		6	4
More than 6 months		131	87.33
Motorcyclist Trained on highway code			
Yes		100	66.67
No		50	33.33
Registered motorcycle			
Yes		136	90.67

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No		14	9.33
Motorcyclist registered motorcycle			
Yes		45	30
No		105	70
Motorcyclist have a driver's license			
Yes		42	28
No		108	72
Involved in road accident in the last 6 months			
Yes		58	38.67
No		92	61.33
Total		150	100

➢ *Co-Developed Interventions:*

To co-develop a behavioral change model with stakeholders in preventing road traffic accidents among motorcyclists in Goma City, DR Congo. As part of the development of this objective, stakeholders were invited to reflect on and develop intervention models that can help prevent road traffic accidents in the city of Goma. The stakeholders included the Ministry of Transport and Communication, the Road Traffic Police, the National Road Safety Commission, and leaders of motorcyclist associations. The issue of road traffic management in the city of Goma and the results of the baseline statistics were presented to help stakeholders understand the essence of the study, provide their input, and identify and develop intervention models that can help prevent road traffic accidents. A preventive and safety-oriented attitude primarily depends on the behavior of the driver. It is necessary to anticipate one's own risks as well as those of other users.

The participants expressed their interest in this workshop, which allowed them to contribute to addressing a real problem in the city of Goma, given the increase in accident cases and the loss of human lives. The exchange of experiences was beneficial and enriched the audience's awareness of the fight against losses in road traffic management. After reviewing the presentation of the baseline results, the researcher asked the assembly to develop intervention models that can help prevent road traffic accidents in the city of Goma.

➢ *Proposed Interventions:*

Awareness campaigns, improvements in signage,training of drivers on the code of conduct, improvement of infrastructure, training of traffic police, sanctions for cases of compromising behavior, regular road checks with rigor, development of public transport, installation of speed cameras, identification of parking areas. After developing the interventions, participants were asked to choose three models that could be implemented in our study to prevent road traffic accidents in the city of Goma. The three selected intervention models were: First one enhanced driver training: Create a rigorous training plan for drivers and traffic police, emphasizing road safety and stress management. The highway code must be mastered before a driver's license is granted. Second; regular road checks: Initiate frequent and random checks to enforce speed limits, driving under the influence of alcohol, and the mandatory use of personal protective equipment. Reduced-speed zones should be created for the safety of pedestrians. Third; deterrent sanctions: Impose severe penalties for serious offenses such as drunk driving to deter risky behavior. All participants agreed on the co-developed intervention models, which need to be explained and taught to the study intervention group. Formation of the intervention group As indicated in the study, after identifying the interventions, training for 75 intervention subjects took place to help implement and assist in comparison with 75 control subjects after the initial data collection.

Training on the identified interventions was conducted to ensure mastery of the guidelines before implementation. The interventions were presented by experts from the National Road Traffic Prevention Commission and the Road Traffic Police, with detailed explanations for a clear understanding of the principles. The Highway Code formed the basis of the training and was explained in detail. To test the effectiveness of the co-develop model of interventions to prevent road traffic accidents.

➢ *Using the Difference in Difference Analysis of Factors Associated with Road Accident in Goma City.*

The study revealed that 44% of motorcyclist in the control group involved in road accident and after the study ends the number had reduced by 12.1% while in treatment group the of cases involved in road accident had reduced by 22.5% resulted a decrease of 10.4% of the causal effect of traffic road accident caused by motorcyclist in Goma City.

On the other hand, 100% motorcyclist in the control group wear helmet and after the study the number has reduced by 1.4%. In comparison to the treatment group, before the intervention wearing helmet was at 98.7% but after the intervention the number of those who wearing helmet regularly had increased by 1.3% depicted that the causal effect of wearing helmet as increased by 2.7%.

Use of protective clothing such as gloves and fluorescent jackets in the control group was 77.3% but after the study the use of the protective clothes reduced by 36% while in the Treatment group the use of protective clothes was 52.5% before the intervention while after the intervention, the number of motorcyclists using the protective clothes increased by 38.5% suggested that the causal effect of using protective clothes among motorcyclist in Goma city was 72.0% while motorcyclists engaging in activities like texting, talking on the phone were 16% in the control group while

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after the study they increased by 74.3% in comparison to treatment group, 36% were engaging in such activities before intervention but after the intervention they had increased by 43.7% depicts a causal effect in engaging activities such as texting, talking on the phone has reduced by 30.6% among motorcyclist in Goma city.

Used of headphones or earphones while riding in the control group was 34.7% but after the study the use of headphone had increased by 33.4% while in the treatment group the use of headphones while driving was at 17.3% before the intervention but after the intervention the use of headphone or earphones while driving had increased by 8.2 depict a decrease of 25.2% of causal effect in use of headphones while driving in Goma city.

Again, 26.7% motorcyclists were being distracted while they were driving in the control group but after the study the number decreased by 0.3% whereas in the treatment group 14.7% were distracted before intervention and after the intervention there was a decreased of 12% in distraction depicted 11.7% of causal effect in motorcyclist distracted while they were driving. Issues of ridden a motorcycle under the influenced of alcohol in the control group was at 14.7% but after the study the influenced of alcohol had increased by 39.5% whereas in the treatment group before intervention influenced of alcohol was at 24% and after the intervention it was significantly reduced by 5.1%.

The causal effect in the influenced of alcohol among motorcyclist in Goma city reduced by 44.6%. The motorcyclist exceeded speed limit when they were driving in the control group was at 54.7% but at the end of the study the number of motorcyclists had increased by 43.6% while in the treatment group the number increased by 21.2% after the intervention revealed a decreased of 22.7% in the causal effect.

Motorcyclists engaged in aggressive behavior in the control group was at 30.7% and after the end of study the number increased by 13.7% while in the treatment group the number had decreased by 11.7% after the intervention depicted a decreased of 25.4% in the causal effect. Those who knowingly disobey traffic rules and regulations while riding in the control group was at 76% and the end of the study there was an increase of 24% while in the treatment group the number of motorcyclists disobeyed traffic rules and regulations had increased by 5.0% suggested a decreased of 19% of the causal effect.

On the other hand, 85.3% of motorcyclist in the control group had a riding behavior in the adverse weather conditions such as rain, fogs but after the study the number of motorcyclists who drove in adverse weather increased by 14.7% whereas in the treatment group the number of motorcyclists who drove in adverse weather condition increased by 10.7% resulting to a decreased in causal effect by 4.0 %. Motorcyclist received traffic warning or fines related to motorcycle riding behavior in the control increased with 14.1% while in the treatment group those received on traffic warning had reduced by 14.3% resulted to 28.4% decreased in the causal effect as shown in Table 2

Table 2 Shows Difference in Difference Analysis in Factors Associated with Road Accident Among Motorcyclist in Goma City

	Control Group	**Treatment Group**					
Variable Name	**Before (%)**	**After (%)**	***diff***	**Before (%)**	**After (%)**	***diff***	**DID**
Regularly wear a helmet when riding a motorcycle	100	98.6	-1.4	98.7	100	1.3	2.7
Use protective clothing, such as gloves or florescent jackets	73.3	37.5	-36	52	90.5	38.5	72.0
Engage in activities like texting, talking on the phone	16.0	90.3	74.3	36	79.7	43.7	-30.6
Use headphones or earphones while riding	34.7	68.1	33.4	17.3	25.7	8.2	-25.2
How often have you been distracted while riding	26.7	26.4	-0.3	14.7	2.7	-12	-11.7
Ridden a motorcycle under the influence of alcohol in the past 6 months	14.7	54.2	39.5	24	18.9	-5.1	-44.6
Exceed the speed limit while riding	54.7	98.6	43.9	76	97.2	21.2	-22.7
Engaged in aggressive behaviors, such as racing with other riders	30.7	44.4	13.7	32	20.3	-11.7	-25.4
Knowingly disobey traffic rules and regulations while riding	76.0	100	24	86.7	91.7	5.0	-19.0
Alter riding behavior in adverse weather conditions, such as rain, fog	85.3	100	14.7	88	98.7	10.7	-4.0
Received traffic citations, warning or fines related to motorcycle riding behavior	38.7	52.8	14.1	44	29.7	-14.3	-28.4

Note: *DID= 〖Diff〗_(Treatment group)- 〖Diff〗_(Control group);; diff within group=After intervention-Before intervention*

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From the model, the study revealed that wearing helmet regularly significantly increases the traffic road accident by 0.027 while Use of protective clothing, such as gloves or florescent jackets in the control group increases traffic road accident by 0.72. On the other hand, engaging in the activities like texting, talking on the phone in the treatment group significantly reduced traffic road accident by 0.306 (DID=-0.306, 95%Cl= -0.312, -0.300)compared to the control group while using headphones while riding in the treatment group significantly reduces the traffic road accident by 0.252 (DID=-0.252, 95%Cl= -0.262 , -0.242).The motorcyclists being distracted while riding in the Treatment group also reduced the accident by 0.117 (DID=-0.117, 95%Cl=-0.139 -0.095) compared to the control group. Again, riding a motorcycle under the influence of alcohol in the past 6 months in the treatment group significantly reduces the traffic road accident by 0.446 (DID= -0.446, 95%Cl= -0.462, -0.430) compared to the control group. On the other hand, motorcyclists exceeding the speed limit significantly reducing the traffic road accident in the treatment group by 0.227 (DID= --0.227, 95%Cl= -0.235 , -0.219) compared to the control group. Motorcyclists engaged in aggressive behaviors such as racing with other riders after receiving the intervention significantly reducing the traffic road accident by 0.254 (DID= -0.254, 95%Cl= -0.270 -0.238) compared to the control group while Motorcyclists knowingly disobey traffic rules and regulations while riding after the intervention significantly reduced the traffic road accident by 0.19 (DID= 0.19, 95%Cl= -0.206, -0.174) compared to the control group and alter riding behavior in adverse weather conditions , such as rain, fog in the treatment group significantly reduces the traffic road accident by 0.04 (DID= -0.04, 95%Cl= -0.044, -0.036) and lastly, motorcyclists often perform maintenance on their motorcycle in the treatment group significantly reduced traffic road accident by 0.284 (DID= -0.284, 95%Cl= -0.294 , -0.274) compared to the control group as shown in the table 3

Table 3 DID Regression Analysis with Factors Associated with Traffic Road Accident in Goma City

Variable name	DID	Std error	95%Cl	P-value
Regularly wear a helmet when riding a motorcycle	0.027	0.003	0.021 0.032	0.040
Use protective clothing, such as gloves or florescent jackets	0.720	0.004	0.708 0.732	0.011
Engage in activities like texting, talking on the phone	-0.306	0.004	-0.312 -0.300	0.018
Use headphones or earphones while riding	-0.252	0.005	-0.262 -0.242	0.000
How often have you been distracted while riding	-0.117	0.011	-0.139 -0.095	0.020
Ridden a motorcycle under the influence of alcohol in the past 6 months	-0.446	0.008	-0.462 -0.430	0.049
Exceed the speed limit while riding	-0.227	0.004	-0.235 -0.219	0.017
Engaged in aggressive behaviors, such as racing with other riders	-0.254	0.008	-0.270 -0.238	0.026
Knowingly disobey traffic rules and regulations while riding	-0.190	0.004	-0.206 -0.174	0.035
Alter riding behavior in adverse weather conditions, such as rain, fog	-0.040	0.002	-0.044 -0.036	0.000
Often do you perform maintenance on motorcycle	-0.284	0.005	-0.294 -0.274	0.019

In general, the intervention in the treatment group had a significantly brought some impact on reducing traffic road accident in Goma city by 68% (OR=0.32, 95%Cl= 0.11 0.9, P<0.05). In conclusion, the intervention had reduced traffic road accident caused by motorcyclist in Goma city by 68% as shown in the model. Table 4

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Table 4 Difference in Difference regression analysis to evaluate the effect of intervention on traffic road accident among motorcyclists in Goma City.

Variable	OR	95%CI	P-value
DID	0.320	0.112, 0.901	0.013
LR chi	5.440		
Prob>Chi2	0.019		
Pseudo R2	0.027		
Observation size	150		

NOTE: DID is the Interaction between Time and Association

IV. DISCUSSION

This study revealed that 44% of motorcyclist in the control group involved in road accident and after the study ends the number had reduced by 12.1% while in treatment group the of cases involved in road accident had reduced by 22.5% resulted a decrease of 10.4% of the causal effect of traffic road accident caused by motorcyclist in Goma City. This study agrees with [10] who examined evaluations of mass media campaigns focusing on their impact on crashes, especially those addressing themes related to driver behavior, safety devices within vehicles and indicated that a road safety mass media campaign led to an 8.5 percent reduction in crashes during the campaign's operation. This study reports that use of headphones or earphones while riding in the control group was 34.7% but after the study the use of headphone had increased by 33.4% while in the treatment group the use of headphones while driving was at 17.3% before the intervention but after the intervention the use of headphone or earphones while driving had increased by 8.2 depict a decrease of 25.2% of causal effect in use of headphones while driving in Goma city.

In a related study conducted on evaluation of driver behaviour criteria for evolution of sustainable traffic safety, the Analytic Hierarchy Process (AHP) was similarly applied for 20 examined driver behavior factors in a three-level hierarchical structure with linguistic data collected from three nominated evaluator groups in order to detect the difference of responses on perceived road safety issues [11].These findings are at variance with those by a study in the United Kingdom which found that removing the traditional separation between traffic and people in traffic areas can make the streets safer and less congested, and that the removal of standard kerbs, barriers, highway signs and road markings which will force motorists to use eye contact with other road users and pedestrians [12].These differences in the findings may be attributed to the levels of development in the road infrastructures in the two research areas. The findings therefore agree with this study that the Extended Parallel Process Model [13] and the Theory of Planned Behaviour [14] are able to support development of effective models.These findings resonate with the facts that the Co-developed model is designed to fight any negativities that may be attached to the accident risks in a friendlier atmosphere without prejudices of a 'foreign facilitator' as it happens in the conventional models of training on new interventions [15].

V. CONCLUSIONS FROM THE STUDY

This study has confirmed that co-developed model has a direct and measurable impact on motorcycle accident reductions was confirmed by the positive that have been depicted despite a small sample size. These study's results provide impetus for mainstreaming the co-developed model into the country's traffic safety programs. Results of this study have shown that co-developed model results in the increase in awareness factors that can cause motorcycle accidents and therefore empowers communities. This study therefore contends that co-developed model is a strategy for reducing the number of motorcycle accidents but need to be integrated with complementary strategies. This study contributes to the understanding of mediators of motorcycle accidents and suggests that using the theories of planned behaviour and socio-cognitive theory constructs. This study also reported that the co-developed model delivered by trainers can increase awareness of the causes of motorcycle accidents and this is in consonance to another. The outcomes of this study will be useful in the provision of an initial framework on which pilot projects for such activities may be anchored.

RECOMMENDATIONS FROM THE STUDY

DRC policy makers on reduction of traffic accidents should consider mainstreaming co-developed model into their programs. The policy makers should also consider strengthening the programs on motorcycle accident reduction at the communities using innovative service delivery model in alignment to witnessed dramatic shift from information – based health education towards participatory approaches.

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