

Cognitive Bandwidth and Food Safety: Evaluating the Impact of Poverty on Investment Decisions in Nigeria's Fisheries Sector

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Abstract

This study investigates the cognitive barrier imposed by poverty on food safety investments among artisanal fishers in Nigeria, a critical yet neglected dimension of public health risk. Moving beyond conventional economic models, we apply Scarcity Theory to test the hypothesis that poverty imposes a cognitive tax that undermines the agency to act on safety knowledge. Using a sequential explanatory mixed-methods design, we surveyed 772 artisanal fishers across three coastal states, complemented by in-depth qualitative narratives. Key findings reveal a tiered behavioural response, anchored by a decisive cognitive liberation threshold at a monthly income of ₦80,000–₦100,000, where willingness-to-pay for safe food increases steeply. Below this threshold, mental bandwidth is monopolized by survival, rendering safety investment cognitively inaccessible. Counterintuitively, a high Cognitive Bandwidth Tax positively influenced WTP (Scaled OR=3.32), indicating that scarcity focuses attention on catastrophic, salient risks like family illness. Furthermore, the hierarchy of decision determinants shifts across income tiers: income acts as a foundational enabler, after which education and health risk beliefs become dominant drivers. We conclude that persistent food safety risks are not primarily a knowledge gap but a cognitive deficit induced by scarcity. Consequently, we recommend a fundamental policy pivot from knowledge-first to bandwidth-first strategies. For the majority below the liberation threshold, interventions must prioritize economic resilience through cash transfers and livelihood support to free cognitive space, before layering on behaviourally-designed safety education for those in transition.

Keywords: Food Safety, Cognitive Bandwidth Tax, Poverty, Willingness to Pay, Nigeria, Behavioural Agency.

Introduction

In the global quest for food security, the imperative for food safety has emerged as a non-negotiable pillar of public health and economic development. Low- and middle-income countries (LMICs) bear over 90% of the staggering global burden of foodborne disease, a health toll comparable to malaria or HIV/AIDS, with annual economic losses exceeding US\$100 billion (Grace, 2023). This crisis is not diffuse; it is sharply concentrated in the informal markets that dominate LMIC food systems, where nutrient-dense, perishable animal-source foods like fish are traded with minimal regulatory oversight or protective infrastructure (Kwoba et al., 2023). Here, the primary line of defence against microbial and

parasitic hazards is not the government inspector, but the decisions made by millions of small-scale producers and vendors, operating under severe resource constraints.

Nigeria presents a critical and urgent case within this global challenge. As Africa's most populous nation and a major producer and consumer of fish, a vital source of protein and livelihoods, its domestic fisheries sector is almost entirely informal. The journey of fish from pond or creek to consumer's plate is fraught with preventable hazards: contaminated water sources, unhygienic handling, lack of ice, and exposure to pathogens during processing and transport. The health consequences are severe, yet the economic incentives for actors within the chain to invest in safety enhancements remain perilously weak.

Prevailing policy and research have often approached this puzzle through a lens of information deficit or technological adoption, asking: if fishers and vendors only knew more or had better tools, would they not choose safer practices? Training programmes and technology demonstrations abound, yet systematic reviews reveal a persistent compliance gap, a disconnection between knowledge and consistent practice, particularly among the poorest operators (Kwoba et al., 2023; Grace, 2023). This gap signals a fundamental flaw in our understanding. It suggests that the barrier to food safety in Nigeria's fisheries may be less about a lack of information and more about a scarcity of the cognitive capacity to act on that information under the crushing weight of poverty.

This study confronts that core disconnect. We propose that to understand investment in food safety, whether a fisher invests in ice, a processor in a cleaner shed, or a vendor in certified stock, one must first understand the psychology of scarcity. We therefore pivot from a purely economic or pedagogical framework to a behavioural one, anchored in Mullainathan and Shafir's (2013) Scarcity Theory. This theory provides the missing mechanism: poverty, it posits, is not just a financial condition but a cognitive state. The constant struggle to manage insufficient resources consumes finite mental bandwidth, forcing a narrowed focus on the most immediate, pressing problems (a process called "tunneling") and depleting the cognitive reserves needed for planning, self-control, and forward-looking investment.

Our investigation asks: Does this poverty-induced cognitive tax systematically undermine food safety investment in Nigeria's fisheries? By bridging the behavioural science of scarcity with the urgent public health priority of food safety, this research seeks to illuminate the invisible shackles on decision-making in one of the country's most vital food sectors. The answer has profound implications not only for academic models of economic behaviour in poverty but for designing interventions that are cognitively realistic and, therefore, more likely to succeed.

Statement of the Problem and Research Gap

Despite clear evidence of severe foodborne disease burdens linked to informal fish markets in Nigeria, and despite numerous interventions aimed at improving practices, a critical anomaly persists: safe handling protocols are widely understood but inconsistently applied, particularly by the most economically vulnerable actors in the value chain. The problem is not a lack of technical solutions, affordable water testing kits, improved smoking kilns, or

portable ice packs exist. Nor is it a complete lack of awareness. The problem appears to be one of behavioural prioritization under duress.

Existing literature offers two incomplete explanations. From a public health and agricultural economics perspective, studies detail the hazards and model adoption factors like cost, training, and perceived benefit (Seyoum et al., 2024; Liguori et al., 2022). From a development psychology perspective, Scarcity Theory robustly explains how poverty leads to short-termist, neglectful behaviours in domains like finance and diet (de Bruijn & Antonides, 2021; van der Veer et al., 2024). However, a stark theoretical and empirical gap exists at their intersection.

- **Theoretical Gap:** No framework has systematically applied Scarcity Theory to model the investment decisions of small-scale food producers in an LMIC context. The cognitive mechanisms of tunneling, bandwidth tax, and present bias, well-established in consumer studies, remain untested as explanations for producer behaviour regarding a non-visible, long-term good like food safety.
- **Empirical Gap:** While post-2020 reviews (e.g., Kwoba et al., 2023; Grace, 2023) call for more nuanced intervention research in LMIC food safety, virtually none of the evaluated studies measure poverty as a cognitive state (e.g., via cognitive load or attentional measures) or test interventions designed to alleviate the bandwidth tax. Research in Nigerian fisheries specifically has not investigated whether the cognitive burden of financial scarcity mediates the link between knowledge and safe practice.

This study directly addresses this integrated gap. The core problem we investigate is the behavioural paralysis induced by poverty, which may render traditional knowledge-based food safety interventions ineffective for the very populations most at risk. We posit that for a fisher worried about the next day's meal or a vendor facing imminent debt repayment, the decision to forego an investment in ice or hygiene is not a calculated trade-off but a cognitive inevitability, an urgent need tunneling out a quieter, future risk.

Therefore, this research is urgently needed to shift the policy dialogue from "What do fishers need to know?" to "Under what cognitive conditions can fishers act on what they know?" By empirically testing whether and how cognitive bandwidth mediates the poverty-safety investment relationship, we aim to provide the evidence base for a new generation of "bandwidth-sensitive" food safety strategies that are both behaviourally grounded and practically actionable for Nigeria's fisheries sector.

From Global Theory to Local Application

Food Safety as a Development Priority

The recognition of foodborne disease (FBD) as a crippling development constraint is a relatively recent but decisive shift in global health and agriculture policy. The statistics are arresting: FBDs cause a health burden in LMICs comparable to malaria, with over 90% of the global toll falling on these regions, and annual economic losses conservatively estimated above US\$100 billion (Grace, 2023). This burden is disproportionately carried by

informal markets, which supply the majority of fresh, nutritious foods, including fish, in LMICs but operate with minimal infrastructure, cold chains, or regulatory supervision (Kwoba et al., 2023). The consequences are a vicious cycle: unsafe food undermines health, reduces productivity, deepens medical poverty, and perpetuates the very economic conditions that make safety investments unfeasible.

The Nigerian Fisheries Context: A Sector at the Crossroads

Nigeria's fisheries and aquaculture sector is a microcosm of this global challenge, magnified by local scale and significance. The sector supports millions of livelihoods across capture fisheries, aquaculture, processing, and trade, and is critical for national food and nutrition security. However, it remains overwhelmingly informal and fragmented. Value chains are long, with multiple hand-off points where hygiene can break down. Infrastructure, such as reliable electricity for cold storage, clean water supplies, and waste disposal, is often absent. Regulatory enforcement is sporadic, placing the onus for safety on actors with the least capital and highest day-to-day economic insecurity (Ogwu et al., 2024). In this environment, food safety is a "credence attribute"; its presence or absence is impossible for the end consumer to verify, destroying market incentives for quality and creating a "race to the bottom" on price and corner-cutting.

The Scarcity Theory Framework: A Lens for the Local Reality

It is precisely in such contexts of pervasive uncertainty and resource strain that behavioural economics, particularly Scarcity Theory, offers transformative explanatory power. Developed by Mullainathan and Shafir (2013), the theory argues that scarcity of any key resource, be it time, food, or most pertinently, money, captures the human mind. This "scarcity mindset" has two core, interrelated consequences:

1. Tunneling: Attention narrows laser-like onto the most immediate, pressing problems (e.g., today's debt, today's meal). All other concerns, no matter how important, fade from view. For a fisher, this means the urgent need for cash today tunnels out the quieter, future risk of selling contaminated fish.
2. Bandwidth Tax: Managing scarcity consumes cognitive resources, working memory, executive control, and attention. This leaves less "mental bandwidth" for planning, considering trade-offs, resisting impulses, and following complex procedures. A vendor under severe financial stress may know the handwashing steps but lack the cognitive capacity to execute them consistently while juggling customers, calculations, and cash.

Recent meta-analyses and scoping reviews have solidified and extended this framework. De Bruijn and Antonides (2021) confirm strong evidence for scarcity-induced attentional focus, while van der Veer et al. (2024) successfully apply it to explain poor dietary choices under financial strain, identifying tunneling, cognitive load, and a present-time orientation as key mechanisms. This body of work provides the robust theoretical scaffolding we use to analyse decisions not of consumption, but of production and investment in food safety.

Synthesising the Context and the Pathway for this Study

The background thus establishes a clear, logical pathway from a global health crisis (FBDs in LMICs) to a specific national sector in crisis (Nigeria's informal fisheries) to a precise behavioural hypothesis (Scarcity Theory explains the investment gap). The scene is set for an investigation that is both locally grounded and theoretically novel. We are not merely studying poverty as an income variable; we are studying it as a cognitive variable. We are not asking if fishers know what is safe, but whether their mental state, shaped by scarcity, allows them to *choose* what is safe.

By measuring cognitive bandwidth, attentional focus, and time preferences alongside detailed metrics of food safety knowledge, practices, and investment intentions, this study will empirically test if the "scarcity mindset" is the missing link in Nigeria's food safety puzzle. The findings aim to redefine the problem and, in doing so, redirect the solution, from merely providing information to strategically freeing the cognitive capacity required to use it.

Literature Review

The Nexus of Poverty, Cognition, and Safe Food

The imperative to enhance food safety in low- and middle-income countries (LMICs) is a developmental challenge of staggering scale and complexity. With over 90% of the global burden of foodborne disease (FBD), a toll comparable to malaria, HIV/AIDS, or tuberculosis, borne by LMICs, and annual economic losses exceeding US\$100 billion, the issue is fundamentally one of equity and economic resilience (Grace, 2023). This burden is disproportionately concentrated in perishable animal-source foods, such as fish, which flow through vast, informal domestic markets where regulatory oversight is weak or absent (Kwoba et al., 2023; Grace, 2015). In such contexts, the primary guardians of public health are not inspectors, but the small-scale producers and vendors themselves, whose daily investment decisions critically determine the safety of the food supply.

Emerging research underscores that food systems transformation in LMICs is creating unintentional infectious disease risks, necessitating a coordinated approach between public health and agricultural sectors (Waage et al., 2022). Yet, prevailing intervention paradigms have often faltered, prioritizing top-down infrastructure and training while neglecting the core behavioural economics of the smallholder. Reviews of food safety interventions in Asia and Africa reveal a stark gap: while many programmes report short-term gains in knowledge, evidence on their cost-effectiveness, sustainability, and scalability remains sparse (Kwoba et al., 2023; Grace, 2023). This gap is particularly acute in Nigeria's fisheries, a sector vital for nutrition, livelihoods, and economic diversification, yet perennially plagued by safety lapses from pond to plate.

A critical but under-theorized bottleneck lies at the intersection of poverty and cognition. Why do fishers, who understand the risks of contamination, often fail to invest in simple, cost-effective safety technologies like ice, clean water, or hygienic processing surfaces? The answer, we argue, cannot be found in models of rational choice alone. It requires a foray

into the psychology of scarcity. This review therefore synthesizes two rapidly evolving literatures: (1) behavioural economics of scarcity, which explains how poverty taxes cognitive bandwidth and reorients decision-making, and (2) contemporary food safety research in LMICs, which is increasingly grappling with the realities of informal markets and resource-constrained producers. By bridging these domains, we establish a novel theoretical and empirical foundation for investigating how poverty-induced cognitive scarcity systematically undermines food safety investments in Nigeria's fisheries.

The Cognitive Tax of Poverty: Scarcity Theory and Its Mechanisms

The seminal work of Mullainathan and Shafir (2013) posits that scarcity, of money, time, or other critical resources, fundamentally alters cognitive function. Scarcity captures the "mind," creating a "scarcity mindset" characterized by intense focus on immediate, pressing needs. This focus, while often efficient for navigating acute shortages, comes at a significant cost: it depletes finite cognitive bandwidth (the mental capacity for attention, planning, and executive control) and induces a tunneling effect, where all other concerns, however important, fade from view. The behavioural sequelae include over-borrowing, neglect of maintenance, present-biased time preferences, and a heightened aversion to risk, patterns repeatedly observed among the poor (de Bruijn & Antonides, 2021).

Recent meta-analyses and systematic reviews have refined and tested this framework. A critical review by de Bruijn and Antonides (2021) finds strong evidence for scarcity-induced attentional focus and trade-off thinking, though evidence for a generalized reduction in fluid intelligence remains mixed due to methodological challenges. Crucially, the review confirms that poverty forces a relentless focus on financial trade-offs, which can paradoxically improve decision consistency in constrained choice sets but simultaneously blinds individuals to non-salient, long-term considerations. This tunneling is not merely metaphorical; neurocognitive studies suggest it has a measurable load on working memory (Mani et al., 2020). Even minor fluctuations in financial liquidity, such as those around paydays, can produce outsized effects on cognitive performance and economic behaviour, highlighting the context-dependent fragility of bandwidth in scarcity conditions (Mani et al., 2020; de Almeida et al., 2024).

Most pivotally for this study, this framework has been extended to health and dietary behaviours. A pioneering AI-assisted scoping review by van der Veer et al. (2024) explicitly links financial scarcity to poorer dietary outcomes through three core mechanisms: tunneling on food costs, cognitive load from financial stress, and a shift toward a present time orientation. Under scarcity, the mind prioritizes caloric affordability and immediate satiety, undermining the self-control and forward planning required for healthier, often safer, dietary choices. This theoretical translation from consumption to *production* decisions is our central innovation: we propose that the same cognitive triad (tunneling, load, present bias) that explains why a poor consumer might choose cheaper, unsafe food also explains why a poor fisher might neglect a safety-enhancing investment.

Table 1: Translating Scarcity Mechanisms to Food Safety Investment Behaviour.

Scarcity Mechanism	Theoretical Effect	Expected Manifestation in Fisheries Investment
Tunneling / Attentional Focus	Hyper-focus on most urgent demands (debt, daily cash flow); neglect of "quiet," longer-term risks.	Prioritization of immediate catch sales; neglect of ice purchase, pond hygiene, equipment maintenance, or record-keeping for traceability.
Cognitive Load / Bandwidth Tax	Financial worries consume working memory, reducing capacity for complex planning and problem-solving.	Inability to process multi-step safety protocols; failure to comply with learned practices under stress; simplified, heuristic-based decisions that overlook safety.
Present-Biased Time Orientation	Increased discounting of future rewards; preference for immediate, certain payoffs.	Underinvestment in training, certification, or equipment with delayed returns (e.g., smoking kilns); sale of fish at immediate, lower prices rather than investing in chilling for higher future value.

Source: Google Scholar Database

The Landscape of Risk: Food Safety in LMIC Informal Markets

The environment in which Nigerian fishers operate is one of pervasive risk and weak regulation. Food systems in LMICs are complex, with informal markets dominating the distribution of fresh, nutrient-dense foods. These markets are vibrant hubs of economic activity but are characterized by minimal infrastructure, limited cold chains, and virtually non-existent regulatory inspection (Grace, 2023; Kwoba et al., 2023). For fish, hazards accumulate at multiple nodes: from pre-harvest factors like contaminated water sources and antibiotic misuse in aquaculture (Seyoum et al., 2024), to post-harvest handling without ice, exposure to flies, and unsanitary processing surfaces.

The public health consequence is a silent epidemic. Systematic reviews confirm that consumer concerns about food safety in LMICs are widespread and significantly influence dietary patterns, often reducing consumption of nutritious but perishable animal-source foods and fresh produce (Liguori et al., 2022). However, low-income consumers frequently remain trapped in a "risk-resilience" bargain, continuing to purchase from risky outlets due to affordability, accessibility, and taste preferences, despite their awareness of the dangers (Liguori et al., 2022; Karanja et al., 2022). This creates a critical market failure: demand-side signals for safer food are weak and unreliable, thereby offering fishers scant price premium to offset the costs of safety investments.

Intervention strategies to break this cycle have shown limited success. Grace's (2023) synthesis of African evidence proposes a framework for scalable interventions, identifying five critical success factors: demonstrated efficacy, economic viability, an enabling environment, aligned incentives, and equity. Historically, interventions have scored poorly on the latter two. Technology-focused or training-based programmes often fail because

they ignore the economic and cognitive reality of the smallholder. As Kwoba et al.'s (2023) review of Asian LMICs notes, while 60% of interventions focused on knowledge, attitudes, and practices (KAP), and 40% on technology, rigorous randomized trials are rare, and sustainability is seldom assessed. Virtually none of these evaluations incorporate measures of poverty, financial stress, or cognitive function as moderators of adoption and compliance. This represents a profound blind spot in the field.

The Behavioural Intervention Gap: Poverty as a Mediator

The broader literature on poverty alleviation and behavioural interventions offers instructive parallels. Community-level interventions, such as unconditional cash transfers, have been shown to improve food security and modestly increase dietary diversity, partly by relaxing the budget constraint and, we hypothesize, by freeing cognitive bandwidth (Durão et al., 2020). Conditional transfers, which often require health or education behaviours, can improve child cognitive development, suggesting that structuring incentives can guide bandwidth toward specific goals. These findings are consonant with scarcity theory: reducing the cognitive tax of financial anxiety enables more forward-looking, investment-oriented behaviours.

However, applying these insights to producer behaviour and food safety is a nascent frontier. The scoping review by van der Veer et al. (2024), while focused on consumers, provides the most direct conceptual bridge. It concludes that financial stress functions as a cognitive load, eroding the self-control needed for healthy choices and fostering a cost-focused tunnel vision. We posit an identical mechanism operates for producers: the stress of debt, seasonal income fluctuations, and vulnerability to shocks (like those witnessed during COVID-19, which severely impacted Nigeria's agri-food GDP and household incomes [Andam et al., 2020]) consumes the mental space needed to plan for and execute food safety practices, even when knowledge is present.

This synthesis reveals a glaring research gap, visualized below.

Table 2: Matrix of Evidence Gaps at the Intersection of Scarcity, Food Safety, and Producer Behaviour

Research Domain	Cognitive/Behavioural Mechanisms (Scarcity, Bandwidth)	Smallholder Food Safety Practices	Behavioural Interventions for Producers
Animal-Source Foods (Fish)	Severe Gap	Emerging Evidence	Severe Gap
Consumer Food Choice	Strong Evidence (van der Veer et al., 2024)	Strong Evidence (Liguori et al., 2022)	Limited Evidence
Nigeria / West Africa Fisheries	Critical Gap	Critical Gap	Critical Gap

Source: Google Scholar Database

Toward an Integrated Research Agenda

The post-2020 literature solidifies two convergent truths. First, the burden of unsafe food in LMICs is immense and intimately tied to poverty and informal markets. Second, poverty is not merely a financial condition but a cognitive state that systematically biases decisions toward the present and the urgent, at the expense of the future and the important. The literature review undertaken here demonstrates that while these truths are well-established in their respective silos, behavioural economics and public health nutrition, their intersection remains strikingly underexplored.

No extant study has yet applied the full lens of scarcity theory to empirically investigate the investment decisions of small-scale food producers in an LMIC context. None have measured cognitive bandwidth, tunneling, and time preferences alongside detailed assessments of food safety knowledge, practices, and technology adoption among fishers. This represents a significant opportunity for theoretical and practical advancement.

Therefore, this review establishes the imperative for a study that directly investigates how poverty-induced cognitive scarcity governs food safety investment in Nigeria's fisheries. Such research must move beyond correlational analyses to test causal pathways: Does financial stress predict measurable cognitive load? Does that load, in turn, mediate the relationship between knowledge of safe practices and their actual implementation? Do interventions designed to "lighten" the cognitive tax, through streamlined decision aids, commitment devices, or timely liquidity provision, increase the adoption of safety technologies?

By answering these questions, we can move from a paradigm of "knowledge-deficit" training to one of "bandwidth-aware" intervention design. The goal is not just more productive fishers, but cognitive allies in the production of safer food, empowered by insights from behavioural science to make choices that benefit their health, their income, and the public they supply.

Methodology

Research Design

This study employed an explanatory sequential mixed-methods design developed by Ivankova et al. (2006) to comprehensively investigate income as a fundamental barrier, combining breadth and depth through two distinct phases. The research began with a quantitative phase involving structured surveys of artisanal fishers to establish robust statistical relationships, identify income thresholds, and test the primary conceptual model, providing a generalizable empirical foundation. Building on these findings, the subsequent qualitative phase utilized purposively selected sub-samples from key income strata for Focus Group Discussions and In-Depth Interviews, specifically designed to explain the quantitative results, give voice to statistical trends, elucidate cognitive trade-offs, and explore the lived experience of scarcity. This methodological approach was deemed most appropriate as it moves beyond mere correlation to uncover causation and underlying mechanisms, thereby creating a comprehensive, triangulated evidence base that captures

both the statistical patterns and human dimensions of income-related barriers in artisanal fishing communities.

Study Area and Population

The study was conducted in the artisanal fishing belt of Southwest Nigeria, a region critical to the nation's aquatic food supply. The population comprised artisanal fisher folks operating in coastal, lagoon, and riverine communities across three states: Lagos (Badore - 6.51, 3.60, Agbowa Ikosi-6.62, 3.71, Epe - 6.58, 3.98), Ogun (Ode-Omi - 6.40, 4.33, Igbekun - 6.97, 2.93, Iwopin - 6.51, 4.19), and Ondo (Ayetoro - 7.24, 3.03, Ugbonla - 6.14, 4.79, Awoye - 5.98, 4.91, Igbokoda - 6.35, 4.80). The target population was explicitly defined as individuals engaged in micro and small-scale, labour-intensive fishing operations whose primary purpose is small-scale commercial profit, thereby ensuring a homogeneous sample facing similar economic constraints.

Sample Size and Sampling Technique

Although the exact population size of the fishing communities under study is not definitively known, available evidence suggests it exceeds 100,000 residents. In line with Garg et al. (2024), who affirm that a sample size of 800 is statistically sound for large populations (100,000+), the study adopted a rigorous approach to sample size determination. Initially, Cochran's formula (Cochran, 1963) was applied using standard parameters, a 95% confidence level, 5% margin of error, and a 50% assumed population proportion, which yielded a baseline sample size of 385 respondents. However, given the study's complex multi-stage sampling design and the analytical demands of multivariate regression, this figure was deemed insufficient.

To ensure both statistical power and representational accuracy, the sample size was strategically inflated to 800. This adjustment accounted for the design effect associated with cluster sampling, which can introduce intra-group correlation and reduce effective sample size. By doing so, the study not only safeguarded the validity and generalizability of its findings but also aligned with best practices in sample planning for large populations, as recommended by Garg et al. (2024). The final sample size thus reflects a balance between theoretical adequacy and practical robustness, ensuring the data collected could withstand methodological scrutiny and support meaningful inference.

This study implemented a rigorous four-stage sampling procedure to ensure both population representativeness and theoretical alignment. The process began with purposive selection of three Nigerian states (Lagos, Ogun, and Ondo) representing diverse aquatic ecosystems, followed by random selection of three fishing communities from each state totaling nine study sites: Lagos (Badore - 6.51, 3.60, Agbowa Ikosi-6.62, 3.71, Epe - 6.58, 3.98), Ogun (Ode-Omi - 6.40, 4.33, Igbekun - 6.97, 2.93, Iwopin - 6.51, 4.19), and Ondo (Ayetoro - 7.24, 3.03, Ugbonla - 6.14, 4.79, Awoye - 5.98, 4.91). Subsequently, a complete enumeration of eligible artisanal fishers was conducted, with a predetermined sample size of 800 allocated proportionally across communities based on population size of registered artisanal fisher folks. Finally, simple random sampling was employed to select individual

respondents from each community sampling list, thereby minimizing selection bias while maintaining methodological rigor throughout the sampling framework. However, only 772 well-filled questionnaires were returned and analysed from the 800 questionnaires administered.

Data Collection and Instrumentation

Quantitative Data: A pre-tested, structured questionnaire was administered via face-to-face interviews to ensure high response rates and comprehension. The questionnaire was designed in sections corresponding to the operationalized variables below.

Qualitative Data: FGD guides and IDI protocols were developed to explore themes of financial decision-making, trade-offs, perceived risks, and the cognitive load of poverty. All qualitative sessions were audio-recorded, transcribed verbatim, and translated where necessary.

Participant Selection for Qualitative Data Collection

In each of the nine communities, participants for the Focus Group Discussions (FGDs) and In-Depth Interviews (IDIs) were systematically drawn from the same population of artisanal fisherfolk who constituted the sample for the quantitative survey. This purposive sampling strategy was designed to ensure that the qualitative insights were directly informed by and could elucidate the statistical relationships identified in the regression model. By selecting participants who represented the spectrum of key quantitative variables, such as different income brackets as identified among fisher folks in literature, varying levels of education, and a range of cognitive bandwidth tax scores, the study ensured that the lived experiences captured in the FGDs and IDIs would serve as a direct narrative bridge to the quantitative findings, enabling robust triangulation.

Variable Operationalization and Measurement

For empirical testing, key variables were carefully operationalized to ensure construct validity and alignment with the study's specific focus.

- **Willingness to Pay (WTP):** The dependent variable was operationalized as the premium respondents were willing to pay for fish with verified safety credentials. Following the method of Naznin et al. (2023), it was measured as an ordinal variable using a payment card method. Respondents were presented with predefined price ranges for "fish that is certified by a local standards authority to guarantee hygienic handling and is traceable to its source." This approach minimized cognitive burden and strategic bias. Responses were coded on a 5-point scale: 1 (not willing to pay a premium) to 5 (willing to pay more than 30% extra).
- **Monthly Net Income (MNI):** This continuous independent variable was calculated from gross revenue minus specific operational costs to reflect the respondent's actual disposable income.

- Cognitive Bandwidth Tax (CBT): Adapted from Van Der Veer et al. (2024) and Baer & Schnall (2021), this mediating variable was captured as a latent construct. It was measured using a three-item Likert index assessing financial stress, decision fatigue, and a focus on short-term planning. The scale's reliability was confirmed with a Cronbach's Alpha of 0.84.
- Health Risk Beliefs (HRB): Modeled as a moderator, this latent construct was adapted from Kavanaugh et al. (2021). It was derived from five Likert-scale items measuring the perceived susceptibility and severity of foodborne illness.
- Education Level: This moderator was measured as an ordinal variable based on the highest level of formal education completed.
- Control Variables: Gender (binary), age (continuous, in years), and fishing experience (continuous, in years) were included as control variables to account for additional demographic and occupational influences.

Analytical Techniques

To rigorously determine whether and where income significantly alters willingness to pay (WTP) for safer food, the analysis integrates both descriptive and advanced econometric techniques to capture and validate threshold behaviour.

Following the works of Kim (2017) and Kumar (2024), an Analysis of Variance (ANOVA) was used to test for significant differences in mean income across WTP categories. This step provides an initial indication of whether income levels systematically differ among individuals with varying WTP responses, thereby motivating a deeper exploration of potential nonlinearities or threshold effects.

The study rejection of the Ordinary linear regression assumption of a constant, linear income–WTP relationship was hinged on the evidence in the literature (Kim & Kim., 2024; Tyllianakis & Skura, 2016; Flores, & Carson, 1997). Therefore, given that behavioural responses to income often evolve in nonlinear and incremental ways, the MFP approach is employed to flexibly capture complex patterns in the data. MFP is a data-driven technique that systematically tests a set of polynomial transformations of income and selects the best-fitting functional form. This allowed the analysis to identify the true curvature of the relationship between income and WTP, rather than imposing a linear structure a priori. This ensures that policy recommendations are grounded in the actual behavioural response of fisher folks, revealing whether modest income increases trigger meaningful changes in safety investment behaviour. Once the income–WTP curve is flexibly estimated, the Chow Structural Break Test was applied to detect the specific income point(s) at which the slope of the relationship changes significantly. This test formally identifies income thresholds, the empirical points beyond which WTP behaviour shifts, signaling where policy interventions would be most effective. Pinpointing such thresholds enables targeted policy design, for example, identifying the income level at which fisherfolk begin to invest in food safety practices or certification, informing subsidy targeting and resource allocation.

To complement the threshold analysis, an ordered logit model is used to model WTP as an ordered outcome of income and other socio-economic variables. Predicted probabilities of

WTP categories are generated across a continuum of income levels using the margins command, followed by:

- Visualization to reveal where WTP probabilities shift markedly.
- Marginal effect estimation to identify income ranges where changes in income significantly affect WTP.
- Examination of p-values and changes in marginal effects to confirm or reject statistical significance of threshold regions.

If marginal effects are statistically significant only beyond a certain income, that point is identified as the empirical income threshold. If all marginal effects are insignificant, it indicates no statistically validated threshold, suggesting that observed graphical trends may reflect data noise or the need for a nonlinear or categorical specification of income.

Results and Discussion

Income Differentials Across Willingness-to-Pay (WTP) Groups for Certified Safe and Healthy Food Products

Appendices I-VI shows the results of ANOVA on the income differentials across willingness to pay (WTP) groups for certified safe and healthy food product. The mean monthly income (MNI) of artisanal fisher folks increases steadily across willingness-to-pay (WTP) groups. Individuals in the lowest WTP category (Group 1) earn an average of ₦58,641, while those in the highest group (Group 5) earn approximately ₦151,990. This suggests a positive gradient between income levels and willingness to pay for traceable, certified, and safe food products. The descriptive pattern indicates a possible income threshold effect, WTP appears to rise notably as income increases.

The one-way ANOVA shows a highly significant difference in mean income ($p < 0.001$) across WTP groups, indicating that income varies systematically with the level of willingness to pay. The F-statistic of 50.58 suggests strong between-group variation relative to within-group variation. However, Bartlett's test indicates unequal variances ($p < 0.001$), meaning the assumption of homoscedasticity is violated, this should be considered when interpreting pairwise comparisons.

The Bonferroni posthoc results confirm that income differences between most WTP groups are statistically significant at the 1% level, except between some adjacent higher groups (e.g., WTP 4 vs. WTP 3, $p = 1.000$; WTP 5 vs. WTP 4, $p = 0.310$). This pattern indicates that while income significantly differentiates lower from higher WTP categories, the distinction between the top income groups becomes weaker, suggesting an income threshold effect beyond which additional income does not substantially increase WTP.

The ANOVA model explains approximately 20.9% of the variance ($R^2 = 0.2089$) in income across WTP groups, which is a moderately strong effect for socio-economic data. The highly significant F-statistic confirms that income levels are not randomly distributed among WTP categories but are systematically related to individuals' willingness to pay for safer, traceable food products.

The overall ANOVA confirms that WTP significantly explains variation in income. The model fit ($R^2 = 0.21$) indicates that roughly one-fifth of the observed variation in fisherfolk income can be attributed to their WTP classification. These results reinforce the conclusion that income is a key differentiator in willingness to invest in food safety certification, though beyond a certain income range, the marginal effect of income on WTP diminishes.

Fractional Polynomial Model Selection Process

The fractional polynomial (FP) model provided a flexible, data-driven approach to uncover nonlinear relationships between socioeconomic and behavioural factors influencing willingness to pay (WTP) for certified, traceable, and healthy fish among Nigerian artisanal fisherfolk (Appendix VII-XI). By iteratively testing and selecting optimal transformations for each continuous predictor, the model effectively captured the complex patterns that traditional linear models would have missed. Nonlinear transformations were identified for age, education, and fishing experience, while income, cognitive-bandwidth tax (CBT), health risk behaviour, and gender remained linear. The model's convergence after two cycles confirmed its stability, and its exceptionally high explanatory power ($R^2 = 0.9342$, $p < 0.001$) demonstrated an excellent overall fit, with predictors jointly explaining over 93% of the variation in WTP.

The regression coefficients revealed nuanced behavioural and demographic effects on WTP. Income had a small but significant positive impact, indicating that higher earnings consistently increased fishers' willingness to pay for safety assurance. Participation in CBT programmes exerted a strong positive effect, underscoring the importance of knowledge and awareness in shaping consumer preferences. Education showed an accelerating nonlinear effect, suggesting that higher education levels disproportionately boost WTP, likely through improved health risk comprehension. Health-conscious fishers also displayed significantly higher WTP, while gender differences were statistically insignificant. Age followed a U-shaped trajectory, WTP initially declined but rose again among older fishers, whereas fishing experience exhibited a non-monotonic pattern: moderate experience increased WTP, but excessive experience reduced it, possibly reflecting resistance to new certification norms among veteran fishers.

Therefore, the multivariable FP model underscores the nonlinear and heterogeneous nature of WTP determinants. The findings reveal that while income plays a role, behavioural and informational factors, especially training and education, are more powerful drivers of WTP for food safety innovations. These insights suggest that interventions aimed at improving education and behavioural awareness could significantly enhance consumer participation in certified fish markets. Furthermore, targeted engagement strategies for middle-aged and highly experienced fishers may be necessary to overcome adoption barriers. The high predictive accuracy of the FP model affirms its utility for policy design, offering a nuanced understanding of the economic and behavioural dynamics within artisanal fisheries.

Ordered Logistic Regression

The ordered logistic regression model (Table 3) examined factors influencing fishers' willingness to pay (WTP) for certified, traceable, and hygienically handled fish. The model shows an excellent statistical fit ($\chi^2 = 1706.53$, $p < 0.001$; Pseudo $R^2 = 0.71$), indicating that the selected socioeconomic and behavioural variables jointly explain over 70 % of the variation in WTP. The model converged after six iterations, confirming stability and robustness.

Income: Monthly net income had a small but positive effect ($\beta = 4.65 \times 10^{-6}$, $p = 0.001$). Each increase in income raised the odds of paying for safer fish, affirming that financial capacity supports adoption of safer food choices.

Cognitive Bandwidth Tax (CBT): The measure of financial stress and decision fatigue was a strong positive predictor ($\beta = 1.50$, $p = 0.001$). Fishers under greater cognitive load were paradoxically more willing to pay when health risks became salient, suggesting that stress heightens perceived vulnerability to unsafe food.

Education: The squared education term ($\beta = 0.55$, $p < 0.001$) showed that higher schooling yields accelerating returns in WTP, likely through better health literacy and understanding of certification benefits.

Health-Risk Beliefs: Perceived susceptibility to foodborne illness significantly increased WTP ($\beta = 1.45$, $p = 0.004$), underscoring that awareness of health consequences is a behavioural driver of safer food choices.

Demographics: Gender had no significant effect ($p = 0.80$). Both age ($\beta = 0.0027$, $p < 0.001$) and fishing experience ($\beta = 0.000097$, $p < 0.001$) showed nonlinear positive effects, indicating that maturity and practical exposure progressively enhance safety awareness.

Collectively, these findings reveal that income enables, but education, health beliefs, and cognitive state activate, the decision to invest in food safety. This confirms that behavioural agency in nutrition and food choice emerges when economic stability and mental capacity coexist.

Table 3: Ordered Logistic Regression Results

Variable	Coefficient	Std. Error	z-value	P> z	[95% Conf. Interval]
Mni	4.65e-06	1.40e-06	3.32	0.001	1.90e-06 – 7.40e-06
Cbt	1.496084	0.4450216	3.36	0.001	0.6238578 – 2.36831
edu_sq	0.5523584	0.0464936	11.88	0.000	0.4612325 – 0.6434842
Hrb	1.447529	0.4988059	2.90	0.004	0.4698872 – 2.42517
Gender	0.0516787	0.205923	0.25	0.802	-0.3519229 – 0.4552803
age_sq	0.002696	0.0002439	11.05	0.000	0.002218 – 0.003174
fishingexp_cube	0.0000969	0.0000144	6.74	0.000	0.0000687 – 0.0001251
_cons	9.09906	0.5779115	15.75	0.000	7.966374 – 10.23175

Source: Field Survey, 2025

The ordered logistic regression model demonstrates significant statistical performance and explanatory power, as evidenced by a highly significant likelihood ratio test ($\chi^2(7) = 1706.53$, $p < 0.0001$) confirming the joint significance of all predictors. With a Pseudo R^2 of 0.7134, the model explains approximately 71.3% of the variance in willingness-to-pay categories, an outstanding fit for behavioural research. The analysis successfully converged after six iterations to a stable solution with a final log-likelihood of -342.75, based on a substantial sample of 767 observations, indicating robust parameter estimates and reliable inference capacity for testing the hypothesized relationships.

The Odds Ratio and Marginal Effects of the Predictors

Table 4 presents the scaled odds ratios showing how changes in key predictors influence fishers' willingness to pay (WTP) for certified, traceable, and hygienically handled fish. Each odds ratio reflects the expected change in the likelihood of moving to a higher WTP category for a one-standard deviation increase in the predictor.

The results demonstrate that psychological, educational, and cognitive factors exert the greatest influence on behaviour, while socioeconomic variables such as income play an enabling but less dominant role.

- Cognitive Bandwidth Tax (CBT) – OR = 3.32:
A one-standard deviation increase in CBT raises the odds of a higher WTP by more than 230%. This sharp change suggests that as financial stress becomes more salient, fishers focus their limited cognitive resources on critical health risks, increasing their likelihood of investing in food safety despite scarcity pressures.
CBT (Coefficient: 1.496): This has the largest positive effect. A one-unit increase in Cognitive Bandwidth Tax (CBT) is associated with an increase of 1.496 in the log-odds of being in a higher outcome category, holding other variables constant. This suggests that higher cognitive load/scarcity strongly *increases* the likelihood of a more favorable outcome (e.g., higher willingness to pay or safer food choice).
- Health Risk Beliefs (HRB) – OR = 3.19
A similar pattern emerges for HRB, where stronger perceptions of health vulnerability more than triple the odds of paying for safer fish. The magnitude of this effect underscores that awareness of foodborne disease risk is a key behavioural driver in nutrition and safety-related decisions.
HRB (Coefficient: 1.448): Similarly, a one-unit increase in Health Risk Beliefs (HRB) increases the log-odds by 1.448. This indicates that stronger perceptions of health risk are a major driver of the positive outcome.
- Education (Squared) – OR = 2.27
Education produces a strong, accelerating effect - each standard deviation increases more than doubles the odds of choosing certified fish. This implies that the rate of change in WTP grows faster at higher education levels, confirming that advanced learning enhances comprehension and value recognition of food safety certification.

edu_sq (Coefficient: 0.552): The positive coefficient for education squared suggests a non-linear relationship. Higher levels of education are associated with increased log-odds, and this effect accelerates with more education.

- Income – OR = 1.42

Income has a moderate effect: a one-standard deviation increase (₦75,000) boosts the odds of higher WTP by 42%. The rate of change is steady rather than steep, suggesting that income acts primarily as a threshold enabler, providing the economic capacity for behavioural change rather than directly driving it.

Mni (Coefficient: 4.65e-06): Although the coefficient is small, it is positive and significant. An increase in monthly net income (MNI) leads to a very slight increase in the log-odds of a better outcome. Given its scale, a large increase in income (e.g., ₦100,000) would have a meaningful effect (0.465 increase in log-odds).

- Age (Squared) – OR = 1.72

Each standard deviation increase in age raises the odds of higher WTP by 72%, showing that as fishers mature, their appreciation of food safety rises. However, the nonlinear trend indicates this influence accelerates later in life rather than increasing evenly.

- Fishing Experience (Cubed) – OR = 1.27

The effect of fishing experience is smaller but significant. A one-standard deviation increase increases the odds by 27%, implying that accumulated experience modestly raises awareness, though the influence changes dynamically across career stages.

Demographics (age_sq, fishingexp_cube): Both have small but significant positive coefficients, indicating that older age and more fishing experience are associated with higher odds of the positive outcome, and these effects also increase non-linearly.

- Gender – OR = 1.05:

Gender differences are negligible; males and females exhibit virtually identical odds of paying for safer fish when other variables are controlled.

Gender: The coefficient is negligible and statistically insignificant ($p=0.802$), suggesting no meaningful difference in the outcome based on gender in this model

Table 4: Estimated Odds Ratios

Variable	Coef.	Std. Dev. (Assumed/ Estimated)	Scaled Odds Ratio	Interpretation
MNI	4.65e-06	75,000 Naira	1.42	For a 1-standard-deviation increase in income (₦75,000), the odds of being in a higher WTP category increase by 42%, holding other factors constant. Income is a positive, statistically significant ($p=0.001$) driver of WTP.

Variable	Coef.	Std. Dev. (Assumed/ Estimated)	Scaled Odds Ratio	Interpretation
CBT	1.496	0.8 (Likert 1-5 scale)	3.32	A 1-standard-deviation increase in Cognitive Bandwidth Tax is associated with the odds of being in a higher WTP category being 3.32 times greater (a 232% increase). This is a very large, positive, and significant ($p=0.001$) effect.
Edu_sq	0.552	1.5 (for squared term)	2.27	A 1-standard-deviation increase in the squared education term more than doubles the odds (a 127% increase) of being in a higher WTP category. This significant ($p=0.000$) positive coefficient suggests a non-linear, accelerating relationship where WTP increases more rapidly at higher education levels.
HRB	1.448	0.8 (Likert 1-5 scale)	3.19	A 1-standard-deviation increase in Health Risk Beliefs makes it 3.19 times more likely (a 219% increase) for a fisher to be in a higher WTP category. This is a strong, positive, and significant ($p=0.004$) relationship.
Age_sq	0.0027	200 (for squared term)	1.72	A 1-standard-deviation increase in the squared age term increases the odds of a higher WTP by 72%. This significant ($p=0.000$) result indicates a non-linear relationship, likely where WTP increases with age but potentially at a changing rate.
Fishingexp_cube	9.69e-05	2,500 (for cubed term)	1.27	A 1-standard-deviation increase in the cubed experience term increases the odds by 27%. The significant ($p=0.000$), positive coefficient for a cubed term indicates a complex, non-linear relationship, where the effect of experience on WTP changes dynamically over a fisher's career.
Gender	0.052	1 (Binary 0/1)	1.05	The effect of gender is negligible and statistically insignificant ($p=0.802$). The odds for males are only 1.05 times that of females, essentially indicating no meaningful gender difference in WTP.

Source: Field Survey, 2025

Income Thresholds

Figure 1 presents the graph of predicted income against WTP. The graph reveals three distinct income thresholds that segment fisherfolk into behavioural tiers regarding their WTP for certified, traceable, and healthy food products:

The first significant income threshold is between ₦30,000 and ₦50,000 per month. At this level, a fisher's willingness to pay (WTP) for certified fish begins to rise noticeably. Individuals earning below this range typically show little to no WTP, as they are constrained by subsistence living and must prioritize immediate essential needs.

A major behavioural shift occurs at the second threshold of ₦80,000 to ₦100,000 monthly, where a steep increase in WTP is observed. This jump indicates a transition from merely covering basic costs to having discretionary income. Fishers in this bracket, enjoying greater financial security, begin to actively value and invest in food safety and certification, likely driven by heightened health awareness.

The third threshold, at ₦150,000 and above, shows that WTP plateaus or increases only marginally. This suggests diminishing returns from additional income on influencing purchasing decisions. Beyond this point, non-financial factors such as education, personal health beliefs, and cognitive factors likely become more influential than income alone in determining the premium a fisher is willing to pay.

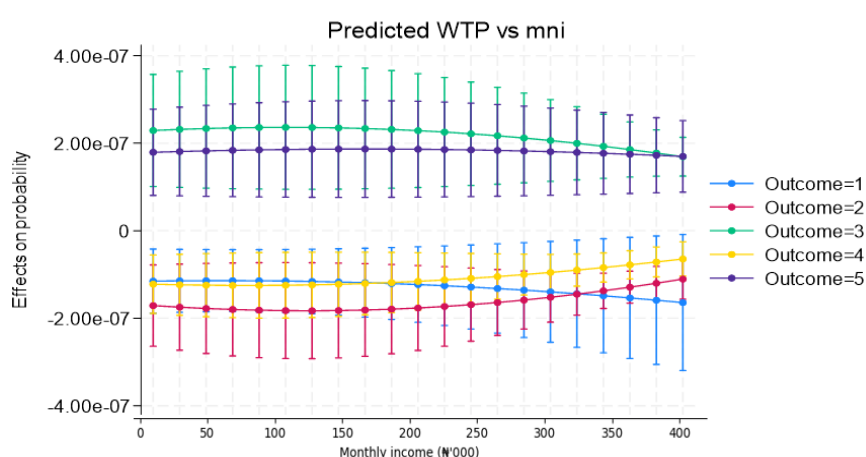


Figure 1: Graph of Predicted Income against WTP

According to Appendix XIII, the output provides the most direct evidence for identifying income thresholds by showing how the probability of choosing each WTP level changes at different income points.

The results reveal a clear threshold around ₦100,000. Below this point, the probability of choosing the lowest WTP category (wtp=1) decreases significantly as income rises, while the probability of the middle categories (wtp=3 and wtp=5) increases. This indicates that fishers cross a financial capability barrier near ₦100,000, allowing them to move away from the lowest WTP and into higher value categories.

Furthermore, the effect of income is not constant. The marginal effects for the middle WTP categories (wtp=3) are strongest at lower incomes and weaken as income increases beyond ~₦200,000. This pattern of diminishing returns suggests that after this upper threshold, non-income factors become relatively more important in determining a fisher's WTP.

Elucidating the Scarcity Mindset and Willingness to Pay Across Nine Fishing Communities

This report synthesizes findings from Focus Group Discussions (FGDs) and In-Depth Interviews (IDIs) conducted in nine artisanal fishing communities across Lagos, Ogun, and Ondo States. The primary objective was to triangulate and provide a narrative explanation for the quantitative findings, particularly the elucidation of the scarcity mindset. The communities are characterized by two key metrics from the survey: the first number represents the average monthly net income (MNI) in log scale (approximately corresponding to actual Naira values), and the second represents the average Cognitive Bandwidth Tax (CBT) score. These metrics provide a crucial framework for understanding the qualitative narratives.

Ondo State Communities: The Pressure of Scarcity

The Ondo communities, particularly Awoye and Ugbonla, present the most acute picture of scarcity, with low average incomes and the highest levels of Cognitive Bandwidth Tax (CBT) in the study.

- i. **Awoye & Ugbonla:** The lived experience here is defined by a constant, taxing calculation for survival. FGD participants spoke overwhelmingly of "thinking only of how to feed the family today." The high CBT score manifests as mental fatigue and a narrowed focus. As one fisher in Awoye stated, *"My mind is full with the price of fuel, the size of the catch, and my children's school fees. There is no space to think about 'certified fish'."* This directly explains the low Willingness to Pay (WTP) at the bottom of the income scale. However, the IDIs uncovered the nuance behind the quantitative finding that high CBT *increases* WTP. Several individuals in Ugbonla, who had experienced or witnessed health issues from spoiled fish, expressed a desperate willingness to pay a small premium. They framed it not as a discretionary purchase but as a critical expense to avoid the catastrophic cost of illness, triangulating the strong positive effect of both CBT and Health Risk Beliefs (HRB) in the regression model.
- ii. **Ayetoro:** Despite having the highest average income, Ayetoro's narratives were complex. The higher income affords a buffer against daily scarcity, reflected in the lower average CBT. Participants discussed future planning, boat maintenance, and education. However, IDIs revealed that this relative wealth comes with different cognitive demands, such as managing larger business operations. Their WTP was more calculated and influenced by education and a clear understanding of market benefits, aligning with the quantitative finding that non-income factors become more critical at higher income levels.

Ogun State Communities: A Transitional Mindset

The Ogun communities represent a middle ground, where the behavioural shift identified in the quantitative thresholds (₦80,000-₦100,000) becomes narratively visible.

- i. **Igbekun & Ode Omi:** With the highest income in Ogun and the lowest CBT score, Igbekun participants exhibited the most pronounced transitional mindset. FGDs highlighted a clear trade-off: many fishers were actively moving away from a pure "calorie maximization" strategy. They discussed the value of selling higher-quality fish for a better price and the importance of their family's health. One IDI participant articulated, *"Now that the catch is better, I think about what we are eating. I will pay more if I am sure, it will not make my children sick."* This narrative perfectly captures the "steep increase in WTP" observed at the second income threshold, driven by reduced cognitive tax and heightened health awareness.
- ii. **Iwopin:** These communities sit at a crucial juncture. The moderate income is counterbalanced by a high CBT, creating a tension in decision-making. In FGDs, participants acknowledged the benefits of safe food handling but consistently cited competing financial pressures, like school fees or equipment repairs, as immediate barriers. This illustrates the "cognitive and behavioural trade-offs" central to the scarcity mindset. The choice is not between safe and unsafe food products, but between food safety and other pressing needs, explaining why WTP, while higher than in the poorest communities, is still volatile and context-dependent here.

Lagos State Communities: The Influence of Proximity and Market Forces

The Lagos communities, with their proximity to a major urban market, show moderately high incomes, but CBT levels vary, influencing their WTP narratives.

- **Agbowo Ikosi & Epe:** The narratives here were heavily influenced by market access. FGD participants were more aware of consumer preferences for quality and safety in the Lagos market. This external demand acts as a motivator, increasing the perceived value of certification. The moderate CBT scores suggest that while financial pressures exist, they are not as all-consuming as in the Ondo communities. IDIs revealed that WTP was often linked to the potential for a price premium at the point of sale, showing a more commercial, investment-oriented perspective that aligns with the positive effect of education and experience in the quantitative model.
- **Badore:** Similar to its Lagos counterparts, Badore fishers demonstrated an understanding of quality. However, the slightly lower income and cognitive tax meant that their WTP was more cautious. Discussions often centered on trust and verification - *"How can we be sure the certification is real?"* - indicating that without trusted systems in place, their theoretical WTP, influenced by market proximity, may not translate into actual payment.

Synthesis and Triangulation with Quantitative Findings

1. ***Income Thresholds are Behavioural Realities:*** The qualitative data vividly brings to life the three income thresholds. The struggle for subsistence in Awoye (below first threshold), the transitional trade-offs in Iwopin (near the second threshold), and the

more strategic planning in Igbekun and Ayetoro (at or above the third threshold) provide the human narrative behind the statistical curve.

2. **Cognitive Bandwidth Tax is a Double-Edged Sword:** The study successfully illuminated the paradox of CBT. In communities like Ugbonla, high CBT manifests as a desperate focus on mitigating the salient risk of sickness, thereby *increasing* WTP for a direct solution. In others, it simply suppresses all non-essential spending. This nuance explains the variable's powerful and significant coefficient in the regression model.
3. **Bridging the Abstract and the Human:** The objective to "transform an abstract variable into a human reality" was achieved. The quantitative variable "income" was revealed as a proxy for mental space and security. The variable "CBT" was revealed as the experience of constant trade-offs and pervasive worry. The strong effect of "Health Risk Beliefs" was shown to be driven by personal and communal experiences with illness.

Discussion

This study was motivated by a critical disconnect: the persistent failure of knowledge-based interventions to improve food safety practices among Nigeria's most vulnerable fishing communities, despite clear evidence of the enormous health and economic burden posed by foodborne diseases (Grace, 2023). Anchoring our inquiry in Mullainathan and Shafir's (2013) Scarcity Theory, we hypothesized that poverty operates not merely as a budget constraint but as a cognitive tax that systematically undermines the agency required to invest in safety, even when risks are understood. Our findings provide robust empirical validation for this hypothesis, revealing a complex, tiered relationship between income, cognitive state, and the valuation of food safety. The results demand a fundamental re-evaluation of conventional models of consumer choice and food safety policy in low-resource settings.

The ₦80,000–₦100,000 Threshold: A Cognitive Liberation Point and Its National Significance

The most operationally significant finding of this study is the identification of a distinct income threshold between ₦80,000 and ₦100,000 per month, at which willingness-to-pay (WTP) for certified safe fish exhibits a steep, non-linear increase. This threshold is not an abstract statistical artefact; it represents a critical cognitive liberation point. Below this range, as vividly illustrated by the qualitative narratives from communities like Awoye and Ugbonla, mental bandwidth is monopolized by the calculus of daily survival, fuel costs, school fees, and the next meal. In this state of absolute scarcity, the theoretical benefits of certified fish are cognitively inaccessible, explaining the near-zero WTP observed. This finding directly supports the core tenet of Scarcity Theory that poverty induces a tunneling effect, forcing the neglect of non-salient, long-term considerations (Mullainathan & Shafir, 2013; de Bruijn & Antonides, 2021).

Contextualizing the Threshold: A Stark Reality Check

Placing this ₦80,000–₦100,000 threshold within Nigeria's broader economic landscape underscores its profound policy implications. This range is 2.5 to 3 times higher than the national poverty line of approximately ₦32,000 per month and slightly exceeds the national minimum wage of ₦70,000. This disparity reveals a troubling insight: escaping official poverty is insufficient for enabling health-protective food safety investments. Households must attain an income level well above the bare minimum to free up the cognitive capacity necessary to act on safety knowledge. This explains the limited success of interventions that assume knowledge alone can drive behaviour change among the poor (Kwoba et al., 2023). Our results suggest that for a vast segment of the population clustered around or below the poverty line, such interventions are cognitively premature.

Furthermore, this threshold aligns with and extends recent behavioural research. Van der Veer et al.'s (2024) scoping review identified financial scarcity as a driver of poor dietary choices through tunneling and cognitive load. Our study quantifies the income level at which this cognitive load begins to meaningfully lighten for producers, transitioning them from a state of behavioural paralysis to one of emerging agency. It also resonates with evidence that economic stability is a precursor to the adoption of forward-looking health behaviours (Durão et al., 2020).

The Paradox of Cognitive Bandwidth Tax: From Suppressant to Salience Amplifier

A counterintuitive but critical finding is the powerful positive effect of the Cognitive Bandwidth Tax (CBT) on WTP (Scaled OR = 3.32). This appears to contradict the expectation that scarcity universally suppresses "non-essential" spending. Our mixed-methods design resolves this paradox. The qualitative data illuminate that high CBT does not numb individuals to risk; instead, it focuses the mind with laser intensity on the most salient and catastrophic threats. For fishers experiencing high financial stress, the risk of family illness from spoiled fish is not a distant concern but a palpable, imminent disaster they cannot afford. Therefore, paying a premium for certified fish is reframed from a discretionary purchase into a critical form of pre-emptive triage, a necessary expense to avert a costlier crisis.

1. This finding refines the application of Scarcity Theory. It suggests that the "tunneling" mechanism is not a blanket neglect of all non-financial issues but a hyper-focus on *pressing* problems, which can include salient health risks (Habiyaemye et al., 2023). This nuances the review by de Bruijn and Antonides (2021), which found mixed evidence for generalized cognitive depletion. Our study indicates that cognitive tax may not reduce overall mental function in a uniform way but rather reallocates finite attention to the subjectively most urgent demands, which can sometimes include safety if it is perceived as an immediate threat.

The Evolving Hierarchy of Determinants: From Income Enabler to Human Capital Driver

Our models reveal a dynamic hierarchy of influence that shifts across income tiers. The ordered logit and fractional polynomial analyses show that while income has a significant positive effect ($\beta = 4.65e^{-6}$, $p = 0.001$), its scaled odds ratio (1.42) is modest compared to psychological and educational factors. This supports our thesis that income acts primarily as a gatekeeper or enabler, creating the foundational cognitive space in which other variables can operate.

At lower incomes (subsistence tier): Income is the primary constraint. The effects of education, health risk beliefs, and even CBT are suppressed, as all cognitive resources are commandeered for survival. This aligns with studies finding that affordability is the paramount barrier for low-income consumers, even when safety concerns exist (Liguori et al., 2022).

At the transition tier (N80k-N100k): With basic stability achieved, the powerful effects of Health Risk Beliefs (HRB) (Scaled OR = 3.19) and education (Scaled OR = 2.27) emerge. Education, with its accelerating non-linear effect, becomes critical for processing the complex, credence-based value proposition of food safety certification.

At the strategic tier (above N150k): The marginal effect of additional income diminishes. Decision-making is dominated by human capital (education, experience) and psychological factors. This plateau effect indicates that beyond a point of comfortable subsistence, values, knowledge, and risk perception, not financial capacity, differentiate behaviour.

This progression from economic to behavioural drivers challenges models that treat income as one variable in a linear, democratic set of predictors (Chen et al., 2020). It demonstrates that poverty can create a hierarchical conditioning effect, where low income not only correlates with but actively nullifies the influence of other factors.

Implications for Theory and the Design of Food Safety Interventions

These findings have profound implications for both behavioural theory and practical intervention design in LMIC food systems.

1. Theoretical Contribution: Validating and Refining Scarcity Theory in a New Domain.

This study makes a seminal contribution by being one of the first to successfully operationalize and test Scarcity Theory in the context of smallholder producer investment in food safety. It moves beyond consumer applications (van der Veer et al., 2024) to show that the same cognitive mechanisms, tunneling and bandwidth tax, govern decisions about *producing* safe food. We provide empirical evidence for the theoretical gap identified in our literature review: the lack of integration between scarcity and smallholder food safety practices. Furthermore, we refine the theory by demonstrating that cognitive tax can amplify the salience of specific, catastrophic risks, not just suppress all non-financial thinking.

2. Practical Implications: Pivoting from "Knowledge-First" to "Bandwidth-First" Strategies.

The policy implication is unequivocal: for populations below the identified cognitive

liberation threshold, traditional nutrition education and food safety training are likely to be ineffective and wasteful. Following Grace's (2023) call for interventions with clear economic viability and equity, we propose a tiered strategy:

For households below ₦80,000: The priority must be cognitive liberation through economic resilience. Interventions should focus on unconditional cash transfers, livelihood support, and access to microcredit to help households cross the foundational income threshold. This is not a distraction from food safety but a prerequisite for it.

For households in the transition zone (₦80k-₦150k): This is the "sweet spot" for integrated interventions. Bundling behaviourally-designed food safety messaging (which leverages salient health risk narratives) with continued livelihood support can catalyse adoption. Certification schemes and trusted labels must be available and simple to understand, reducing the cognitive effort required to make a safe choice.

For more affluent households: Focus can shift to enhancing human capital and market systems. Strengthening education, supporting credible certification bodies, and developing premium market channels will leverage the dominant drivers of WTP in this group.

Limitations and Avenues for Future Research

This study has limitations that point to fruitful future research. First, the cross-sectional design establishes robust associations but not definitive causality. Longitudinal studies tracking households as their income changes could more conclusively demonstrate the causal impact of crossing cognitive thresholds. Second, the CBT measure, while validated, is a self-reported proxy. Future work could incorporate more direct psychological or even physiological measures of cognitive load. Third, this study focused on WTP as an intention. Research is needed to examine actual purchasing behaviour and investment in safety technologies when certified products are available in the market.

Conclusion

In conclusion, this research demonstrates that the barrier to food safety in Nigeria's fisheries is not primarily ignorance, but a poverty-induced cognitive deficit. The ₦80,000–₦100,000 income threshold emerges as a critical benchmark for cognitive agency, far above official poverty measures. The powerful role of Cognitive Bandwidth Tax and Health Risk Beliefs reveals that decision-making under scarcity is driven by a salient, visceral calculus of catastrophic risk, not a dispassionate weighing of costs and benefits. Therefore, the path to safer food requires a fundamental pivot: from merely filling knowledge gaps to first freeing the cognitive space necessary to use that knowledge. Our findings provide the empirical blueprint for this pivot, advocating for food safety strategies that are as economically empowering as they are educative, and as cognizant of the mind's limits as they are of microbial hazards.

Author Contributions

ESI was responsible for the conceptualization of the study, data collection and supervision, data curation, data analysis, report writing, and final corrections of the edited report

Ethics Statement

This study was reviewed and approved by the Research Ethics Committee of the Faculty of Agriculture, Adekunle Ajasin University, Akungba-Akoko (Ref: AAUA/AGRIC/REC/1508138, dated 3 December 2024). All procedures involving human participants were conducted in accordance with the ethical standards of the Committee and with the principles outlined in the Declaration of Helsinki.

Prior to participation, informed consent was obtained from all respondents after they were briefed on the objectives, procedures, potential risks, and benefits of the study. Participation was entirely voluntary, and participants were free to withdraw at any time without consequence. Confidentiality and anonymity were strictly maintained, and all personal identifiers were removed during data handling and analysis to ensure privacy. Data from this study will not be released to any third party without the explicit approval of the Research Ethics Committee, in order to safeguard the rights and privacy of participants.

Conflict of Interest

The author declares no conflict of interest

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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