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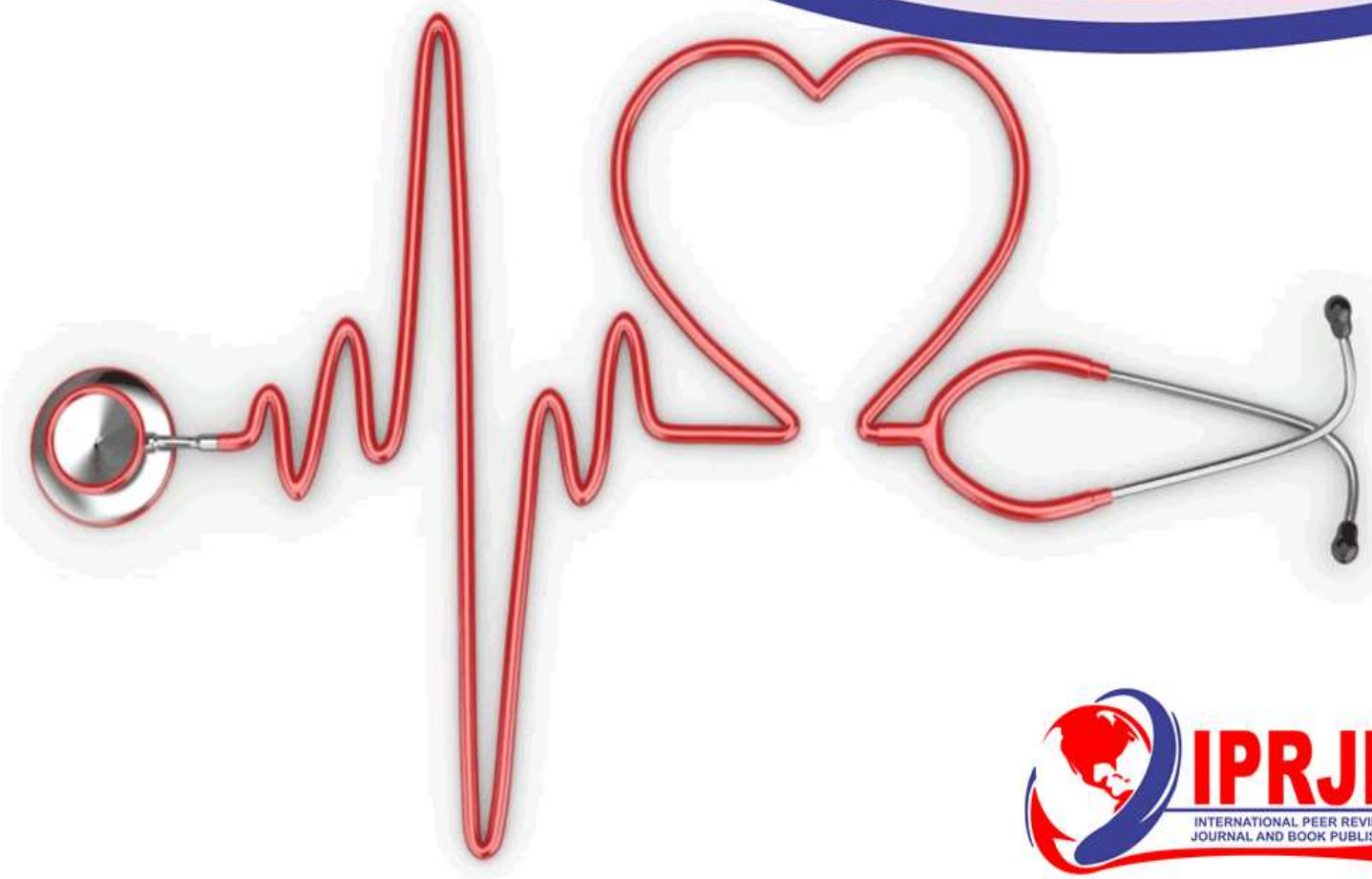

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Effectiveness of Bystander Knowledge through Community-Based Training on Responsiveness of Prehospital Emergency Care in Nairobi County, Kenya

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Abstract

Purpose: Most of the emergencies occur outside heath care setting and prehospital emergency care is vital in reducing preventable deaths and disabilities. In Nairobi, emergency response remains fragmented, and bystander involvement is limited due to low knowledge and training. To assess the effect of bystander Knowledge through community-based training on responsiveness of pre-hospital emergency care**.**

Methodology: This quasi-experimental pre-post intervention in Mama Lucy Kibaki Hospital's catchment area trained 128 Community Health Promoters (CHPs) to educate 64,000 households on emergency notification and response. Baseline and end-line data collected via questionnaires were analyzed using SPSS v26.0.

Findings: Training bystanders dramatically improved their emergency response knowledge and efficiency. Knowledge scores significantly increased (p=0.001), with notable gains in knowing the emergency number (55% to 83%), saving the toll-free number (16% to 73%), and recognizing 1508 (4% to 48%)—all p<0.0001. The percentage of individuals knowing what to do in an emergency rose from 85% to 94% (p<0.001), and the mean knowledge score increased from 6.39 to 7.30 (p<0.001). Improvements were observed across all demographic groups. Post-secondary educated respondents showed the strongest gains (+13.7 percentage points to 96.5%, p<0.001). Males experienced greater improvement (+14.4 points to 93.7%) than females (+9 points to 82.2%). The training was most effective for interior residents (achieving 100% knowledge) and those near major roads (+21.3 points to 78.9%, p<0.001). Casual labourers demonstrated the largest gains (+40.9 points to 90.9%). Working-age participants, specifically those aged ≤30 and 31-40 years, also showed significant knowledge increases (+11.4 and +10.9 points, respectively). These knowledge gains led to faster emergency responses, with 87% of reports occurring within 0-5 minutes post-intervention, compared to 0% at baseline. Delays exceeding 15 minutes plummeted from 80.4% to 4.1% (p<0.001). The strongest predictors of knowledge were post-secondary education (OR=5.64, p<0.001) and interior residence (OR=7.32, p<0.001). Casual labourers showed reduced odds of knowledge (OR=0.24, p=0.017), while respondents aged 31-40 years had 74% higher odds (OR=1.74, p=0.039). Gender, most employment statuses, and age >50 years did not significantly affect knowledge

Unique Contribution to Theory, Practice and Policy: Community-based training significantly improves bystander knowledge and emergency response times, offering a vital solution for strengthening pre-hospital emergency systems in Low- and Middle-Income Countries (LMICs). This highlights the critical need for diverse bystander training strategies. The study recommends; developing a specialized pre-hospital emergency care training model for the elderly. Conducting further research on how marital status influences knowledge acquisition from training. Revising the WHO Emergency Care System Framework (ECSF) to explicitly incorporate bystander training.

Keywords: *Bystander knowledge, Pre-Hospital Emergency Care, Community Training, Emergency Notification, CHPs*

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INTRODUCTION

Globally, pre-hospital emergency health care systems play a vital role in reducing preventable morbidity and mortality by ensuring timely and effective medical intervention during emergencies. The importance of prehospital emergencies is often neglected in low- and middle-income countries (LMICs), and this translates into a substantial toll of avoidable deaths from time sensitive conditions such as injuries, cardiac problems, and obstetric emergencies [1].

This study utilizes the WHO Emergency Care Systems Framework (ECSF) [2], a structured approach designed to guide policymakers in evaluating and strengthening emergency care from initial contact to inpatient treatment. While the ECSF addresses the entire emergency care pathway, including bystander response, it notably lacks specific guidance on empowering bystanders with the training and knowledge necessary for effective emergency intervention. A bystanders are the general public, anyone who witnesses an emergency and is expected to take action.

Despite advancements in hospital-based care, a significant gap exists in the provision of pre-hospital emergency care, especially in LMICs like Kenya. In Kenya, the Emergency Medical Services (EMS) remains fragmented, under-resourced, and underutilized [3], affecting the linkage of community to the emergency care system. A survey by [4] in Nairobi, involving 14 ambulance services, 19 emergency care centers, and 39 key informants across 10 sub-counties, revealed significant shortcomings in emergency response. The study highlighted poor public knowledge of emergency numbers (77%), inadequate responder training, and a lack of standardized procedures. These factors contribute to alarmingly long emergency response times of 40–60 minutes, drastically exceeding the WHO's recommended 15–20 minutes. Consequently, emergency service utilization is low (37%), with the public often being the first to assist in emergencies (79%).

Timely emergency response is hindered by bystanders' lack of knowledge, poor community awareness of emergency numbers, and inadequate coordination [4]. This leads to heightened risk of mortality and long-term disability. Studies by [5] have linked increased morbidity and mortality to delays and inadequacies in emergency response, which are often compounded by weak emergency care infrastructure and limited public knowledge. When trained in pre-hospital emergency care, bystanders become a vital part of the system. Training empowers bystanders to act effectively in emergencies by teaching them emergency numbers, how to provide crucial scene information to the EOC, and immediate life-saving first aid like assessing casualties, controlling bleeding, and proper patient positioning, ultimately increasing survival chances. Bystanders prompt action in offering initial assistance can significantly improve patient outcomes, [6].

The effectiveness of bystanders depends largely on their knowledge of emergency protocols, access to emergency contacts, and confidence in taking immediate action [7]. In many Kenyan communities, including Nairobi County, bystanders remain underutilized due to limited awareness on emergency numbers, and what do in an emergency scene, lack of training on emergency notification and response, and systemic support. However, the burden of emergency medical incidents in Nairobi continues to grow, driven by a combination of natural disasters, road traffic accidents, acute medical events, and public health crises such as the COVID-19 pandemic [8]. Despite the establishment of Emergency Operations Centers (EOCs) and public ambulatory services, uptake remains low due to poor community engagement. According to data from Mama Lucy Kibaki Hospital (the only public County Referral Hospital serving the

highly populated eastlands region in Nairobi County and has accident and emergency department), out of over 60,000 emergency patients seen in 2019 and 2020, fewer than 10% had utilized emergency ambulance services. Furthermore, analysis of emergency call records indicated that only 10% of the calls received at the Nairobi County EOC originated from the community, while the vast majority were hospital referrals. These statistics reveal a critical knowledge gap among the public and demonstrate the need for structured interventions aimed at empowering bystanders with life-saving knowledge and skills.

Public engagement in emergency care has been shown to significantly improve emergency outcomes in other settings, particularly when communities are trained in basic emergency response, identification of critical patients, and communication with emergency services, [9]. Empowering the community is crucial since most emergencies occur outside healthcare facilities. This study investigates the critical role of bystander knowledge in enhancing pre-hospital emergency healthcare in Nairobi County. We found that trained bystanders can effectively assess scene safety, recognize emergencies, initiate immediate action, and deliver crucial information to the EOC, this process of a bystander gaining knowledge is founded in the theory of bystander intervention model.[10] created the bystander intervention model, also known as the situational model. The model is a five-step model suggesting that intervention decision is complex and bystanders should notice the event first, interpret it as an emergency, take accountability for acting, make a decision on how to act, and make a choice to act. This proficiency leads to faster emergency response times and improved patient outcomes, essentially decentralizing the first responder model into a community-based response system.

This research highlights the silent response gap between an emergency's onset and the arrival of professional help. Empowering ordinary citizens through community-based education directly addresses this gap, significantly improving emergency notification and response. This approach expands the existing ECSF, which often is silent on the vital role of bystander training.

Statement of the Problem

Most emergencies worldwide, including in Kenya, happen outside healthcare facilities, significantly contributing to the global burden of disease. Nairobi County faces a particular challenge due to its weak, underdeveloped, and underutilized pre-hospital emergency healthcare system. The rising incidence of natural and man-made disasters, mass casualty incidents, and acute medical emergencies in Nairobi has escalated the demand for a responsive, safe, and effective pre-hospital emergency care system. While ambulances are a common sight, a 2021 study in Nairobi revealed low public awareness of emergency numbers and underutilization of emergency services. Data from emergency patient admissions at Mama Lucy Kibaki Hospital (MLKH) and a low percentage of calls to the Emergency Operations Centre (EOC) further confirm this underutilization, leading to prolonged emergency response times that jeopardize lives.

Therefore, this study intentioned to answer whether bystander knowledge has influence on responsiveness of prehospital emergency care. The study, focused on training the public on how to promptly notify emergency services, effectively communicate vital information to the EOC and administer immediate aid at the emergency scene as there is always a lap before the health professional arrives at the scene. This initiative aimed to drastically reduce emergency notification and response times, ultimately saving lives.

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METHODOLOGY

Study Design: This study employed a quasi-experimental pre-post intervention design using quantitative research method.

Location of the Study: The study was conducted in Embakasi West, the subcounty hosting Mama Lucy Kibaki Hospital (MLKH) in Nairobi County, MLKH accident and emergency department, and Nairobi County Emergency Operation Center (EOC)

Study Population: The study populations included 64,000 households within Embakasi west the Sub-County hosting MLKH, MLKH accident and emergency department, and Nairobi County EOC

Sample Size Determination: The study sample size was 376 households, including a 10% attrition rate, determined using the OpenEpi Version 3 open-source calculator. The sample was calculated with a 5% precision level, a 95% two-sided confidence level (1-alpha), an 80% power (chance of detecting). The power of 80% implies that the study expects (80%) to get the difference between the pre and post intervention [11]. Hypothetical percentage of controls with exposure of 37% is bench marked on a study conducted in Nairobi County by [4].

Sampling Procedure: Purposive and stratified sampling were used in this study. Embakasi West Sub- County was purposely chosen due to MLKH, which serves as an emergency patient referral and follow-up center. Households in Embakasi West were stratified into 64 community units, each containing 1,000 households. To achieve the desired sample size, two households were randomly selected from each unit, and one adult resident (18 years or older) was interviewed per sampled household. The Nairobi County EOC and MLKH were also purposively selected for their roles in coordinating emergency notification and response.

Study Intervention: In this study, 128 Community Health Promoters (CHPs) were trained for two days on prehospital emergency care, including how to use Nairobi's emergency number (1508), manage an emergency scene (safety assessment, patient assessment, breathing, bleeding control, recovery position, and emergency notification to the Emergency Operations Centre), and convey crucial information (self-identification, location, incident type, number and condition of casualties). Baseline knowledge data was collected before the training, and implementation was done at the community while the evaluation of the outcome was at the EOC.

Following the training, CHPs were assigned to Embakasi West, where each educated 500 households between March 2023 and February 2024. During this 12-month period, emergency calls, patient referrals, and response times were monitored. Households also received educational posters and stickers in English and Kiswahili with the toll-free number and key emergency reporting information. After 12 months, end-line data was collected to evaluate changes in knowledge and its impact on emergency notification and response.

Data Collection Instruments: Structured questionnaires were used to gather data from the households. Emergency operation center observation checklist was used to collect data on the number of emergency calls, quality of emergency calls, emergency response times interval.

Data Collection Procedure: Baseline data were collected before the intervention to establish pre-intervention status, and post-intervention data were gathered to assess changes and outcomes attributable to the intervention. This design enabled the researcher to measure within-group changes over time in emergency response time, calls to the EOC, and changes in knowledge on the emergency number and how to respond to emergencies.

Data Analysis Procedure: Quantitative data from baseline and end-line surveys was cleaned, coded, and analyzed using SPSS version 26.0. Descriptive statistics (frequencies, percentages, means) summarized bystander knowledge of emergency notification and toll-free numbers. To assess significant changes in knowledge before and after the training intervention, Chi-square tests were employed for categorical variables (e.g. knowledge of the toll-free number, demographic characteristics by knowledge, etc.) and emergency response metrics (e.g. Notification intervals) at baseline and post-intervention to quantify the impact of the intervention. For continuous knowledge scores, an independent samples t-test was used to compare means between baseline and post-intervention, comparing different participant groups across time points. Logistic regression was also used to identify the demographic predictors of knowledge among the respondents. This assessed whether higher knowledge scores were associated with improvements in pre-hospital emergency health care delivery.

Ethical consideration

Approval for the study was obtained from the Kenya Methodist University Research and Ethics Committee, the National Commission for Science, Technology and Innovation, and the Nairobi County Directorate Health Services Research and Ethics Committee. Permission was also secured from the respective hospital management, EOC, and consent obtained from respondents prior to data collection.

RESULTS

Demographic Profile of the Respondents

Across both baseline and post-intervention surveys, women comprised the majority of respondents (62.4% baseline, 57.3% post-intervention), ensuring good gender representation. The largest age group shifted from 21-30 years at baseline (38.4%) to 31-40 years post-intervention (37.9%). Most respondents were married in both phases (60.7% baseline, 65.9% post-intervention). Education levels were generally high, with over half having secondary education or above at baseline (50.4%) and 46.5% having post-secondary education post-intervention, suggesting a literate participant pool. Residence patterns changed, with 59.9% living in interior areas at baseline versus 61.0% along major roads post-intervention. Employment also shifted, from 42.6% unemployed at baseline to 45.2% self-employed post-intervention, indicating a prevalence of flexible, informal employment, which could enhance their role as bystanders in emergencies as in Table 1.

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Table 1: Demographic Characteristics of the Respondents

Demographic Characteristics	Baseline n (%)	Post-Intervention n (%)
gender		
Male	135 (37.6)	159 (42.7)
Female	224 (62.4)	213 (57.3)
Age of Respondents in Years		
20 years and below	19 (5.3)	7 (1.9)
21-30 years	138 (38.4)	127 (34.1)
31-40 years	121 (33.7)	141 (37.9)
41-50 years	46 (12.8)	73 (19.6)
51 years and above	35 (9.8)	24 (6.5)
Marital status		
Married	218 (60.7)	245 (65.9)
Single	114 (31.8)	114 (30.6)
Separated/Divorced	27 (7.5)	13 (3.5)
Level of Education		
Primary/Less	44 (12.3)	39 (10.5)
Secondary	181 (50.4)	160 (43.0)
Post-Secondary	134 (37.3)	173 (46.5)
Residence		
Along a major highway/ road	144 (40.1)	227 (61.0)
Interior	215 (59.9)	145 (39.0)
Employment Status		
Full employed	59 (16.4)	58 (15.6)
Casual laborer	14 (3.9)	11 (3.0)
Unemployed	153 (42.6)	135 (36.3)
Self-employed	133 (37.0)	168 (45.2)

Baseline and Post-Intervention Results on Knowledge of Emergency Toll-Free Number, and Action to Take in Case of an Emergency

While various emergency numbers were mentioned, 1508 was emphasized during training as the dedicated health emergency toll-free number for Nairobi County. The results show a significant improvement in knowledge and awareness of emergency response after the intervention. At baseline, only 54.9% (197) of respondents knew the toll-free emergency number, but this increased sharply to 82.8% (308) post-intervention ($p < 0.001$). Similarly, the proportion of people who saved the number in their phones rose dramatically from 16.2% (32) to 72.7% (224) ($p < 0.001$). Before the intervention, 96.4% (346) were unaware of the dedicated emergency number 1508, but after training, awareness improved significantly, with 47.8% (178) now knowing it ($p < 0.001$)., confirming the intervention's effectiveness in establishing actionable knowledge of the emergency toll-free number (Table 2). Confidence in emergency response also improved. While 85.0% (305) initially agreed they knew what to do at an emergency scene, this rose to 94.4% (351) post-intervention ($p < 0.001$). Knowledge of the correct emergency number to call increased from 59.6% (214) to 84.7% (315) ($p < 0.001$). Similarly, the proportion of respondents who knew who to call first in an emergency improved from 79.9% (287) to 90.1% (335) ($p < 0.001$), and those who knew the right message to convey increased from 82.2% (295) to 91.9% (342) ($p < 0.001$).

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The mean of knowledge scores was compared at baseline and endline using an independent samples t-test. The results show a clear improvement in knowledge scores after the training. At baseline, the average knowledge score was 6.39, which increased to 7.30 at endline. This 0.91-point gain was statistically significant, with an extremely small p-value ($p < 0.0001$), indicating that the observed increase is very unlikely to have occurred by chance. The t-test compared the mean scores between the two independent groups (baseline vs. endline) and confirmed the intervention was effective in improving knowledge.

Table 2: Toll-Free Number Knowledge, Saved Number, and Action to Take in Case of an Emergency

	Baseline n (%)	Post-Intervention n (%)	Chi-square (P-value)
Knowledge on toll-free number to call			
No	162 (45.1)	64 (17.2)	<0.001
Yes	197 (54.9)	308 (82.8)	
Have you saved this number in your phone?			
No	165 (83.8)	18 (27.3)	<0.001
Yes	32 (16.2)	224 (72.7)	
Knowledge of toll-free number (1508)			
No	346 (96.4)	194 (52.2)	<0.001
Yes	13 (3.6)	178 (47.8)	
You know what to do at an emergency scene			
Disagree	37 (10.3)	14 (3.8)	<0.001
Undecided	17 (4.7)	7 (1.9)	
Agree	305 (85.0)	351 (94.4)	
You know the emergency number to call			
Disagree	129 (35.9)	56 (15.1)	<0.001
Undecided	16 (4.5)	1 (0.3)	
Agree	214 (59.6)	315 (84.7)	
You know who to call first in an emergency			
Disagree	45 (12.5)	27 (7.3)	<0.001
Undecided	27 (7.5)	10 (2.7)	
Agree	287 (79.9)	335 (90.1)	
You know the message to convey			
Disagree	33 (9.2)	19 (5.1)	<0.001
Undecided	31 (8.6)	11 (3.0)	
Agree	295 (82.2)	342 (91.9)	
Knowledge Scores (Mean)	6.39	7.30	<0.001

Changes in Knowledge by Demographic Characteristics of the Respondents

Gender-Based Knowledge Improvement

Males showed a more substantial knowledge improvement (+14.4 percentage points, from 79.3% to 93.7%, $p<0.001$) compared to females (+9 percentage points, from 73.2% to 82.2%, $p=0.025$). This suggests males benefited more despite starting with higher baseline knowledge.

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Age-Based Knowledge Improvement

Initially, respondents aged ≤20 years showed a negative change. Combining this group with 21–30-year-olds into a single ≤30 years category resulted in an 11.4-point improvement (75.2% to 86.6%, p=0.015). Other age groups also showed gains: 31–40-year-olds improved by 10.9 points (78.5% to 89.4%, p=0.016), and 41–50-year-olds by 11.6 points (76.1% to 87.7%). The oldest group (>50 years) had the smallest improvement (+9.3 points, from 65.7% to 75%. Significant knowledge changes were only observed in respondents below 30 years and those aged 31–40 years

Table 3: Changes in Knowledge by Demographic Characteristics of the Respondents

Demographic Characteristics	Baseline n (%)	Post-Intervention n (%)	Percentage Change	Chi-square (P-value)
Gender				
Male	107 (79.3)	149 (93.7)	+ 14.4	<0.001
Female	164 (73.2)	175 (82.2)	+ 9	0.025
Age of Respondents in Years				
=<30 years	118 (75.2)	116 (86.6)	+ 11.4	0.015
31-40 years	95 (78.5)	126 (89.4)	+ 10.9	0.016
41-50 years	35 (76.1)	64 (87.7)	+ 11.6	0.100
>50	23 (65.7)	18 (75)	+ 9.3	0.447
Marital status				
Married	167 (76.6)	205 (83.7)	+ 7.1	0.056
Single	85 (74.6)	106 (93)	+ 18.4	<0.001
Separated/Divorced	19 (70.4)	13 (100)	+ 29.6	0.028
Level of Education				
Primary/Less	30 (68.2)	20 (51.3)	- 16.9	0.012
Secondary	130 (71.8)	137 (85.6)	+ 13.8	0.002
Post-Secondary	111 (82.8)	167 (96.5)	+ 13.7	<0.001
Residence				
Along a major highway/ road	83 (57.6)	179 (78.9)	+ 21.3	<0.001
Interior	188 (87.4)	145 (100)	+ 12.6	<0.001
Employment Status				
Fully Employed	50 (84.8)	54 (93.1)	+ 8.3	0.150
Casual laborer	7 (50)	10 (90.9)	+ 40.9	0.030
Unemployed	113 (73.9)	118 (87.4)	+ 13.5	0.004
Self-employed	101 (75.9)	142 (84.5)	+ 8.6	0.061

Marital Status Knowledge Improvement

Single individuals saw the most significant improvement in knowledge (+18.4 points, from 74.6% to 93%, p<0.001), followed by separated/divorced respondents (+29.6 points, from 70.4% to 100%, p=0.028). Married participants showed more modest gains (+7.1 points, from 76.6% to 83.7%, p=0.056).

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Education Level Knowledge Improvement

Post-secondary education was associated with highly significant improvements ($p<0.001$), with a +13.7-point increase (from 82.8% to 96.5%). Secondary education also showed strong improvements (+13.8 points, from 71.8% to 85.6%). Conversely, those with primary education or less experienced a decline in knowledge (-16.9 points, from 68.2% to 51.3%).

Residence Location Bystander Knowledge Improvement

Residents along major roads showed a notable jump in knowledge (+21.3 points, from 57.6% to 78.9%, $p<0.001$). Interior residents maintained high scores, improving by +12.6 points from an already high baseline (87.4% to 100%, $p<0.001$).

Employment Status Bystander Knowledge Improvement

Casual labourers demonstrated the most dramatic improvement (+40.9 points, from 50% to 90.9%, $p=0.030$), despite starting with the lowest baseline knowledge. Unemployed individuals improved by +13.5 points (from 73.9% to 87.4%, $p=0.004$), and the self-employed group by +8.6 points (from 75.9% to 84.5%, $p=0.061$). Overall, most groups showed knowledge improvement. The most substantial gains were observed among males (+14.4 points), single individuals (+18.4 points), those with higher education (+13.7-13.8 points), interior residents (+12.6 points), and casual workers (+40.9 points). The intervention appeared particularly effective for highly motivated groups (single individuals, casual workers) or those with greater access to information (interior residents, educated groups). The strongest predictors of knowledge improvement were post-secondary education and residence location.

Table 4: Multiple Logistic Regression Assessing Factors Associated with the Respondent's Knowledge

Demographic Characteristics	OR	CI	P-value
Constant	0.61	0.23 – 1.63	0.327
gender			
Female	0.67	0.42 – 1.06	0.093
Age of Respondents in Years			
31-40 years	1.74	1.03 – 2.93	0.039
41-50 years	1.61	0.84 – 3.06	0.151
>50	1.03	0.49 – 2.14	0.946
Level of Education			
Secondary	2.03	1.14 – 3.64	0.017
Post-Secondary	5.64	2.83 – 11.24	<0.001
Residence			
Interior	7.32	4.44 – 12.06	<0.001
Employment Status			
Casual laborer	0.24	0.08 – 0.77	0.017
Unemployed	0.83	0.39 – 1.75	0.626
Self-employed	0.77	0.37 – 1.61	0.492
Model Information:			
Log-likelihood = - 278.2549		OR–Odds Ratio; CI – Confidence Interval	

Note: *The model was adjusted for gender, level of education, residence, and employment status. We controlled for the timepoint of data collection*

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Factors Associated With Bystanders' Knowledge

While not statistically significant, females showed 33% lower odds of knowledge than males (OR=0.67). Respondents aged 31-40 years had 74% higher odds of knowledge (OR=1.74, p=0.039) compared to those ≤30 years. Education strongly predicted knowledge: secondary education doubled the odds (OR=2.03, p=0.017), and post-secondary education showed nearly six-fold higher odds (OR=5.64, p<0.001) compared to primary or less. Interior residents had over seven times greater odds of knowledge (OR=7.32, p< 0.001). Casual laborers had 76% lower odds (OR=0.24, p=0.017) than fully employed individuals. Higher education (especially post-secondary), being middle-aged (31-40 years), and residing in interior locations were the strongest positive predictors of emergency notification and response knowledge.

Responsiveness of Pre-Hospital Emergency Healthcare Delivery

Pre-hospital emergency healthcare delivery was determined by evaluating the emergency response time interval obtained from the EOC during the baseline and post-training. The number of emergency notifications increased from 112 to 146. The time interval examined included the notification interval, which was measured in a range of 0-5, 6- 10, 11- 15, and 15 and above. All the times were in minutes as shown in Table 5, below.

Table 5: Chi-square Test for Notification Interval Pre- and Post-training

Notification Interval	Baseline n (%)	Post-Intervention n (%)	Chi-square (P-value)
0 - 5 minutes	0 (0)	127 (87)	<0.001
6 - 10 minutes	8 (7.1)	10 (6.9)	
11 -15 minutes	14 (12.5)	3 (2.1)	
>=15 minutes	90 (80.4)	6 (4.1)	

For the notification interval, the majority of the notifications took above 15 minutes, 90 (80.4%) during the baseline survey, and 0-5 minutes, 127 (87%) during the post-intervention survey. The chi-square test was used to determine if the training caused a shift in the notification interval at baseline and post-intervention. The p-value (p<0.001) indicated extremely significant improvements in the notification interval after the bystander training intervention. This confirms that the training eliminated long delays in notification intervals.

Discussion

Demographic Characteristic

The study's demographic profile, characterized by a majority of women (62.4% baseline, 57.3% post-intervention) and participants aged 21-50 years, is representative of typical Kenyan household dynamics and the nation's most economically active adult population [12], [13], [14], [15]. This demographic composition is advantageous for understanding health-seeking behaviors. Furthermore, the high educational attainment, with most participants having secondary education (87.7% baseline, 89.5% post-intervention), mirrors findings in comparable studies [16]. This suggests that a more educated populace is better positioned to engage with and benefit from prehospital emergency care training, thereby enhancing the overall efficacy and responsiveness of such services [17], [18], [19].

Bystander Knowledge on Responsiveness of Prehospital Emergency Care

Training effectively equipped bystanders with essential prehospital emergency response knowledge, vital for improving EMS outcomes, especially in low- and middle-income

countries where formal systems are often nascent [1], [20]. This study found a significant increase in participants' knowledge of emergency toll-free numbers (from 54.9% to 82.8%, p<0.001) and their preparedness to act (saving numbers on phones, from 16.2% to 72.7%, p<0.001), demonstrating improved awareness and actionable knowledge, aligning with the studies by [21], [22].

The training also significantly improved participants' practical skills for emergency scene management (e.g., assessing safety, patient condition, making emergency notification), with knowledge increasing from 85% at baseline to 94.4% post-intervention. Furthermore, their understanding of crucial information to convey to the EOC (e.g., self-identification, location, incident type) rose from 82.2% to 91.9%. These gains in skills and communication are critical for timely EOC response [22], [23] and align with regional and international research on lay responder training effectiveness [24], [25], [26], [27]. The overall mean knowledge score significantly increased from 0.7549 to 0.8710 post-intervention (p <0.001), reinforcing that the training demonstrably enhanced bystander knowledge, a consistent finding in similar interventions [22], [26].This evidence underscores the critical role of community-based level training in strengthening prehospital emergency response and improving outcomes [28]

Changes in Knowledge by Demographic Characteristics of the Bystanders

Changes of Knowledge by Gender

This study revealed a notable gender disparity in knowledge improvement following emergency training. Males demonstrated a significantly greater leap in knowledge, with a 14.4 percentage point increase (from 79.3% to 93.7%, p<0.001), compared to females who showed a 9-percentage point improvement (from 73.2% to 82.2%, p=0.025). This suggests males might possess higher perceived self-efficacy or a stronger inclination for immediate action during emergencies, fostering more active learning and application of crucial knowledge. These findings resonate with existing research indicating gender differences in risk perception and help-seeking behaviors, where women may delay seeking emergency care [18], [29]. In a prehospital context, this could translate to males being more prone to initiating Emergency Medical Services (EMS) contact or providing immediate assistance, potentially leading to improved patient outcomes.

Changes of Knowledge by Age Categories

This study reveals age-dependent effectiveness in emergency knowledge acquisition. Initially, individuals ≤20 years showed a negative trend, but when combined, the ≤30 years age group demonstrated an 11.4 percentage point improvement (from 75.2% to 86.6%, p=0.015), indicating high receptivity and significant knowledge gain. Similarly, the 31-40 years group also showed a significant 10.9 percentage point improvement (from 78.5% to 89.4%, p=0.016).

Conversely, the 41-50 years group, despite an 11.6 percentage point increase (from 76.1% to 87.7%), did not achieve statistical significance (p=0.100). The >50 years group showed the smallest improvement of 9.3 percentage points (from 65.7% to 75%) which was also not statistically significant (p=0.447). This suggests that while older demographics can still learn, the training's impact may be less pronounced, potentially requiring different educational approaches to achieve significant knowledge acquisition [30]. The significant knowledge gains observed in those under 40 align with findings by [31] likely attributable to higher neuroplasticity and diverse learning styles in younger adults. This underscores the critical need to tailor prehospital emergency services training to different age groups. For older populations,

who experience higher rates of falls, chronic conditions, and cognitive decline, making them more vulnerable to needing emergency services [32], effective training strategies should incorporate reinforcement, repetition , experiential learning [33], and specific attention to confidence and prior knowledge [25].

Changes in Knowledge by Marital Status

Our study found a significant relationship between marital status and post-training knowledge improvement in emergency preparedness. Single individuals demonstrated an impressive 18.4 percentage point gain (from 74.6% to 93%, $p<0.001$), while separated/divorced respondents showed an even more remarkable 29.6 percentage point increase (from 70.4% to 100%, $p=0.028$). In contrast, married participants exhibited more modest gains of 7.1 percentage points (from 76.6% to 83.7%, $p=0.056$), which were not statistically significant. This disparity may stem from single, separated, or divorced individuals having more disposable time and flexibility for training, potentially due to fewer domestic responsibilities compared to married individuals who often juggle work, spousal relationships, and childcare [34], [35]. This increased availability could foster deeper engagement with the training material, leading to superior knowledge acquisition. Furthermore, several psychological factors might be at play, individuals without immediate family might feel a stronger personal responsibility or urgency to acquire life-saving skills, driven by a desire for self-reliance or a heightened awareness of their vulnerability in emergencies [36]. This training could also be perceived as an opportunity for personal growth or career advancement. While married individuals may be accustomed to collaborative problem-solving within their households, the training format might have been less aligned with their preferred learning styles [37]. It's crucial to note that this study's training was designed for accessibility, conducted at the household level and through community dialogues, aiming to reach everyone regardless of marital status. This area requires further research as to why the gap in knowledge uptake among marital status.

Changes of Knowledge by Education Level

Education level significantly impacts knowledge acquisition and retention. Post-secondary and secondary education consistently demonstrate substantial knowledge improvements, with gains of +13.7 and +13.8 points respectively, suggesting that higher levels of formal education provide a stronger foundation for learning and information retention [36], [37]. Conversely, individuals with primary education or less experienced a notable decline in knowledge (-16.9 points), highlighting a potential vulnerability to knowledge loss without continued formal learning or reinforcement. This indicates a strong correlation between sustained engagement in educational systems and sustained knowledge levels, emphasizing the importance of accessible and continuous learning opportunities for all educational backgrounds.

Changes of Knowledge of Bystanders by Residential

This study reveals a compelling link between geographical location and life-saving knowledge acquisition. Residents along major roads showed a significant increase in knowledge (from 57.6% to 78.9%), likely due to their increased exposure to emergencies like road traffic accidents. This heightened awareness is crucial, as these bystanders are often the first responders. Their improved knowledge makes them more likely to promptly call emergency services, administer first aid, or initiate CPR [38], ultimately improving patient outcomes before professional help arrives. Targeted training in these high-traffic areas could further enhance bystander competence.

Conversely, interior residents demonstrated high baseline knowledge (87.4%), which remarkably improved to 100%. This suggests prior training, strong community preparedness, or higher education levels within these communities. Despite being further from major roads, their superior knowledge equips them well to respond to emergencies within their communities, particularly where formal Emergency Medical Services (EMS) response times might be longer.

Changes of Knowledge of Bystander by Employment Status

Training bystanders in prehospital emergency care significantly boosts knowledge, particularly among vulnerable groups. Casual laborers, despite starting with the lowest baseline knowledge (50%), showed the most dramatic improvement (+40.9 points, reaching 90.9% knowledge, p=0.030). Unemployed individuals also demonstrated substantial gains (+13.5 points, from 73.9% to 87.4%, p=0.004), as did the self-employed (+8.6 points, from 75.9% to 84.5%, p=0.061).

These findings align with the broader understanding that layperson first responder training is crucial for improving patient outcomes in prehospital settings, especially in areas with limited formal EMS [24], [39]. The significant improvement among casual laborers, in particular, highlights the potential for such interventions to empower individuals who may be at higher risk of witnessing emergencies and previously lacked critical life-saving skills. This underscores the importance of targeted and accessible training programs to build community resilience and enhance immediate emergency response capabilities.

Factors Associated with Bystander Knowledge

The analysis of this study identified key factors impacting prehospital emergency care knowledge. While not statistically significant, females showed 33% lower odds of knowledge than males (OR=0.67), warranting further investigation into gender differences in health literacy [18], [29]. Age was a significant predictor, with 31–40-year-olds having 74% higher odds of knowledge (OR=1.74, p=0.039) compared to younger individuals, aligning with findings on middle-aged adults' receptiveness to emergency information [31]. Education strongly predicted knowledge; secondary education doubled the odds (OR=2.03, p=0.017), and post-secondary education showed nearly six-fold higher odds (OR=5.64, p<0.001) compared to primary education or less. This underscores education's role in understanding complex emergency protocols and health literacy [30], [40].

Geographical location also played a substantial role, with interior residents having over seven times greater odds of knowledge (OR=7.32, p<0.001). This suggests stronger community preparedness or reliance on local networks in these areas. Conversely, casual laborers faced significant barriers, showing 76% lower odds of knowledge (OR=0.24, p=0.017) compared to fully employed individuals, likely due to socioeconomic vulnerabilities and limited access to training [34], [35]. Finally, higher education, being middle-aged (31-40 years), and residing in interior locations were the strongest positive predictors of emergency knowledge. These insights are crucial for developing tailored and equitable prehospital emergency care training programs, prioritizing vulnerable populations to enhance community resilience.

Bystander Knowledge on Responsiveness of Prehospital Emergency Healthcare Delivery

Statistically significant improvements were observed in prehospital emergency care knowledge and responsiveness. Post-training, 96% (n=140) of bystanders could notify the Emergency Operations Center (EOC) within 15 minutes, a substantial increase from 19.6% (n=22) at baseline (p<0.001). This marked improvement contrasts sharply with challenges identified in

a Nairobi County survey [4], which highlighted poor public knowledge of emergency numbers, inadequate responder training, and prolonged response times hindering effective prehospital care. Training demonstrably enhances bystanders' ability to accurately describe emergencies, including their nature, location, and casualty conditions, informing the EOC for critical, life-saving actions [4], [41]. When bystanders possess the knowledge to promptly contact the EOC and relay essential information for dispatching emergency services, notification and overall response intervals significantly decrease [41], [42]. This critical role of bystander training in improving knowledge, skills, and subsequently reducing emergency response times is consistently emphasized [22], [23].

Limitation

This study, conducted in Nairobi County, focused on training Community Health Promoters (CHPs) to educate households with prehospital emergency care knowledge. While primarily engaging women, both genders were well-represented across the 64,000 households reached. Training occurred at the household level and through community dialogues, utilizing emergency information stickers for wider dissemination. The study leveraged the Nairobi County EOC, which provides free emergency services via a toll-free number, as the central hub for emergency response. Mama Lucy Kibaki Hospital (MLKH), Nairobi's largest county referral hospital, was selected for this study due to its structured accident and emergency department, high patient volume, and its role as the sole public referral facility for the densely populated eastern Nairobi region. Notably, advanced procedures like CPR were excluded from the training, and the study focused solely on household and community settings, omitting other public institutions.

CONCLUSION AND RECOMMENDATIONS

Bystander training significantly improves knowledge and responsiveness in pre-hospital emergency care. We recommend making this training widely accessible through flexible, community-based programs, possibly integrating it into the WHO emergency care system framework. Link training to familiar platforms like schools and social groups, and partner with NGOs, government agencies, and media for sustained efforts. Training modules for the elderly on pre hospital emergency response is essential and a community-based emergency response model. Further research is needed on how marital status and gender influences learning outcomes to ensure optimized training for all.

Competing Interest

The authors declare that they have no competing interest

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Author’s Work

Felistus N. Musyoka was involved in the study conception and design, data collection, analysis, and manuscript writing and revision. Professor Wanja Temberngen and Dr. Job Mapesa were involved in supervision and conceptualization of the study, provided guidance regarding methodology and critically reviewed, revised and approved the final Maunscript

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