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https://doi.org/10.5109/7340483

出版情報：九州大学大学院農学研究院紀要. 70 (1), pp.59-69, 2025. 九州大学大学院農学研究院
バージョン：
権利関係：

J. Fac. Agr., Kyushu Univ., **70** (1), 59–69 (2025)

Consumers Perception of Safety Toward Locally Produced Raw Milk in Paktia, Afghanistan

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(*Received October 25, 2024 and accepted November 6, 2024*)

Local milk production in Afghanistan faces significant challenges in meeting the growing consumer demand, leading to a heavy reliance on imported dairy products. Recent efforts have been initiated to improve local dairy production by establishing dairy cooperatives, collection centers, and dairy unions. These efforts aim to address the substantial gap between local milk supply and consumer demand, which has resulted in the emergence of local raw milk businesses across the country. Raw milk refers to the milk that has not been pasteurized and homogenized. The majority of dairy products in Afghanistan consist of raw, unpasteurized milk and traditional fermented items. These products are mainly distributed through small-scale and informal channels that do not employ cold chains. Afghanistan's dairy sector faces significant food safety challenges that pose health risks to consumers and compromise the integrity of dairy products. Studies on consumers' safety perceptions of milk in Afghanistan are limited, despite its importance in the diet and economy. The current studies have focused on the quality and objective understanding of dairy product safety issues, such as physicochemical properties and contamination levels while neglecting to explore consumer concerns regarding food safety. Therefore, this study is conducted to examine consumer perceptions of safety regarding locally sourced raw milk in Paktia, Afghanistan. Based on a sample of 230 consumers in the rural and urban areas, we employed ordered logistic regression modeling. The results show that socio–demographic factors significantly influence consumers' safety perceptions regarding local raw milk. The findings suggest that addressing concerns raised by consumers regarding food safety—particularly among older populations, larger households, and packaged milk users—could help build trust in local dairy products.

Key words: food safety perception, raw milk, rural and urban consumers, ordered logistic regression

INTRODUCTION

The livestock sector in Afghanistan is heavily reliant on smallholder farmers, playing a significant role in both the agricultural economy and food security. Notably, 47 percent of Afghanistan's territory is classified as rangelands (FAO, 2023). Within this sector, dairy farming is particularly of immense importance, with rural women actively involved in various management tasks (Hussain and Ahmadzai, 2022). Livestock serves not only as a source of income but also plays an important role in rural livelihoods, providing sustenance and economic stability for many families. The livestock sector consists of sedentary and nomadic production systems, with the majority of farmers practicing sedentary farming by raising sheep, goats, and cattle on small holdings across the country.

For the nomadic population, primarily consisting of Kuchis, who account for 5 percent of the total national population, livestock serves as their sole source of income (NSIA, 2020). Most dairy cattle in Afghanistan are Watani, Kunari, Kandahari, and Sistani, which are indigenous breeds with low levels of milk productivity. Meanwhile, urban population density is rising, increasing the demand for milk and dairy products (Naeimi and Almas, 2021).

Indeed, local milk production in Afghanistan faces substantial challenges in meeting rising consumer demand, hence leading to a heavy reliance on imported dairy products. Once self–sufficient in dairy, Afghanistan now depends largely on imports from neighboring countries to satisfy its growing market. Efforts by the government and aid organizations to improve dairy production have increased the number of small milk shops, facilitating access to fluid milk, and dairy products in urban areas. Afghanistan currently produces over 1.5 million tons of milk annually; it imports an estimated 70% of the dairy products (Ebner *et al*., 2023); with 90% of urban demand met by imported milk (MAIL, 2020). The quality characteristics of some imported milk brands do not meet the standards of regular milk and may cause health and nutritional problems (Noori *et al*., 2024).

Dairy production in developing countries is rapidly increasing, significantly impacting health, nutrition, and livelihoods. However, it also poses health risks due to potential biological, chemical, and allergenic hazards in dairy products. The World Health Organization estimates that dairy–borne diseases contributed to 20 disability–adjusted life years per 100,000 people in 2010, accounting for about 4% of the global foodborne disease burden, primarily affecting low– and middle–income countries (LMICs). In order to supply safe dairy prod-

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ucts, food packaging is utilized for storage, preservation, and protection. Pasteurization of raw milk, introduced in the late 19th century, enhances dairy products' safety through heat treatment. In the past two decades, the market for ultra–high temperature (UHT) milk has surged, leading to a decline in pasteurized milk sales due to its longer shelf life. Recent advancements in fluid milk processing have focused on improving separation, standardization, pasteurization, homogenization, and packaging, enhancing production capacity and hygiene. In the context of Afghanistan, the terminology related to local milk, raw milk, and unpacked milk reflects the different processes and practices involved in dairy production and consumption. In this study, the term "local milk" or "locally produced milk" specifically refers to milk produced in the Paktia Province, sourced from small–scale local farms and household animals within the province. Further, raw milk refers to milk that has not been pasteurized, a process that removes disease–causing germs by heating milk to a high enough temperature for a certain length of time. However, the comparison that consumers will draw is usually with processed milk that is not only pasteurized but also standardized, homogenized, and semi–skimmed (Christopher, 2019). Although raw milk is not processed in a technological sense, it is subject to biological processing. Also, Tania and Francisco (2019) state that raw milk is often considered a "complete food"—since it contains natural enzymes, fatty acids, vitamins, and minerals. In the study area, almost all milk is raw, which is sold in bulk to consumers; therefore, in this study, we frequently used "local milk" instead of "local raw milk". While local milk is valued for its freshness and connection to local agricultural practices, it poses significant health risks due to potential pathogens and contaminants, especially if hygiene standards are not maintained during milking and handling (Giffel M., and M. H. J. 2010). Furthermore, the lack of packaging technologies in the study areas increases the risk of foodborne illnesses among consumers. "Unpacked milk" refers to milk obtained directly from local farms and producers without being subjected to commercial packaging processes. This milk is sold openly unpacked to consumers, meaning it is sold in bulk containers, such as plastic bags and metal cans, often without refrigeration or labeling.

The dairy sector in Afghanistan faces significant food safety challenges that pose risks to public health and compromise the integrity of dairy products. Key concerns include microbial contamination, insufficient regulatory frameworks, and inadequate hygiene practices. A study by Ahmadi *et al.* (2021) indicates that 25.7% of dairy samples tested positive for Staphylococcus aureus, with notable antibiotic resistance. In addition, a significant concern for local raw milk consumers is antibiotic residues (Şeyda and Joshua, 2020). *Brucellosis*, an infectious disease caused by *Brucella* bacteria, has remained one of Afghanistan's major public health issues, primarily transmitted from animals to humans. A study by Zarif Akbarian, *et al.* (2015) found that approximately 15.7% of households had at least one *Brucella* seropositive person. In the study, 93.18% of patients mentioned consuming unpasteurized milk as the major source of infection. Besides the above concerns, mouth and foot disease (FMD) is a highly contagious viral infection that affects livestock and can lead to significant economic losses and potential health risks in Afghanistan. A study conducted in western Afghanistan showed that only 34.4% of raw milk samples met safety standards, with many having high bacterial concentration, coliform presence, and adulteration with water and starch (Ebner *et al.*, 2016). Mainly, these concerns can be attributed to poor sanitation at various stages of dairy production because many producers lack adequate training in food safety practices (Ebner *et al.*, 2016).

Milk contamination risks are of various types, including physical contamination (foreign components), chemical impurities (antibiotics, hormones, pesticides, detergents, or heavy metal residues), and microbiological agents (germs and somatic cells). Our study focuses on the safety of raw bovine milk for human consumption and examines consumer choices based on safety indicators. Given that a significant portion of the population relies on locally produced raw milk in Afghanistan, understanding consumer perceptions of safety is essential. Many consumers are unaware of the potential risks associated with unregulated dairy production, which can lead to health issues and decrease their trust in local dairy products. Indeed, cultural practices and economic factors play a significant role in shaping purchasing decisions, adding complexity to consumer attitudes toward milk safety. Similarly, economic factors such as affordability and convenience drive consumers to choose locally produced raw milk, despite potential safety issues (Kang'ethe *et al.*, 2015). Studies on consumers' perceptions of milk safety in Afghanistan are limited, despite its importance in the diet and economy. The current studies have focused on quality and objective understanding of dairy product safety issues such as physicochemical properties and contamination levels, while neglecting to explore consumer concerns about food safety. Therefore, this study aims to describe consumers' safety perceptions of local raw milk, and dentify the consumers' safety predictors in Paktia, Afghanistan.

LITERATURE REVIEW

Over the past two decades, numerous international and governmental programs have focused on increasing milk production in the country, identifying dairy production and processing as having significant potential for development and growth (Steele, P., *et al.* 2008). Much of this growth is evident in larger milk cooperatives and processing plants, but there has also been a notable increase in small milk shops, playing an important role in supplying dairy products to consumers (Ebnera Paul D. *et al.* 2016). These shops sell fluid milk and often produce value–added products on–site, such as yogurt, cheese, and other fermented dairy items (e.g., dough). Further, these small businesses also can be counted as a source of raw milk for consumers who commonly pro-

duce various fermented dairy products at their homes (Bonnier J. 2007).

Neill and Williams (2016) state that consumers have a greater tendency to buy food products labeled as eco–friendly or locally produced. According to the classification of food as "local" is primarily influenced by geographical proximity and remoteness (Eriksen, 2013); a product can be labeled as locally produced if its final purchase occurs within a 400–mile radius of its origin or state boundaries (Martinez *et al*., 2010). Besides geographical proximity, additional characteristics also contribute to its conceptualization, such as social and cultural aspects of a community (Feenstra, 1997). In this study, the term "local milk" specifically refers to milk produced in the Paktia Province, sourced from dairy farms and domestic dairy animals within the province. To ensure the validity of the study, the definition of local milk was clearly communicated to respondents during the field survey. Most of local milk is produced in rural areas, where most farmers reside. Previous studies have documented varying food safety perceptions among consumers (John Paul B., *et al*., 2018); with those in rural areas generally viewing local milk as safer than their urban counterparts. One study argues that food risks in rural areas are shaped by a desire to preserve a strong rural identity, which contrasts with scientific discussions surrounding food safety (Enticott, 2003). Therefore, this study examines rural and urban consumers through different models to mitigate bias and make valid conclusions.

Food safety is one of the major concerns in developing countries, such as Afghanistan, where food safety systems are often poor or underdeveloped (DCA 2018). The prevalence of foodborne illnesses and food poisoning have caused a large proportion of consumers to express concerns regarding food safety, particularly within the dairy industry (Naeimi & Almas, 2021; Khalid, S.M., 2016). Ahmadi *et al*. (2021) stating that 25.7% of dairy samples tested positive for *Staphylococcus aureus*, with notable antibiotic resistance, posing a potential health risk to consumers. *Staphylococcus aureus*, a type of bacteria commonly found in dairy products, can produce toxins that lead to foodborne illnesses (Gilmour & Harvey, 1990). *Brucellosis* which is caused by *Brucella* bacteria, has remained one of the major public health issues in Afghanistan. Annual reports from Afghanistan's Disease Early Warning System (DEWS) indicate a consistently high prevalence of *brucellosis*. For example, in 2011, 500 cases were reported in two districts of Bamyan province (Naeimi M., Almas M. 2021). Also, Farshid Abedi, *et al*. (2022) stated that about 15.7% of households had at least one *Brucella* seropositive person, 12.3% of households had a *seropositive* animal, and 24.5% of households had either *seropositive* animals or humans. Majority of the affected patients were female housewives and students at 40.9% and 18.18%, respectively. In the above study, 93.18% of patients mentioned consuming unpasteurized milk as the source of infection. Also, mouth and foot disease (FMD) is a viral infection that affects livestock resulting in economic losses and potential health risks. Afghanistan is the first country in Asia to report numerous cases of foot–and–mouth disease; infected raw milk is of poor quality and, if sold commercially, may pose health risks for consumers, and contribute to the spread of the virus.

Globally, various antibiotics are utilized in veterinary medicine to treat livestock diseases and promote growth, with substantial quantities potentially transferring to milk. This poses significant health risks to humans. A study by Şeyda *et al*. (2020) in Afghanistan, shows that out of 110 milk samples, 12 samples were positive for the presence of Tetracycline residues and 7 samples were positive for the presence of Beta lactams. Considering that milk is mostly consumed by the elderly and kids, it can be the main concern for public health.

Ebner *et al*. (2016) conducted a study that found a high bacterial concentration, coliform presence, and adulteration with water and starch. Water may have been added to increase volume at some point in the value chain, an alternative explanation is that some milk samples could be reconstituted powdered milk, or more likely, a mixture of raw and reconstituted powdered milk. The study found that over 25% of samples reacted to iodine, indicating the likely addition of starch to the milk, an unnatural component in milk. In addition, powdered milk is widely available and often less expensive than raw fluid milk, and its improper reconstitution can lead to higher water percentages and lower fat percentages in the resulting product.

In Afghanistan, two ministries supervise food safety, ensuring that standards are maintained from producers to consumers. The Ministry of Agriculture, Irrigation and Livestock (MAIL) has responsibility for the control of raw food products, and the Ministry of Public Health (MoPH) has responsibility for the control of processed food. In many cases, the food regulatory system and outdated control infrastructures fail to address foodborne diseases and meet international safety standards across the country (Khalid 2015). Also, some of the raw agricultural products are not controlled for pesticide residue and other diseases on the market (Rahman, 2011).

Consumers' self–reported evaluations of locally produced raw milk safety reflect a complex mix of beliefs, values, information, and knowledge. Factors influencing local milk purchasing behavior are significantly shaped by concerns about food safety, including health consciousness, product quality, and availability. A study by Li, S. *et al*. (2023) showed that consumers value sustainably produced milk and are willing to pay a premium for it; also found that consumers prefer domestic brands that use locally sourced raw milk. A study by Redding, and Bender (2021) indicates that consumer food decision–making is complex, and educating consumers about food safety can alleviate concerns and influence purchasing habits. Also, consumer characteristics of interest impact their milk choices including age, gender, income, education, number of children in the household, and concerns about environmental issues (Saiwei Li, 2022). Caiping *et al*. (2010) argue that consumers often

rely on extrinsic indicators to assess food safety. The study ranked five important factors in determining fluid milk safety: purchase venue, certification, brand, price, and appearance. Uzunöz and Akcay (2012) conducted a study on factors affecting the consumption of packed and unpacked milk in Turkey, which showed that smaller household sizes and higher income levels are associated with greater consumption of packed milk, while price–sensitive consumers are less likely to choose packed options. A study by 1f revealed that consumers in the United States favored milk quality; however, they had concerns about the treatment of dairy animals and chemicals (pesticides, antibiotics, hormones) in dairy products. Mehmet B (2014) used ordered probit to estimate the factors that may affect respondents' purchase decision of certified safe dairy products.

Noori *et al*. (2024) studied the physicochemical properties of various imported milk brands available in Afghan markets, finding that the protein levels in these brands were significantly lower than standard cow milk. Zarif *et al*. (2015) examined *brucellosis* and *Coxiella burnetii* infections in households and their animals in Afghanistan, revealing widespread *Brucella* among both animals and relevant households. Additionally, a quality and safety assessment of raw bovine milk in Herat Province indicated low quality, with milk samples from bazaars frequently containing irregularities such as added starch, low fat percentages, or high–water content.

According to McIntosh *et al*. (1994), knowledge impacts current practices, which, in turn, influences the willingness to change unsafe practices. Knowledge refers to the accumulation of information, comprehension, and abilities obtained through educational pursuits or practical encounters (Oxford Dictionary, 2023). Numerous studies explored the connections between knowledge, attitude, and behavior within the cognitive–affective–behavior theory in social psychology (Schwartz. 1975; Abdul *et al*., 2012; Lim *et al*., 2016). Contrary to some findings indicating a small positive effect or a significant negative relationship between food safety knowledge and behavior (Schwartz. 1975; Meer, and Misner, 2000); it is interesting to observe in the study of Baser *et al*. (2017) that food safety knowledge did not have a significant impact on food safety behavior.

MATERIALS AND METHODS

Study sites and data collection

This study presents an empirical analysis based on data collected from dairy consumers in Paktia province, located in southeast Afghanistan. For this study, three districts of Paktia province —Ahmad Aba, Said Karm, and Mirzaka— were selected from a total of thirteen districts. These areas were chosen because the majority of residents have access to both local and packaged milk, enabling them to differentiate between the two products from a safety perspective. The study area is predominantly rural, with traditional agriculture and livestock production being the primary sources of livelihood for the residents.

Prior to the field survey, one district and one urban commune served as pilot areas, where 25 respondents were interviewed to evaluate the quality and reliability of the data collection. Following this, a consumer survey was conducted using a stratified multistage sampling approach to ensure that the sample was representative of the target population. Trained students from Paktia University helped conduct the face–to–face survey using a structured questionnaire from April to May 2022, with 255 respondents interviewed. Initially, a brief verbal explanation was given to the respondents to clarify the purpose of the data collection and to provide an overview of the main concepts covered in the questionnaire, such as the definitions of "locally produced milk", "packed and unpacked milk", and "milk safety". To prevent data biasness, consumers responsible for food shopping were interviewed at different purchasing venues, including farms (where fresh milk can be directly sold to final consumers), retail shops, and supermarkets.

After compiling a detailed list of milk–purchasing locations, two data collection plans were developed for urban and rural areas. Only respondents who were identified as the primary decision–makers for household food shopping were included in the survey. For urban data collection, three communes were chosen from Gardez City, and then one supermarket, two retail shops, and one dairy farm were randomly selected from the compiled list within each commune. Ten respondents were interviewed at each purchasing venue. To collect data in rural areas, three districts were selected, and five dairy retail shops were randomly chosen from the list in each district. Lastly, the study randomly selected nine potential consumer respondents and interviewed them in each retail shop. Eventually, a total of 230 respondents were deemed eligible for analysis, comprising 93 urban participants and 137 rural participants. As households randomly selected from urban areas could potentially have different consumption preferences and perceptions of milk safety compared to those from rural areas (Paraffin, *et al*., 2017), therefore, the study split the sample into urban and rural groups to measure the divergence of estimates based on respondents' geographical profile.

Data analysis

For this study, we applied the ordered logistic model (OLM) to explore the probability and determinants of consumer perception of local milk safety in a meaningful order (ranging from 1 as "Unsafe", to 5 as "Safe"). Also, consumers' knowledge of milk safety information was assessed using the variable "Safety Knowledge." Participants were asked to rate their understanding of milk safety, including awareness of risks, and hazards, and familiarity with best practices for ensuring safety. A Likert scale was used to measure consumers' safety knowledge, ranging from 1 (Not knowledgeable at all) to 5 (Very knowledgeable). Table 1 reports on the study variables used in OLM. Descriptive statistics of the data were initially presented using frequency and percent ages.

Additionally, OLM, a regression model specifically designed for analyzing ordinal response variables, was

employed. This model relies on the cumulative probabilities associated with the response variable. Specifically, it assumes that the logistic of each cumulative probability follows a linear relationship with the covariates, with regression coefficients that remain constant across different response categories (Widati *et al*., 2019; Williams, 2016). Also, it prevents arbitrary assumptions regarding the scale, and it let the analysis of continuous, dichotomous, and ordinal variables (Winship and Mare, 1984). An ordered logit model for an ordinal response Yi with C categories is defined by a set of C–1 equations where the cumulative probabilities $g_{ci} = Pr\ (Yi \leq y_c \mid x_i)$ are related to a linear predictor $\beta' x_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ...$ through the logit function following Grilli and Rampichini (2014), as given below.

$$logit\,(g_{ci}) = log\left(\frac{g_{ci}}{1-g_{ci}}\right) = \alpha_c - \beta' x_i,\ c = 1,2,...,C-1 \quad (1)$$

The parameters α_c, called thresholds or cutpoints, are in increasing order ($\alpha_1 < \alpha_2 < \ldots < \alpha_{c-1}$). The vector of the slopes β is not indexed by the category index c, thus the effects of the covariates are constant across response categories. An ordinal dependent variable, denoted by Y, has c categories. The cumulative probability, denoted by $Pr\ (Y \leq i)$, is the probability that the response on Y falls in category j or below (i.e., in category 1, 2,…, i). It is the sum of the probabilities in category j and below.

$$Pr\,(Y \leq i) = Pr\,(Y=1) + Pr\,(Y=2) + \cdots + Pr\,(Y=i) \quad (2)$$

A dependent variable with c cumulative probabilities, denoted as a 'c category Y dependent variable', has c cumulative probabilities: $Pr\ (Y \leq 1)$, $Pr\ (Y \leq 2)$,..., $Pr\ (Y \leq i)$. The final cumulative probability is equal to 1. The order of the cumulative probabilities reflects the rank of the dependent variable scale, with each probability satisfying the inequality $Pr\,(Y \leq 1) \leq Pr\,(Y \leq 2) \leq ... \leq Pr\,(Y \leq i) = 1$. In ordered logistic regression, the probability of observing the ith response category is estimated as a linear function of the independent variable and a set of threshold points (also known as cut points). To account for the ordering of the categories, cumulative probabilities, cumulative odds, and cumulative logistics are used. For $k + 1$ ordered categories, these quantities are defined by equations (3) and (4).

$$odds\,(Y \leq i) = \frac{Pr\,(Y \leq i)}{1 - Pr\,(Y \leq i)} \quad (3)$$

$$logit\,(Y \leq i) = ln\left(\frac{Pr\,(Y \leq i)}{1 - Pr\,(Y \leq i)}\right),\ i = 1,\ldots,k \quad (4)$$

This feature is called the parallel regression assumption. Thereby, general equation of OLM is given as follows (Paraffin, *et al*., 2018).

$$\ln \frac{Pr}{Pr-1} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_t X_t + \varepsilon \quad (5)$$

Table 1. Description of the variables used in the ordered logistic model

Variable	Description	Measurement	
Dependent variable			
Perceived local milk safety	onsumers' self–reported evaluation of the safety of locally produced raw milk	1 = Unsafe, 2 = Somewhat unsafe, 3 = Neutral, 4 = Somewhat safe, 5 = Safe	
Independent variables			
Variable	Description	Measurement	Exp sign
Age	The age of respondent in years	Continuous data	–
Gender	The gender of respondent, either male or female	1 = Male, 0 = Female	+
Household size	The number of individuals living in a household	1 = Less than 5, 2 = 5–10, 3 = More than 10	–
Education	The highest level of formal education completed by a respondent	Continuous data	–
Marital status	The current marital status of a respondent, either married or not married	1 = Married, 2 = Unmarried	+
Income	The total monthly household income in US dollars	1 = Low (<200$), 2 = Middle (200$–400$), 3 = High (>400)	–
Occupation	The primary type of job or employment status of the respondent	1 = Farming; 0 = Other	+
Confidence in packed milk	The level of confidence of respondents in the safety of packed milk	1 = Very low confident, 2 = Low confident, 3 = Moderate, 4 = High confident, 5 = Very highly confident	–
Safety knowledge	Represents the respondents' level of information, comprehension, and abilities about milk safety obtained through educational pursuits or practical encounters	1= Not knowledgeable at all, 2 = Not knowledgeable, 3 = Moderate, 4 = Knowledgeable, 5 =Very knowledgeable	–
Consumption frequency	Indicates how often the respondent consumes milk within a given period	1= Daily, 2= Three times/ week, 3= Weekly, 4 = Monthly, 5= Other	+
Purchase venue	The primary outlet where respondent usually purchases milk	1 = Farm, 2 = Retail shop, 3 = Supermarket, 4 = Other	+/–

Where P is probability of farmers (considering a particular factor affecting consumer milk safety perception; $Pr/(1-Pr)$ are odds of a consumer (considering local milk safe; concerned about the milk safety); β_0 is intercept; $\beta_1 X_1 \ldots \beta_t X_t$ are regression coefficients of predictors; ε is random residual or the error term that is not explained by the model.

Empirical equation of the study model is as follows.

$$\text{Safety perception} = \beta_0 + \beta_1 age + \beta_2 gender + \beta_3 hhsize + \beta_4 edu + \beta_5 marry + \beta_6 income + \beta_7 occop + \beta_8 conf + \beta_9 info + \beta_{10} consum + \beta_{11} purch + \varepsilon \quad (6)$$

Where, β_0 is constant, β_1 to β_{11} are the unknown parameters to be estimated. Description of the variables in the equation 6 are presented in the Table 1. Furthermore, the vector of slopes β does not vary with the category index c, which implies that the effects of the covariates remain constant across response categories; this characteristic is commonly referred to as the parallel regression assumption (Fullerton *et al*., 2021).

RESULTS

Sample characteristics

Sociodemographic characteristics

The empirical analysis was carried out with STATA 15. The results presented in Table 2 show that the study sample consisted of 230 respondents, including 93 urban and 137 rural consumers. The table shows that the majority of respondents were male (79.57%). This gender disparity in the sample aligns with cultural norms in the country, where male household members typically handle food shopping at different purchasing venues.

Medium–sized households, with 5 to 10 persons, accounted for 50% of the total. In terms of education level, about one–third of the respondents had secondary education, while less than 10% had a university education. Secondary education was reported by 31.3% of the respondents. Out of the total, 83.91% of the respondents were married with an almost equal proportion between urban and rural areas. Lower-income respondents accounted for 40%, with a slightly higher proportion living in rural areas (41.61%) than urban areas (37.63%).

The majority (46.09%) of respondents documented consuming milk on a daily basis. Finally, supermarkets (49.46%) and farms (23.66%) were the primary purchasing venues for urban respondents. A study conducted by Maitiniyazi and Canavari (2021) indicated that consumers are more likely to purchase dairy products from supermarkets because of the safety regulations and possession of conservation facilities. However, in rural areas, where supermarkets are less accessible, 94.16% of rural respondents primarily relied on retail shops for their milk purchases.

Consumer perception of the safety of milk

Table 2 provides a summary of the descriptive statistics for the study variables. Despite widespread concerns, the majority of consumers have evaluated local milk as safe. Specifically, 34.35% of respondents identified themselves as neutral regarding the safety of local milk, while approximately 32.61% rated it as 'Somewhat Safe,' compared to 14.35% who perceived it as 'Somewhat Unsafe.' Additionally, the results suggest significant differences in safety perceptions between rural and urban consumers. A greater proportion of urban respondents expressed concerns regarding local milk safety compared to their rural counterparts. Further, 41.94% of urban respondents reported a neutral safety perception, whereas only 29.2% of rural respondents held a similar view. Indeed, understanding safety perception requires a foundation of knowledge concerning milk, including potential risks and best safety practices. The self–reported knowledge about milk safety was assessed showing that 30% of respondents rated their milk safety knowledge as "Moderate," with urban respondents more likely to classify themselves as "Knowledgeable" (36.56%) compared to rural respondents (25.55%). While both groups have shown some awareness of milk safety, urban respondents showed a more polarized distribution, with a higher percentage feeling knowledgeable yet also more reporting limited knowledge. The study further examined consumers' confidence in packed milk, considered as a key alternative to local milk in the study regions. The result shows that 47.83% of respondents reported slight confidence in packed milk, with a higher proportion of urban consumers (53.76%) expressing this level of confidence compared to rural consumers (43.8%). A relatively small percentage of respondents were very confident (16.09%) or extremely confident (3.04%), demonstrating a general lack of strong confidence in packed milk across both groups.

Determinants of food safety perception

Table 3 reports on the maximum likelihood estimates from the ordered logistic model. The results demonstrate that both models are statistically significant when compared to the null model, which includes no predictors. The Brant test of the parallel regression assumption, as described by Fullerton and Anderson (2021), involves comparing the model fit between the non–parallel model and the parallel model. The results reveal a failure to reject the null hypothesis, with p–values for the whole, rural, and urban models being 0.08, 0.09, and 0.10, respectively, all of which exceed the 0.05 threshold. The parallel regression assumption is upheld for the ordered logistic model, indicating a consistent relationship between the independent variables across all levels of perceived milk safety.

The result shows, younger consumers are more likely to hold favorable views towards raw milk. One explanation might be that younger consumers are more influenced by marketing and social trends, favoring perceived health benefits and taste, while older consumers prioritize food safety and risk awareness.

The impact of education on consumer perceptions of local raw milk was statistically significant. This may be attributed to increased awareness of the risks associated with less–regulated, lower-quality imported dairy products. It potentially results in a more favorable perception of local milk safety.

The finding also reveals that consumers' marital status had a significantly positive influence on their safety

Table 2. Descriptive statistics of the study variables

Variable	Whole (n= 230)	Rural (n= 137)	Urban (n= 93)	Variable	Whole (n= 230)	Rural (n= 137)	Urban (n= 93)
Perceived local milk safety (Dependent variables)				Education (Cont.)	8.117 (4.52)	8.118 (4.5)	8.11 (4.56)
Unsafe	9 (3.91)	4 (2.92)	5 (5.38)	Confidence in packed milk			
Somewhat unsafe	33 (14.35)	26 (18.98)	19 (20.43)	Not confident at all	49 (21.3)	25 (18.25)	24 (25.81)
Neutral	79 (34.35)	40 (29.2)	39 (41.94)	Slightly confident	110 (47.83)	60 (43.8)	50 (53.76)
Somewhat safe	75 (32.61)	50 (36.5)	25 (26.88)	Moderate	27 (11.74)	21 (15.33)	6 (6.45)
Safe	34 (14.78)	17 (12.41)	5 (5.38)	Very confident	37 (16.09)	27 (19.71)	10 (10.75)
Age (Cont.)	44.54 (15.8)	45 (16.10)	43.88 (15.65)	Extremely confident	7 (3.04)	4 (2.92)	3 (3.23)
Gender				Safety knowledge			
Female	47 (20.43)	26 (18.98)	21 (22.58)	Not knowledgeable	18 (7.83)	10 (7.3)	8 (8.6)
Male	183 (79.57)	111 (81.02)	72 (77.42)	Slightly knowledgea.	46 (20)	30 (21.9)	16 (17.2)
Household size				Moderate	69 (30)	45 (32.85)	24 (25.81)
< 5 persons	60 (26.09)	32 (23.36)	28 (30.11)	Knowledgeable	69 (30)	35 (25.55)	34 (36.56)
5–10 persons	115 (50)	70 (51.09)	45 (48.39)	High knowledgeable	28 (12.17)	17 (12.41)	11 (11.83)
>10 persons	55 (23.91)	35 (25.55)	20 (21.51)	Consumption Frequency			
Marital status				Daily	106 (46.09)	58 (42.34)	48 (51.61)
Married	193 (83.91)	114 (83.21)	79 (84.95)	Three times per week	84 (36.52)	50 (36.5)	34 (36.56)
Unmarried	37 (16.09)	23 (16.79)	14 (15.05)	Weekly	3 (1.3)	1 (0.73)	2 (2.15)
Occupation				Monthly	29 (12.61)	22 (16.06)	7 (7.53)
Farming	88 (38.26)	85 (62.04)	37 (39.78)	Other	8 (3.48)	6 (4.38)	2 (2.15)
Otherwise	142 (61.74)	52 (37.96)	56 (60.21)	Purchasing venue			
Income[1]				Farms	27 (11.74)	5 (3.65)	22 (23.66)
Low	92 (40)	57 (41.61)	35 (37.63)	Retailers	138 (60)	129 (94.16)	9 (9.68)
Middle	110 (47.83)	68 (49.64)	42 (45.16)	Supermarket	46 (20)	3 (2.19)	46 (49.46)
High	28 (12.17)	12 (8.76)	16 (17.2)	Other	19 (8.26)	10 (7.3)	16 (17.2)

Source: Own calculation from survey data.
Note: Number in the bracket indicates the percentage.
[1]Income (1 = low (<200$); 2 = middle (200$–400$); and 3 = high (>400). Income is calculated based on the exchange rate of $1 USD = 85.6 AFN (Afghani, Afghanistan's currency), accessed on May 20, 2022.

perception. However, the absence of significant effects of marital status among rural individuals could stem from strong community ties and social networks that potentially mitigate the influence of individual status.

The study result also shows that household income has a positive and significant impact on consumers' perception of local milk safety. Higher–income individuals typically have greater purchasing options, enabling access to locally sourced milk, which is often regarded as having superior organoleptic properties compared to processed and packaged milk in the study area. As consumers become more aware of foodborne illnesses associated with raw milk, they may develop a generalized fear of local unpacked milk. This study assumed that confidence in packed milk may be associated with a negative safety perception of local milk. The results indicate that confidence in packaged milk is inversely and significantly related to consumers' perceptions of local milk safety. Consumers confident in packaged milk are more likely to view it as a safer choice, which may diminish their perception of the safety of locally sourced unpacked milk.

Knowledge and awareness of the risks associated with raw milk can reduce raw milk-borne infections (Fagnani *et al*., 2021). We asked consumers to rate their knowledge of milk safety, including awareness of its risks, and hazards, as well as their familiarity with best practices for ensuring milk safety. In the result, it can be observed that safety knowledge had a significant positive effect on consumers' perceived local milk safety. Per capita milk consumption in Afghanistan was about 38.21 kg in 2019. Indeed, milk is largely consumed in the rural areas. The study found that milk consumption frequency had a significant positive impact on consumers' perceived local milk safety among the rural respondents. In rural areas, consumers who frequently consume local milk may have a better understanding and appreciation of its quality and safety, leading to a positive evaluation of local milk safety.

In terms of household size, the study found that household size had negatively significant influence on consumers' safety perception. It indicates that smaller households are associated with a higher perception of local milk safety. The study findings regarding purchasing venues differ between rural and urban consumers. In urban areas, purchasing milk directly from farms is negatively associated with perceived milk safety, while buying from retailers has a positive and significant impact on per-

ceived local milk safety. Urban consumers often view milk obtained directly from farms as less safe, it may be because of the concerns about hygiene and processing standards. Retailers often follow strict safety regulations and quality standards, which can result in positive evaluations of local milk safety among urban consumers. This contrasts with rural areas, where a significant relationship between perceived milk safety and purchasing venue was not found.

DISCUSSION

Recent studies in Afghanistan have identified significant concerns, including *Brucellosis*, *Coxiellosis*, foot and mouth disease (FMD), high bacterial concentrations, antibiotic residues, and adulteration with substances such as water and starch. These issues are compounded by poor sanitation practices throughout the dairy production process, which necessitate enhanced food safety training among producers and greater food safety awareness among consumers. Our study solely focuses on the safety of raw bovine milk for human consumption and examines consumer choices based on safety indicators. Published reports on milk safety in Afghanistan are limited. To our knowledge, this is the first published study on the safety perception of local milk available through bazars and milk shops in Afghanistan. The study results indicate that increase in age negatively influences consumers' perceptions of local milk safety. It is consistent with Piochi *et al.* (2022) who found a negative correlation between age and the perceived safety of milk. Also, Paraffin, *et al.*

Table 3. Estimates of ordered logistic regression analysis for determining factors influencing consumers' local milk safety perception in Paktia

Perceived local milk safety	Scale/ or measure	Whole (230)			Location					
					Rural (137)			Urban (93)		
		Coef.	SE	*P*	Coef.	SE	*P*	Coef.	SE	*P*
Age	Age in year	–0.04	0.01	0.000***	–0.05	0.01	.000***	–0.02	0.02	0.243
Gender	1 if male, 0 female	0.29	0.36	0.423	0.25	0.48	0.597	1.16	0.72	0.108
Education	Years of schooling	0.15	0.04	0.000***	0.16	0.05	0.001**	0.19	0.08	0.012*
Marital status	1 if married, 0 unm.	1.42	0.42	0.001**	1.78	0.56	0.002**	0.89	0.82	0.278
Occupation	1 if farmer, 0 other	0.29	0.29	0.323	0.24	0.38	0.531	–0.21	0.64	0.746
Income	1 if lower, 3 if higher	1.41	0.26	0.000***	1.15	0.33	0.001**	2.53	0.59	0.000***
Confidence in PM[1]	Ranging between 1–5	–0.95	0.17	0.000***	–0.93	0.21	0.000**	–1.01	0.32	0.002**
Safety know[2].	Ranging between 1–5	1.62	0.46	0.000***	1.80	0.61	0.003**	2.16	0.98	0.028*
Consu. Freq.[3]	Ranging between 1–5	1.40	0.49	0.004**	1.81	0.62	0.003**	1.03	1.13	0.362
Household size	5–10 persons	–0.31	0.35	0.377	0.17	0.46	0.704	–1.26	0.70	0.072
	>10 persons	–1.92	0.45	0.000***	–1.34	0.56	0.017*	–3.21	0.97	0.001**
	<5 person[4]									
Purchasing Venue	Farm	–1.01	0.64	0.117	–0.82	1.47	0.579	–2.00	0.93	0.031*
	Retailer	0.03	0.51	0.959	–0.41	1.17	0.727	2.56	1.14	0.025*
	Supermarket	1.26	0.58	0.030*	1.22	1.49	0.411	1.29	0.77	0.096
	Other[4]									
Safety Know.* Consum. freq.	Interaction term	–0.36	0.15	0.017*	–0.44	0.19	0.021*	–0.39	0.32	0.233
Threshold										
Unsafe | Somewhat unsafe		–0.36	1.86	0.847	–0.03	2.65	0.991	1.80	3.75	9.138
Somewhat unsafe | Moderate		2.54	1.84	0.168	3.91	2.67	0.144	2.90	3.70	10.143
Moderate | Somewhat safe		6.37	1.89	0.001	7.08	2.73	0.010	9.15	3.83	16.656
Somewhat safe | Safe		9.77	1.97	0.000	10.58	2.82	0.000	13.42	4.13	21.514
Model criteria										
Log likelihood		–171.97			–105.16			–45.33		
Chi–square		0.000			0.000			0.000		
Pseudo R^2		0.47			0.45			0.63		
Residual deviance		373.71			242.88			373.71		
AIC		411.71								
Brant test $p>chi^2$		0.08			0.09			0.10		

Note: [1] PM stand for packed milk; [2] Safety knowledge; [3] Consumption frequency; [4] Reference category. Statistical significance is indicated at ***1%, 5%**, and 10%* level.

(2018) stated that farmers aged 30 or above were more likely to believe that milk quality was affected by hygiene. The study by Specht *et al*. (2017) indicates that urban and rural consumers have significantly different perceptions of milk safety. Our results also reveal a significant differential between rural and urban age groups, with age not influencing safety perceptions in the urban model.

Education can be more related to consumers' food safety perception. The study shows that an increase in education is significantly shaping consumer perceptions of local milk safety. The result aligns with the findings that well–educated residents perceived greater risks to food safety (Han, Yan, & Fan, 2020; Han & Liu, 2018); as they have more knowledge regarding food–induced diseases and the scientific handling process of food (Lindell & Hwang, 2008). Household size negatively impacts consumers' perceived milk safety. Probably, smaller households have more control over milk storage and consumption. A study by Merlino *et al*. (2022) states that household size is more likely to influence consumer's milk safety concerns. Also, in the previous studies, it was observed that urban households with children were more concerned and willing to pay for milk safety (Maitiniyazi & Canavari, 2021). The result is contradictory to Muunda (2023), stating that as the size of a household increases, the likelihood of procuring milk from formal markets decreases.

Per capita milk consumption in Afghanistan was about 38.21 kg in 2019. In fact, milk is widely consumed in the country. A study by Poole (2018) in northern Afghanistan indicates that the prevalence of daily dairy consumption was 87%, with 8% consuming dairy products a few times a week, and slightly over 1% consuming dairy less than once a week. This study indicates that milk consumption frequency had a significant positive impact on perceived local milk safety among the rural respondents. Local milk is widely accessible in rural areas, hence consumers with more frequent milk consumption are more likely to perceive it as safe.

Raw milk–borne infections can be decreased by knowledge and awareness of their associated risks (Fagnani *et al*., 2021). This study reveals that safety knowledge has positively influenced consumers' views on local milk safety. The result is in line with Ferk (2015) affirming that sufficient knowledge about food safety can result in a higher perception of food safety.

The study revealed that milk-purchasing venues are of greater importance in urban than in rural areas. Significant issues are reported by consumers who frequently purchase directly from livestock farms. Former research has shown that consumers' milk safety concerns vary depending on the purchasing outlet. For instance, a study by Thapa, *et al*. (2020) found that food safety-conscious consumers are more likely to choose formal market outlets. Also, Kushwaha, *et al*. (2017) arguing other factors influence purchasing behavior in a particular outlet such as product price, layout, and ease of reaching the store.

Consumers' marital status had a significantly positive influence on their safety perception. Married individuals may exhibit a higher degree of caution possibly for their children, as indicated by Han, Yan, & Fan, (2020) that married people and families with children have negative perceptions of food safety and fear food risks more than unmarried individuals. Also, Al–Makhroumi, *et al*. (2022) reported that married women have higher food safety knowledge than unmarried women. However, marital status had no significant effects on the rural model, according to Lee *et al*. (2012) indicated that married and cohabiting respondents did not perceive more food safety risks than unmarried ones.

Household income is more likely to positively affect the perception of local milk safety. The result aligns with (Han & Liu, 2018; Smith & Leiserowitz, 2012) who found that income is negatively correlated with risk perception; as wealthier individuals are generally more concerned about quality–of–life issues, including food safety (Liu & Ma, 2016). Confidence in packed milk is negatively associated with the safety perception of local milk. Consumers who trust packaged milk are more likely to view it as a safer and more reliable option, it may decrease their perception of locally sourced milk.

CONCLUSION

Given that a significant portion of the population relies on locally produced raw milk in Afghanistan, understanding consumer perceptions of safety is essential. Indeed, many consumers are unaware of the potential risks associated with unregulated dairy production, which can lead to health issues and decrease their trust in local dairy products. This study was carried out to evaluate consumers' safety perceptions of local raw milk in Paktia, Afghanistan.

The findings reveal that age, education level, marital status, household size, income, confidence in packed milk, purchasing venue, and frequency of milk consumption significantly shape consumers' safety perceptions regarding local raw milk. Notably, older consumers exhibited a lower perception of safety, while higher education levels were associated with a more favorable view of local raw milk. It is implying that despite some awareness and perceiving local milk as safe, vulnerable groups remain apprehensive about the safety of consuming local raw milk. In addition, the negative influence of household size on safety perception suggests that local milk can be acceptable among smaller households; however, larger households with children and aging individuals are more likely to be concerned about the safety of local milk. Purchasing milk directly from farms was negatively associated with perceived milk safety in urban areas. Also, consumer confidence in packed and pasteurized milk is inversely related to their safety perception of local raw milk. It implies that addressing concerns regarding raw milk can improve local milk acceptance among packed milk consumers.

Despite widespread concerns, local milk is perceived as safe by a proportion of the respondents, more specifically among rural consumers. It can be attributed to cul-

tural practices playing a significant role in shaping their purchasing decisions, adding more complexity to consumer attitudes toward milk safety. Similarly, economic factors such as affordability and convenience drive consumers to choose locally produced raw milk, despite potential safety issues.

Efforts to improve producers' education and training regarding milk safety can enhance locally sourced product safety and could improve public perceptions and increase demand for local milk. Additionally, addressing concerns raised by consumers regarding food safety—particularly among older populations and larger households—could help build trust in local dairy products.

AUTHOR CONTRIBUTION

Najeebullah Ahmadzai designed the questionnaire, collected the data, and analyzed it. All three authors contributed to data organization and model selection. Seiffedine Ben Taieb provided primary guidance on handling the estimation model. Masahiro Moritaka supervised the entire study and contributed to revising the manuscript.

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