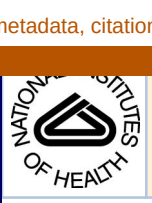

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Effect of Free Distribution of Safety Equipment on Usage among Motorcycle-Taxi Drivers in Tanzania—A Cluster Randomised Controlled Trial

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Abstract

Introduction—Deaths due to road traffic injuries, particularly motorcycle crashes, have increased rapidly in many African nations and context-specific strategies to improve preventative behaviors are needed. Although adhering to conspicuity measures by wearing reflective safety vests is a highly effective crash prevention strategy and mandated by law among motorcycle-taxi drivers in some African countries, actual use is currently low. We aimed to test whether

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eliminating cost-barriers through the provision of free reflective, fluorescent motorcycle safety vests would lead to increased utilization among a high-risk population of motorcycle-taxi drivers in Tanzania.

Methods—A cluster randomised controlled trial was conducted among 180 motorcycle-taxi drivers. Participants randomised to the intervention arm (90) received free, reflective, fluorescent vests; participants randomised to the control arm (90) did not receive free vests. Participants' use of reflective vests was then observed on city streets over a three month period and differential uptake was estimated using mixed-effects logistic regression.

Results—Baseline use of reflective vests was 3.3% in both arms. Seventy-nine drivers in the intervention arm and 82 drivers in the control arm were observed during follow-up. The average proportion of observations during which motorcycle drivers were using a reflective vest was 9.5% in the intervention arm, compared to 2.0% in the control arm (odds ratio: 5.5, 95% confidence interval: 1.1-26.9, p-value: 0.04).

Conclusion—Although distribution of free reflective vests led to a statistically significant increase in vest usage, the absolute increase was modest. Additional strategies beyond removing economic barriers are important to augment adherence to road safety behaviors for injury prevention.

Introduction

Globally, road traffic injuries (RTIs) are the 2nd leading cause of death among males in the economically productive age group (age 15 to 49) [1]. Furthermore, road traffic injuries have risen 47% from 1990 to 2010 [1] and are projected to continue to rise as a result of ongoing economic development and increased motorization [2]. The Africa region currently has some of the world's highest traffic injury rates, with road users such as motorcycle riders bearing a disproportionate share of the injury burden. Moreover, these injuries are often underreported and underestimated from current data [3, 4].

Historically, pedestrians in Africa have borne the largest share of the mortality burden from RTIs [5]. However, recent research indicates that the burden of injury may be shifting to motorcyclists [6, 7]. The increased availability of low cost motorcycles and rising household income levels have helped to promote motorcycles as a rapidly growing form of transport in many African nations [8]. We recently documented this transition in Tanzania, where motorcycle injuries comprised the largest segment of RTI victims among patients presenting to a zonal referral hospital [9].

An effective strategy for the primary prevention of motorcycle crashes is to increase use of conspicuity measures by motorcycle riders. Conspicuity measures—factors that increase a motorcycle rider's ability to be seen by other vehicles—are important as motorcyclists often are difficult to see and can be easily hit by larger vehicles, particularly in chaotic traffic patterns [10]. Wearing reflective or fluorescent clothing, continuously operating the motorcycle headlight (including during the daytime), and wearing a white colored helmet are estimated to be associated with a 37%, 27%, and 24% reduced risk of motorcycle crash, respectively [10]. Thus, large gains in primary prevention of motorcycle crashes can potentially be achieved from relatively simple interventions that make motorcycle riders

more visible. Our study evaluated the uptake of the most protective conspicuity measure, the use of a reflective vest, following free distribution of vests among a high risk population of motorcycle-taxi drivers in Northern Tanzania.

Motorcycle-taxi's are a common form of transport in many developing nations and consist of a motorcycle driver who carries passengers on the back of the motorcycle for a fee. Motorcycle-taxi drivers are a particularly high risk population for motorcycle crashes as they operate a motorcycle for several hours a day and are financially incentivized to provide as many rides as possible daily. The use of reflective/fluorescent vests is mandated by law for motorcycle-taxi drivers in Moshi, Tanzania; however, use of such vests and enforcement of the law is limited. Anecdotally, motorcycle-taxi drivers indicated that the major barrier to use of the vests in our region was cost.

Provision of free health-related equipment in resource limited settings is a highly debated topic, with most of the current literature focusing on malaria bed net distribution [11-13]. Evidence from randomised controlled trial data testing the provision of free equipment for injury prevention campaigns in low-income nations is particularly limited. Our primary aim was to determine, in a cluster randomised controlled trial design, whether distribution of free reflective, fluorescent vests to participants in the intervention arm improved the frequency of use, compared to the control arm, in which no free vests were provided. Both groups also received brief education on all recommended conspicuity measures. As a secondary outcome, we monitored usage of white helmets and daytime running headlights after the provision of education, though no free equipment was provided for these outcomes.

Methods

Study Area and Population

Moshi is a city in the Kilimanjaro region of Northern Tanzania with a population of 184,292 in the most recent 2012 Tanzanian census [14]. Roads in the city where the study was conducted were largely tarmac. Although no systematic information is available on vehicle fleet composition in Moshi, motorcycle traffic appeared to outnumber cars. Motorcycle-taxi drivers in Moshi wait for potential customers at motorcycle-taxi stands located along well-traveled roads. Each motorcycle-taxi driver has a typical stand location that is usually shared with a varying number of other motorcycle-taxis.

Recruitment and Randomization

Motorcycle-taxi drivers were recruited in clusters from motorcycle-taxi stands with randomization to either intervention or control occurring at the stand level. To ensure roughly equal assignment of participants to intervention and control, motorcycle-taxi stands were classified into three strata based on size (1-3, 4-6, and 7 or more drivers). A block randomization sequence was prepared by a researcher not involved in this study using a commercial randomization provider with block sequence and size unknown to study investigators [15]. In the field, study staff first approached a motorcycle-taxi stand, identified the stratum based on number of drivers present, and then opened a sealed, opaque envelope for that stratum revealing the trial arm assignment.

Motorcycle-taxi drivers at the particular stand were then approached for enrollment and consent. For inclusion into the study, drivers had to work at least 2 days per week, have a phone number for ride solicitation, have a license plate able to be recorded, be at least 18 years old, and be willing to be contacted in the future for repeat survey. Motorcycle riders were excluded if they did not meet the above criteria or did not consent to participate.

For sample size determinations, to account for the clustering at the taxi stand level we assumed a between-driver, within-taxi-stand, correlation equal to 0.1 and a 0.95 correlation between observations on the same driver over time. Assuming that 20% of the control group would wear reflective vests and allowing for a drop-out rate of 1 in 6 drivers, 90 drivers per arm (180 total) were required to produce an 80% power to detect a relative 25% or greater difference in vest utilization between arms for a two-tailed 5% significance level. There have been no similar prior studies in this field; assumptions for the intracluster correlations (ICC) and suspected program effectiveness were based on best estimate.

Ethical review board approval was provided by the Ethics Committee of the Kilimanjaro Christian Medical Centre, the Tanzanian National Institute of Medical Research, and the Duke University Institutional Review Board. This trial is registered with ClinicalTrials.gov as NCT01733537. Recruitment began in February 2013 and final observations were completed in June 2013.

Intervention

At the time of enrollment, all study participants were administered a baseline survey. After the survey, all participants also received a brief education session on conspicuity measures. The purpose of the education session was simply to assure that all drivers had equal knowledge at baseline of the utility of road safety vests. The education session was led by a peer motorcycle-taxi driver who was trained to deliver a five minute educational message highlighting that wearing reflective/fluorescent clothing, using daytime running headlights, and wearing a white helmet were protective against crashes. The peer driver also communicated estimated risk reductions of the above conspicuity measures along with locations where such equipment could be purchased.

Each participant within a cluster selected for the intervention group, however, additionally received a free reflective, fluorescent vest. All vests were identical in brand and style and similar to other vests locally available for purchase (see Figure 1). Participants were able to select their appropriate size.

Outcome Measurement

The primary outcome was the proportion of individual drivers wearing a reflective, fluorescent vest in the intervention group compared to the control group over a three month time period. Secondary outcomes were the use of daytime running headlights and the wearing of a white colored helmet. Over the observation period, research assistants attempted to observe drivers at least once per month. To assess each participant's use of the recommended conspicuity measures we utilized a naturalistic observation strategy in which study staff unknown to the participants from the initial recruitment phase solicited rides from each taxi-driver during the daytime. During the ride the study staff would observe the

participants use of a reflective vest, use of headlights, and presence and color of a helmet. The use of this observation method helped to avoid a “Hawthorne effect,” in which participants may change their behavior simply because they know that their behavior is being observed [16].

The above ride-solicitation procedure was utilized for the first month of observations. However, observations at this point indicated that the intervention had very low levels of uptake. Thus, for months two and three of observation, we transitioned to a less intensive and lower cost strategy in which study assistants unknown to the motorcycle-taxi drivers identified the drivers at their taxi stand or driving on the road based on their license plates and subsequently observed their use of conspicuity measures from a distance in an inconspicuous manner. At the close of the three months of observations, a second survey was performed to gauge participants’ opinions. At enrollment, study participants were asked if they always used the same motorcycle and at study closure participants reported whether they had changed motorcycles at any point in the study. For participants who had changed motorcycles during month two and three, when identification was based on license plate number, observations made after the date of the switching of their motorcycle were not used.

Statistical Analyses

As mentioned, the primary outcome of interest was the proportion of participants using a reflective, fluorescent vest. To determine the percentage of reflective vest usage in a particular trial arm over the study period, the average of each individual driver's observations over the study period was incorporated into a grand average of all participants in each trial arm. In other words, the proportion of observations that each motorcycle-taxi driver was noted to be wearing a vest was averaged together with the proportion of observations that the other drivers in the same trial arm were noted to be wearing a reflective vest. Secondary outcomes assessed were use of white helmets and daytime running headlights.

Outcomes were analyzed using mixed-effects logistic regression to account for the multilevel structure of the data which contained multiple observations per taxi driver and multiple taxi drivers clustered within taxi stands. In addition to taking into account the nested structure of the data, regression analyses adjusted for baseline conspicuity measure usage (for use of reflective vest and white helmet) and stratum of randomization. All analyses were performed according to the intention to treat principle. Analyses were performed in Stata 12.1 (StataCorp, College Station, TX).

Results

The study sample recruited included 180 motorcycle-taxi drivers; 17 clusters with 90 drivers were assigned to the intervention arm and 16 clusters with 90 drivers were assigned to the control arm (Figure 2). After three months of observations, 11 participants in the intervention group and 8 participants in the control arm were unable to be observed leaving 79 and 82 participants for analysis in the intervention and control groups, respectively. Baseline characteristics of participants recruited into both arms were comparable (Table 1).

On average, the motorcycle-taxi drivers worked over 80 hours per week and provided approximately 20 rides to clients daily. Drivers reported just over one previous crash on average.

Over the three month study follow-up, the mean number of observations made per participant was 3.7 and 3.1, in the control group and intervention groups, respectively. In months 1, 2, and 3 of observation, 71, 51, and 38 drivers were observed in the intervention arm, respectively. In months 1, 2, and 3 of observations, 68, 60, and 57 drivers were observed in the control arm, respectively. Over 3 months of follow-up, the average proportion of observations that motorcycle drivers used a reflective vest in the intervention group was 9.5% compared to 2.0% in the control group, with logistic regression model estimates indicating that participants in the intervention group were over 5 fold more likely to use a reflective vest (OR 5.5, 95%CI 1.1-26.9) (Table 2). Thus, provision of a free vest appeared to increase vest usage at a statistically significant level, but the absolute increase was modest. From model post-estimation the ICC for the cluster level was estimated to be 0 and the ICC for the driver level (the correlation between observations among each driver within a cluster) was 0.63.

For the secondary outcome of white helmet usage, at 3 months of follow-up there was no discernible difference between intervention and control groups (OR 0.7, 95%CI 0.03-17.4). Use of white helmets appeared to vary considerably from month to month and was slightly greater at baseline than during follow-up months. Discussions indicated that motorcycle-taxi drivers often share or switch helmets, consistent with these findings.

For the secondary outcome of daytime running headlight usage, there also was no detectable difference between intervention and control groups after 3 months of follow-up (OR 1.2, 95%CI 0.6-2.3). It should be noted that use of daytime running headlights were not observed at baseline because baseline observations were made during the initial study enrollment when participants were at rest and not riding their motorcycle. As with white helmet usage, daytime running headlight usage varied considerably. Anecdotally, rather than maintaining headlights always on, many motorcycle driver use lights intermittently to signal to other vehicles or pedestrians, potentially explaining this variability.

At the study closure survey, before participants were informed of the results of the trial and that their usage of conspicuity measures had been observed, participants reported on reasons for not using a reflective vest (Table 3). For participants in the intervention group, the most common reason cited for not wearing the vest was forgetting, listed by 51.2% of respondents. A lower percentage reported not being convinced that the vest was protective (18.6%) and not liking the look of the vest (11.6%). When asked in an open ended question for other reasons for not wearing the vest, 22.1% of respondents indicated that they still had the vest but were currently washing it.

Among the control group, the majority of respondents (32.6%) indicated that they had not acquired a vest since the start of the study because it was too expensive to buy. Other common reasons for not wearing a vest included forgetting that it was recommended and not

being convinced that it is protective, indicated by 31.5% and 29.2% of respondents, respectively.

Discussion and Conclusion

The primary purpose of this trial was to assess the effectiveness of a program of free equipment distribution to increase the use of conspicuity measures among motorcycle-taxi drivers, focusing on the use of fluorescent, reflective vests. Use of such vests is associated with a 37% lower risk of crash and is a low-cost, high-yield intervention [10]. Furthermore, use of reflective vests is mandated by law in Tanzania among motorcycle-taxi drivers.

Analysis of the primary outcome revealed that after 3 months of observations, provision of a free, reflective vest did lead to a statistically significant increase in reflective vest usage compared to not receiving a free vest, but the absolute difference between groups was relatively small at 7.5%. Prior to the start of the trial we hypothesized a minimum 25% difference between arms, indicating an observed lower level of effectiveness of the intervention relative to initial expectations. Noting no clear increase in reflective vest usage among participants in the control arm and no increase in use of white helmets or daytime running headlights over time, the brief education session given at study enrollment did not lead to any noticeable changes in behavior. Educational interventions of longer duration and greater complexity may be more effective [17].

Among participants who received a free vest, the majority indicated that the main reasons for not wearing the vest were forgetting to wear the vest or that it was currently being washed, suggesting a low priority for vest usage. Among the control group in which participants did not receive any free vest, the main reason listed for not acquiring a vest was that they were too expensive. However, the low utilization in the intervention arm, where vests were provided for free, suggests that cost is not the only reason for non-use, even among those citing cost as the primary barrier.

Although we can find no prior published literature elucidating rationale for non-adherence to conspicuity measures in developing nations, research on helmet use indicates that while cost is often cited by drivers as a major reason in helmet acquisition, there are a multitude of other influential factors [18]. One major factor appears to be enforcement of traffic safety laws [19]. Giveaway programs for child bicycle helmets have been tested previously. In settings where police enforcement is active, programs have been noted to have long-lasting efficacy [20].

Indeed, after the closure of the observation period and follow-up surveys were complete, the participants were revisited and results of this trial were shared with them. Motorcycle-taxi drivers reported candidly that uptake of vest usage would likely not occur unless enforcement of the law requiring their usage occurred. Interestingly, the percent of motorcycle-taxi drivers possessing a helmet (of any color) was exceptionally high, at 93%; drivers indicated that local police were enforcing helmet usage laws with fines of approximately 20 USD per infraction but fines for not using reflective vests were not enforced.

Limitations

There exist some limitations to this study. Given its focused nature, our study provides information mainly about economic incentives to improve road safety behaviors; however, there remain many additional facets of shaping preventative behaviors yet to be explored. Nonetheless, this trial contributes significantly to the motorcycle injury prevention literature because there is little quantitative evaluation of programs that provide free equipment. Furthermore, because injury prevention campaigns often, appropriately, employ multifaceted strategies to attempt to affect behavioral change, the efficacy of specific components of such campaigns is difficult to assess; our study helps to contribute to such knowledge.

Additionally, it is interesting to note that although we were not powered to assess trends over time, we found a general decline in vest usage in the intervention arm for each subsequent month of observation. Even where free distribution strategies are employed, an additional important facet to consider is decrement that may occur without active, ongoing promotion and reinforcement of safety behaviors. Trials that include longer follow-up and elucidate mechanisms for enhancing long-term behavioral change in road safety remain a needed area of future research.

It should also be noted that the rollout of the intervention and distribution of vests was not able to be blinded. The degree to which motorcycle-taxi drivers in the city knew who received a free vest and the potential effects of this are unknown. However, the unblinded nature of this trial mimics real-world program implementation. Additionally, the generalizability of these results remains unclear. Distribution of free health and safety-related equipment and its uptake among a given population is likely influenced by a host of local factors. Nevertheless, this trial provides useful insights for public health strategies that do involve distribution of free items.

Lastly, the modest behavior change noted in this trial highlights the importance of understanding other factors that may influence injury prevention behaviors, such as social marketing or design considerations of safety equipment [21]. A major additional factor to further investigate is the role of effective enforcement of road safety laws [19, 22]. The effectiveness of campaigns involving provision of free equipment or education in injury prevention work may be augmented significantly by strengthening local enforcement capability and remains an area to be explored.

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Figure 1.
Fluorescent, Reflective Safety Vests Used In Study

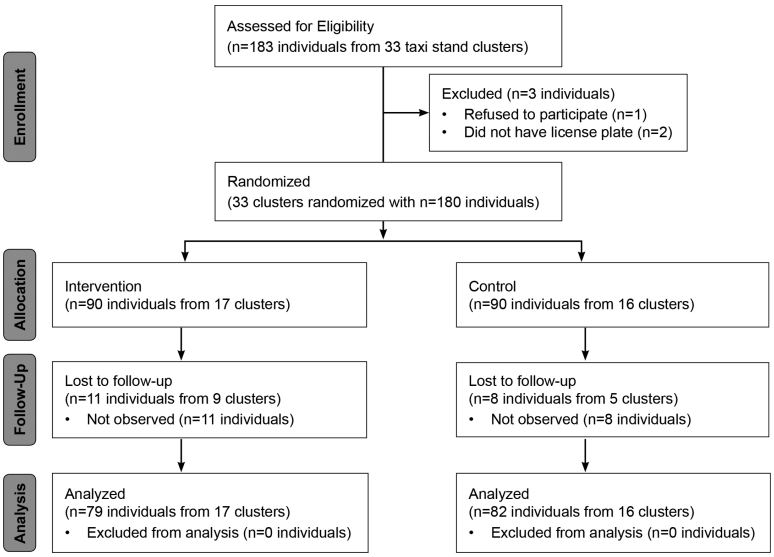

Figure 2.
Study Flow Diagram

Table 1

Baseline Characteristics Motorcycle-Taxi Drivers by Treatment Arm

		Intervention (N=79)	Control (N=82)
Clusters			
Number of taxi-stands by size:			
	1-3 drivers	7	7
	4-6 drivers	8	7
	7 or more drivers	2	2
Individuals Observed			
Male		79 (100%)	82 (100%)
Age in Years, Mean (SD)		28.8 (6.5)	28.8 (6.4)
Married		54 (68.4%)	52 (63.4%)
Number of Dependent Children, Mean (SD)		1.4 (1.2)	1.4 (1.3)
Highest Educational Level Attended	None	1 (1.3%)	0 (0%)
	Primary	55 (69.6%)	56 (68.3%)
	Secondary	23 (29.1%)	26 (31.7%)
Years of Experience Driving A Motorcycle, Mean (SD)		5.9 (4.7)	6.7 (5.1)
Years of Experience Working as a Motorcycle-taxi Driver, Mean (SD)		2.3 (1.2)	2.2 (1.1)
Hours Per Week Worked, Mean (SD)		83.4 (14.7)	86.4 (17.5)
Motorcycle-taxi Rides Per Day Given, Mean (SD)		19.7 (8.0)	21.4 (10.2)
Number of Previous Crashes, Mean (SD)		1.4 (1.2)	1.1 (1.9)

Values are numbers (percentages) unless otherwise stated

Table 2

Proportion of Time Motorcycle-taxi Drivers Followed Recommended Conspicuity Measures[a]

Primary Outcome	Trial Arm	Baseline	Month 1 (N=139)[b]	Month 2 (N=111)	Month 3 (N=95)	Month 1-3 Total (N=161)	Odds Ratio[c] (95% CI)	p-value
Reflective Vest	Intervention	3.3%	12.7%	8.8%	7.7%	9.5%	5.5 (1.1-26.9)	0.04
Used	Control	3.3%	4.4%	1.7%	2.4%	2.0%	1 (ref)	n/a
Secondary Outcomes								
White Helmet	Intervention	11.1%	5.6%	6.4%	7.9%	5.6%	0.7 (0.03-17.4)	0.84
Present	Control	6.7%	4.4%	0.9%	5.5%	3.4%	1 (ref)	n/a
Daytime Running	Intervention	—	17.4%	3.0%	9.3%	11.3%	1.2 (0.6-2.3)	0.67
Headlights Used	Control	—	10.9%	6.3%	5.4%	8.2%	1 (ref)	n/a

[a] The reported measures represent the average percent of observations that drivers in each trial arm used a particular conspicuity measure.

[b] N indicates the total number of individuals drivers observed during each time period.

[c] The odds ratio reported compares the specified outcome in the intervention group vs the control over the entire 3 month follow-up period.

Table 3

Reasons Reported for Not Wearing Reflective Vest After the End of the Study

Intervention Group (N=86)[a]		**Control Group (N=89)**[a]	
Reason	**Percent**[b]	**Reason**	**Percent**[b]
Forgot to wear	51.2	Too expensive to buy	32.6
Not convinced vest is protective	18.6	Forgot it was recommended	31.5
Did not like look or design of vests	11.6	Not convinced vest is protective	29.2
Vest did not fit well	8.1	Money better spent elsewhere	22.5
Lost vest	4.7	Did not like look or design of vests	19.1
Sold Vest	0	Did not know where to buy vest	18.0
Other:		Other:	
Vest being washed	22.1	Wears at night	13.5
Wears at night	15.1	Washing	5.6
Vest is worn out or dirty	11.6	Too hot	5.6
Too hot	8.1	Worn out	3.4

[a] The N reported here includes all study participants located during the follow up survey

[b] Percents do not sum to 100 as more than one reason could be chosen by respondents