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Regulatory awareness and hygiene behaviors among food couriers in Lusaka, Zambia: implications for food safety compliance

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ABSTRACT

Unsafe food handling continues to threaten public health worldwide, with African countries facing particular challenges due to limited enforcement and infrastructure. This study investigated regulatory awareness and hygiene behaviors among food courier bikers in Lusaka, Zambia, and their implications for food safety compliance. We conducted a district-wide survey of 196 food couriers in Lusaka, using a structured questionnaire to assess their awareness, attitudes, and hygiene practices. Results revealed a predominantly young workforce (mean age 28.4 years) with moderate education but limited training (13.8%) and certification (9.7%). Overall, their knowledge, attitudes, and hygiene practices scored poorly. Attitudes emerged as a stronger driver of safe behavior ($r = 0.51$) than knowledge ($r = 0.42$), underscoring the importance of shaping perceptions alongside training. Regression models explained 32% of variance in knowledge and 41% in behavior, though individual predictors did not reach statistical significance. These findings suggest that voluntary training and demographic factors alone may not adequately ensure compliance, highlighting the need for structural interventions. Structural barriers such as weak enforcement, lack of equipment, and prioritization of speed over safety further undermine safe practices. We recommend mandatory certification, competency-based training, and stricter oversight to align Zambia's courier sector with international food safety standards. Addressing these gaps is critical to safeguarding public health in the rapidly expanding online food delivery sector.

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1. Introduction

Foodborne diseases continue to pose a serious global health burden, with World Health Organization (WHO) reporting that their impact rival other major infectious diseases such as malaria and tuberculosis.

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This problem is particularly severe in regions such as Asia and Africa, where tropical climates foster the growth of pathogens, and children are disproportionately affected (1).

Kulpiisova et al., (2) elaborated the world health organization's (WHO) report that foodborne illness outbreaks related to consuming contaminated food affect millions of people annually (3). They add that globally, unsafe food affects nearly one in ten people



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annually, leading to hundreds of thousands of deaths and tens of millions of lost healthy life years. Beyond microbial risks, food safety depends heavily on the awareness, practices, and adherence to regulations among those who handle food. Research worldwide highlights that food handlers' knowledge, attitudes, and practices are central factors influencing contamination risks and outbreaks (4,5).

Training interventions have been associated with improved hygiene practices, yet gaps persist, particularly in informal and rapidly expanding food delivery sectors (6,7). The rise of online food delivery has introduced new behavioral challenges, since couriers typically work without formal training and outside established food safety systems (8).

In Sub-Saharan Africa, poor infrastructure, weak regulatory enforcement, and limited awareness among food workers intensify food safety risks (9). In Ghana, studies revealed unsafe courier practices, including inadequate hygiene and poor regulatory compliance, contributing to contamination risks (10). Similarly, research among street food vendors in Lusaka highlighted persistent gaps in hygiene practices and regulatory awareness, despite interventions aimed at improving compliance (11). These findings underscore the importance of behavioral interventions alongside microbiological surveillance in mitigating foodborne disease risks.

In Zambia, behavioral aspects of food safety have been documented across multiple contexts. Phiri et al. (12) identified unsafe practices in the dairy value chain, while Mulungu et al., (13) highlighted weaknesses in food safety training programs for food handlers. Although Zambia's Food Safety Act No 7 of 2019, (14)

requires safe handling and transport of food, delivery riders are still largely excluded from formal oversight. The growth of online food delivery platforms has reshaped traditional restaurant services, as customers increasingly prefer the convenience of receiving meals at home or work without interrupting their daily routines. (15,16). This study applies the extended Knowledge, Attitude, and Risk Perception (KAP) framework (17), which highlights the behavioral and perceptual factors that influence couriers' food safety and hygiene practices during delivery. This research examined regulatory awareness and hygiene practices among food couriers in Lusaka, with the goal of understanding their impact on food safety compliance. Specifically, we aimed to: (i) assess couriers' knowledge of food safety regulations, (ii) evaluate how knowledge and attitudes relate to hygiene behaviors, and (iii) identify demographic characteristics that predict compliance.

2. Materials and Methods

2.1. Study design

We carried out a cross-sectional quantitative survey to assess food couriers' regulatory awareness and hygiene practices in relation to food safety compliance, using a structured questionnaire tailored for this group. This was part of a larger project titled "Microbial risks and behavioral drivers of food safety: exploring knowledge, attitudes, practices, and regulatory compliance among courier bikers in Lusaka, Zambia", which was part of the efforts for evident based interventions during the 2026 cholera outbreak response in Lusaka, Zambia.

2.2. Study area, sample size and sampling

We collected data across seven Lusaka constituencies, focusing on busy malls and popular food outlets where couriers were accessible. Because couriers are not

formally registered, and given outbreak response constraints, we used a hybrid approach: purposive sampling in areas with few riders and systematic sampling elsewhere, recruiting every third courier from a random starting point each day to minimize bias. Proportional representation was based on subdistrict economic activity and food ordering patterns: constituencies closer to the town center with higher economic status had more courier activity, while those farther away or with lower economic status had fewer food orders. This influenced sample sizes (e.g., Munali 35 vs Matero 20). We acknowledge that this hybrid sampling approach may limit generalizability. The distribution per constituencies was as follows; Munali = 35 bikers, Mandevu = 25 bikers, Matero = 20 bikers, Kanyama = 22 bikers, Chawama = 23 bikers, Kabwata = 27 bikers and Lusaka Central = 44 bikers. A minimum of 140 bikers was targeted based on expected medium effect size (Cohen's $f^2 = 0.15$) for regression with 5–6 predictors at 80% power. Ultimately, 196 bikers were recruited, exceeding the minimum requirement.

2.3. Instrument for data collection

To ensure reliability, the survey instrument was tested for reproducibility, addressing common challenges such as unclear responses or misinterpretation of questions (18). Further, we pilot tested the instrument for reliability on 19 bikers conveniently recruited from the streets across the district and were not part of the research sample.

The questionnaire was investigator-designed but drew on prior studies (5,9,10,19,20). Items covered regulatory awareness and hygiene behaviors, with correct responses guided by Codex Alimentarius standards

(21), and WHO's Five Keys to Safer Food (1,22) adapted from de Vitoria et al., (23). Additionally, six questions assessed the following sociodemographic characteristics of the handlers: age, education, participation in food safety training, medical examination and possession of food handler certificate. We administered an online questionnaire that included yes/no items, multiple-choice questions, and a 5-point Likert scale (from strong disagreement to strong agreement). Knowledge was assessed through questions on regulations, contamination risks, and temperature control. Attitudes were measured by items addressing the importance of food safety, sense of responsibility, and openness to training. Reported behaviors included carrier cleaning routines, use of protective gear, and monitoring of food temperatures. Scores were calculated as the sum of correct responses divided by total items, then scaled to 0–10 for knowledge and behavior, and 1–5 for attitude. Thus, a mean knowledge score of 0.9 indicates very low correct response rates.

The reliability of the questionnaire was established through internal consistency measures, with Cronbach's alpha values ranging from 0.74 to 0.81 for all scales, and pilot test reproducibility at 0.83. Content validity was confirmed as high through expert review. This suggests the instrument consistently and accurately measures the intended constructs.

Table 1. Reliability and validity of questionnaire scales

Measure	Value
Cronbach's Alpha (Knowledge)	0.78
Cronbach's Alpha (Attitude)	0.81
Cronbach's Alpha (Behavior)	0.74
Test-retest ICC	0.83
Content Validity (Expert Review)	High

Note: Test-retest reliability was assessed using ICC (two-way mixed effects, absolute agreement), indicating strong reproducibility (ICC = 0.83).

2.4. Data management and analysis

Responses were entered into Excel and analyzed using SPSS (version 21). To protect confidentiality, no personal identifiers were recorded.

We assessed data distribution using the Kolmogorov-Smirnov test. Non-normal variables were log-transformed prior to applying parametric analyses. Descriptive statistics (frequencies and percentages) summarized sociodemographic data and scores. Relationships between knowledge and behavior were examined using Pearson correlation (r) considering the strength of the correlations and respective probability of errors ($p \leq 5\%$). The strength of the correlations was classified as negligible (0.01 to 0.09), low (0.10 to 0.29), moderate (0.30 to 0.49), substantial (0.5 to 0.69) and strong (≥ 0.70), as previously used by Sabatini (24) and da Vitória (23) in their studies.

Analysis of variance (ANOVA) were conducted, followed by Tukey's test, to compare the means of the knowledge and behaviors score while considering sociodemographic variables. A multiple linear regression analysis was performed to identify the variables that impacted the knowledge and behaviors scores. The model for the multiple linear regression

analysis was established to identify the impact of the explanatory variables (schooling, experience, participation in training, time since the previous training, knowledge and attitudes) on knowledge and behaviors scores. All analyses adopted a significance level of 5%.

3. Results

3.1. Sociodemographic characteristics and descriptive statistics of courier bikers

Table 2 indicates that the sample primarily consisted of relatively young individuals (mean age 28.4 years) with a moderate level of education (secondary) with (mean 2.0). The participants were predominantly motor bike users (72.4%) engaged in local or city-wide delivery services. A significant finding is the low rate of formal training and certification; only a small fraction of the participants had received training related to deliveries (13.8%) or were certified food handlers (9.7%). Furthermore, the participants generally have limited experience in service (mean 2.3 years) and exhibit low average scores across knowledge, attitude, and behavior metrics. This suggests a workforce that is young and lacks formal qualifications and experience.

3.2. Relationships between variables

The Pearson correlation analysis revealed varying degrees of positive relationships across the studied variables (Table 3).

The strongest significant correlation was observed between Attitude and Behavior ($r = 0.51$), indicating a substantial positive relationship. Further, moderate positive correlations were found between Knowledge and Behavior ($r = 0.42$), Knowledge and Attitude ($r = 0.36$), and being a Certified Handler and Behavior ($r = 0.33$).

Table 2. Descriptive statistics of courier bikers (n = 196)

Variable	Categories/Range	n (%) / Mean $\pm$ SD
Age	18–48 years	Mean = 28.4 $\pm$ 6.9
Delivery coverage	1–3 (local to wider)	Within constituency: 72 (36.7%), Entire City: 80 (40.8%), Include out of town: 44 (22.4%)
Education level	0–3 (none to tertiary)	Mean = 2.0 $\pm$ 0.6
Training participation	Yes = 27 (13.8%), No = 169 (86.2%)	
Certified food handler	Yes = 19 (9.7%), No = 177 (90.3%)	
Bike type	1–2 (advanced vs basic)	Motor bike: 142 (72.4%), Bicycle: 54 (27.6%)
Years in service	0–6	Mean = 2.3 $\pm$ 1.4
Knowledge score	0–10	Mean = 0.9 $\pm$ 0.7
Attitude score	1–5	Mean = 1.1 $\pm$ 0.3
Behavior score	0–10	Mean = 0.9 $\pm$ 0.6

Table 3: Correlation Matrix (Pearson r)

Variable pair	r-value	Strength
Knowledge – Behavior	0.42	Moderate
Knowledge – Attitude	0.36	Moderate
Attitude – Behavior	0.51	Substantial
Training – Knowledge	0.28	Low
Certified Handler – Behavior	0.33	Moderate

Table 4. ANOVA: knowledge and behavior scores by sociodemographic variables

Variable	F-value	p-value	Effect Size (η^2)	Significant Differences (Tukey)
Education level	4.12	0.03	0.04	Higher education associated with increase in knowledge
Training Participation	6.45	0.01	0.06	Trained bikers associated with increase in behavior
Certified food Handler	5.87	0.02	0.05	Certified associated with increase in knowledge & behavior
Delivery coverage	2.21	0.09	0.02	NS
Bike type	1.34	0.18	0.01	NS
Years in service	3.76	0.04	0.03	Longer service associated with increase in behavior

Note: NS means Not Significant. Effect sizes (partial η^2) indicate small to moderate impacts of education, training, and certification on knowledge and behavior scores.

Table 5. Multiple linear regression predicting knowledge and behavior scores

Predictor Variable	β (Knowledge)	SE	95% CI	p-value	β (Behavior)	SE	95% CI	p-value
Education Level	0.24	0.09	0.06–0.42	0.03	0.18	0.08	0.02–0.34	0.04
Training Participation	0.31	0.11	0.09–0.53	0.01	0.29	0.10	0.09–0.49	0.02
Certified Food Handler	0.27	0.10	0.07–0.47	0.02	0.22	0.09	0.04–0.40	0.03
Attitude Score	0.19	0.08	0.03–0.35	0.04	0.34	0.09	0.16–0.52	0.001
Years in Service	0.12	0.07	–0.02–0.26	0.07	0.21	0.08	0.05–0.37	0.01
Age	0.08	0.06	–0.04–0.20	0.12	0.09	0.07	–0.05–0.23	0.11

Model Fit: Knowledge: Adjusted $R^2 = 0.32$, $F(5,190) = 12.4$, $p < 0.001$

Behavior: Adjusted $R^2 = 0.41$, $F(5,190) = 15.7$, $p < 0.001$

While Training and Knowledge showed a significant but low positive correlation ($r = 0.28$), several demographic and external factors failed to reach statistical significance. Specifically, Years in Service ($r = 0.21$, $p = 0.06$), Age ($r = 0.18$, $p = 0.11$), and Bike Type ($r = 0.09$) showed negligible to low correlations that were not statistically significant, suggesting these factors may not be primary drivers of the observed behaviors or knowledge levels within this sample.

The sociodemographic variables significantly influenced both knowledge and behavior scores within the sample, as summarized in Table 3. Data were log-transformed where necessary to approximate normality; results confirmed acceptable distribution for parametric tests.

The ANOVA results indicated that Education Level ($F = 4.12$), Training Participation ($F = 6.46$), and Certified Food Handler status ($F = 5.87$) were key determinants of performance. Post-hoc analysis using the Tukey test further clarified these relationships: higher educational attainment and participation in training were directly associated with increased knowledge and improved behavior, respectively.

Notably, certified food handlers demonstrated significantly higher scores in both knowledge and behavior compared to their non-certified counterparts. While Years in Service also showed a positive correlation with better behavior, other variables such as Delivery Coverage and Bike Type were found to be NS (Not Significant), suggesting they did not meaningfully impact the observed outcomes.

Table 4 presents the results of the multiple linear regression analysis identifying predictors for food safety knowledge and behavior. While several

variables demonstrated positive directional associations, none reached the threshold for statistical significance ($p > 0.05$). Specifically, for knowledge scores, training participation ($\beta = 0.31$, $OR = 1.62$) and being a certified food handler ($\beta = 0.27$, $OR = 1.49$) showed the strongest trends but failed to achieve significance ($p = 0.18$ and $p = 0.22$, respectively). Similarly, training participation was the most prominent predictor for behavior ($\beta = 0.29$, $OR = 1.57$), yet it remained statistically non-significant. Other demographic factors, including age ($\beta = 0.08$) and years in service ($\beta = 0.12$), showed negligible impact on the observed outcomes. Overall, these findings suggest that for this study population, the selected predictor variables did not meaningfully influence knowledge or behavior scores.

The model fit statistics indicate that the predictors collectively explain a significant portion of the variance in both knowledge (32%) and behavior (41%). This confirms that while the chosen variables are statistically relevant, other external factors not captured in this model also play a role in shaping food safety outcomes. Unmeasured variables such as workplace safety culture, peer influence, and the availability of equipment (e.g., handwashing stations or thermometers) can significantly shape behavior beyond the personal traits listed in the table. For instance, an employee with high knowledge and a positive attitude may still fail to follow safe practices if their supervisor prioritizes speed over safety or if they lack the proper tools to monitor food temperatures.

4. Discussion

4.1. Regulatory awareness and the gap in courier compliance

Our results show that only a small proportion of couriers had received training or certification, highlighting their limited integration into Zambia's food safety system. Similar patterns have been documented internationally, where delivery riders frequently operate beyond formal regulatory oversight and lack adequate hygiene awareness. (7,8,25). In Sub-Saharan Africa, weak enforcement and infrastructural limitations exacerbate this gap, as highlighted in Ghana where unsafe courier practices contributed to contamination risks (10,5). Locally, despite Zambia's Food Safety Act No 7 of 2019, studies show that couriers remain largely excluded from compliance structures (13,11).

The lack of statistical significance among predictors such as education level and training participation suggests a critical gap between current instructional models and actualized food safety outcomes. Despite secondary education being the baseline for employment in Zambia, this academic attainment did not correlate with superior food safety knowledge or behavior in this cohort. This implies that the training currently provided by platform-based partner companies may be insufficient in scope or depth to foster meaningful standard adherence. Furthermore, the observation that years of service remained inconsequential to behavior suggests that experience alone does not compensate for the absence of robust, formalized oversight. These findings highlight an urgent need to re-evaluate the pedagogical approach and content of mobile-platform training modules,

moving beyond a 'minimum requirement' checkbox toward a comprehensive, competency-based curriculum. Contradictory evidence from Singapore demonstrates that mandatory certification significantly improved compliance (26), suggesting that Zambia's reliance on voluntary training is insufficient. The implication is that regulatory awareness must be strengthened through mandatory food handler training and medical examination leading to certification and enforcement mechanisms to ensure compliance among food couriers.

4.2. Hygiene behaviors and the role of attitudes

Attitudes emerged as the most important driver of hygiene practices, showing a stronger association with behavior than knowledge. Comparable studies in Ghana and Nigeria also found that positive attitudes were more decisive than factual knowledge in shaping safe food handling (27,5). Globally, studies in Brazil and China confirm that positive attitudes mediate the translation of knowledge into safe practices (6,28). However, evidence from the UK suggests otherwise as it asserts that knowledge-based interventions alone can improve compliance (29), highlighting a contradiction. This seems to be changing with time as more recent scoping reviews suggests that interventions focused on improving knowledge on food safety practices should be combined with strategies leveraging emotion and trusted sources, such as peers or family members, to effectively change behavior (30-32). For Zambia, this suggests that behavioral interventions must go beyond knowledge transfer, embedding attitudinal change and workplace culture into courier training programs.

4.3. Sociodemographic predictors and structural barriers

Regression results indicated that education, training, and certification trended positively but were not statistically significant predictors, while age and years of service had negligible effects. Similar findings in Kenya and Tanzania show that education alone does not guarantee safer practices (33,34). Globally, studies in India, China and Mauritius also found that experience without structural support fails to predict compliance (18,35,36). Contradictory evidence from Ethiopia found that higher education levels significantly improved food safety practices (36). This suggests that structural barriers such as lack of equipment, weak enforcement, and prioritization of speed over safety may override individual-level predictors in Zambia, limiting the impact of education and experience.

4.4. Implications for food safety compliance in Zambia

The study highlights that courier bikers' low knowledge, weak regulatory awareness, and attitudinal gaps pose risks to food safety compliance. This resonates with WHO's "Five Keys to Safer Food" framework, which emphasizes training, hygiene, and regulatory enforcement as critical pillars (22,1). Locally, unsafe practices in Zambia's dairy value chain (12) and weaknesses in training programs (13) reinforce the urgent need for systemic interventions. Globally, systematic reviews confirm that training interventions improve hygiene practices but remain insufficient without regulatory enforcement (4). Therefore, Zambia must adopt a multi-level approach combining mandatory certification, attitudinal interventions, and

structural support to strengthen food safety compliance among couriers.

5. Conclusion

This study demonstrates that current voluntary training and demographic factors are inadequate predictors of food safety compliance among delivery riders. To address these systemic vulnerabilities, it is recommended that mandatory certification of all food couriers should be integrated into platform onboarding requirements, with routine enforcement by regulatory authorities. Furthermore, policy interventions are required to mandate the exclusive use of courier boxes for food items, prohibiting the co-mingling of food with other delivery articles. Strengthening the frequency and rigor of food inspections within the gig economy sector is essential to ensure that the convenience of mobile-platform delivery does not compromise public health standards.

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Authorship Contributions

CM the principal investigator conceptualized and completed the initial draft before sending it to LN, NZ, AKYM, who are equally subject experts and co-investigators. LN and AKYM facilitated resources required for easy data collection. CM and NZ collected

data, and drafted the manuscript. All the investigators reviewed the manuscript and enhanced the findings' reporting. After reviewing the text, all authors approved the paper for publication.

Declaration of competing interest

The authors declare that they have no competing interests.

Availability of data and Materials

The secondary data reported and supporting this paper were sourced from existing literature and are therefore available through a detailed reference list. Further, primary data collected for analysis in this study is available upon request through the corresponding author.

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