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HOUSEHOLD CHICKEN CONSUMPTION AND SELF-REPORTED UNSAFE FOOD HANDLING PRACTICES: A CROSS-SECTIONAL SURVEY IN URBAN KHARTOUM STATE, SUDAN

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ABSTRACT

Poultry meat represents a major and affordable source of animal protein for urban households in Sudan, particularly within Khartoum State. Despite its nutritional and economic importance, limited information exists on household-level poultry handling and preparation practices that may influence food safety and the risk of foodborne illness. This study assessed chicken consumption patterns and self-reported food handling practices among sampled households in Urban Khartoum State, Sudan.

A cross-sectional survey was conducted among 536 households in Khartoum State using a structured questionnaire. Data collected included chicken consumption frequency, storage conditions, thawing and preparation practices, and hygiene behaviors. Descriptive analyses were performed to characterize consumption levels and handling practices. Findings are descriptive and inferential only in the context of reported behaviors, and generalizability to all urban households cannot be assumed.

Households reported consuming an average of 5.3 whole chickens per month, with an estimated per capita serving size of 0.22 kg, highlighting the central role of poultry in household diets. Frozen chicken was the predominant form consumed, reported by 88% of households. Mean self-reported storage temperatures were -6.0°C for freezers and 5.4°C for refrigerators; however, nearly half of respondents (48%) were unable to report appliance temperatures, suggesting limited awareness of safe storage conditions. Thawing practices revealed potential food safety risks, as approximately 71% of households thawed frozen chicken at room temperature, with a mean thawing duration of 3.5 hours. An additional critical exposure period was identified during preserving, where cooked chicken was left at room temperature for an average of 47 ± 13 minutes prior to consumption. Hygiene practices were also suboptimal, with about one-third of households reporting the use of the same utensils for raw chicken and ready-to-eat foods, increasing the risk of cross-contamination. The mean reported cooking time was 37 minutes, though cooking temperature and doneness were not assessed.

The findings demonstrate important gaps in poultry storage, thawing, and hygiene practices among urban households in Khartoum State. While microbiological outcomes were not measured, the reported behaviors aligned with practices previously associated with increased food safety risk. The results provide context-specific evidence to inform consumer education and risk-based food safety interventions aimed at improving household poultry handling practices in urban Sudan.

Key words: chicken, food handling, cross-contamination, food safety, Khartoum State, Sudan

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INTRODUCTION

Poultry meat is a cheap and available source of animal protein for many African countries, including Sudan. In the past twenty years, production of broilers in Sudan has increased substantially due to increased demand and expanding commercial poultry production networks [1]. Despite this growth, per capita poultry consumption has been fairly low relative to worldwide figures [2]. Poultry is nevertheless used as a significant part of household diets, particularly in urban areas, which have better access to local markets. Urban families in Sudan usually contain five to six members, and children are represented with high frequency in household populations [3, 4].

Household food handling practices hold significant importance from a public health perspective as the possible risk of foodborne illness is higher among younger children and older adults [5]. Poultry meat has been linked to foodborne pathogens, including *Salmonella* spp., *Listeria monocytogenes*, and *Campylobacter jejuni* that may be present at multiple stages of the production and distribution chain [6, 7].

Since contamination can happen during processing or during retail preparation, household practices connected to the storage, thawing, preparation, and cooking of goods are key determinants of exposure risk [8, 9]. Inadequate refrigeration, ambient-temperature thawing, cross-contamination of raw and ready-to-eat foods, and poor hygiene controls have been recognized as common risk factors included in domestic food safety studies internationally [10, 11, 12]. There is little research on poultry in Sudan, which has mostly consisted of production systems, food security, and consumption patterns, not household-level handling behavior [13]. Domestic practices data are necessary to better assess risk and develop consumer food safety education context-specific to the needs of the region. Thus, it was the objective of this study to describe chicken consumption and self-reported household food handling practices in urban households in Khartoum State/Sudan.

MATERIALS AND METHODS

Study Area

The study was conducted in the urban localities of Khartoum State, including Khartoum, Omdurman, and Khartoum North, between 2022 and 2023. Khartoum State constitutes a metropolitan area comprising three interconnected cities: Khartoum proper, Khartoum North, and Omdurman, linked by a network of bridges and serving as the central economic and administrative hub of Sudan.

Study Design and Sampling

A descriptive cross-sectional survey approach was utilized for this study. The minimum required sample size was determined to be 385 households using Epi Info version 7, a series of freely distributable tools for use by public health professionals for public health surveillance and other tasks.



The parameters used were the population of Khartoum State in 2021, which is 5,989,024 persons according to <http://worldpopulationreview.com>. The margin for error is set to 5% and the confidence level is set at 95%. Ultimately, 536 households participated.

Convenience sampling was employed due to logistical constraints and access limitations. As a result, households without internet access, smartphones, or sufficient literacy may be underrepresented. The findings, therefore, reflect the practices of the sampled households and may not be fully generalizable to all urban households in Khartoum State.

Data Collection

Data were collected from public “households” through a questionnaire using two means: in-person interviews and Google Forms with the free Google account (for personal use) through Google document questionnaire software®. The link was created in the Google Documents questionnaire <https://forms.gle/z76WTykyJp3QcKLT7> and shared with the public through WhatsApp (a mobile phone application). Items in this questionnaire included household demographics, frequency of chicken consumption, storage methods, thawing techniques, food preparation habits, and cooking practices.

Temperature Reporting

Participants self-reported refrigerator and freezer temperatures (as seen on appliances or their knowledge). No standardized thermometer was provided by the research team.

Data Analysis

Data was entered into statistical package for social science (SPSS) version 21 for analysis. Descriptive statistics, including means, standard errors, frequencies, percentages, and 95% confidence intervals, were calculated. The study was designed as a descriptive assessment of reported household practices; therefore, no inferential or subgroup analyses were conducted. Findings are presented to characterize patterns rather than to establish associations or causal relationships.

RESULTS AND DISCUSSION

Household Characteristics and Chicken Consumption

The mean household size was 5.4 ± 0.07 people, with children aged ≤ 12 years and adults aged ≥ 65 years representing 23% and 10% of household members, respectively (Table 1). This demographic structure is consistent with national urban estimates [3, 4]. Households reported consuming an average of 5.3 ± 0.2 chickens per month, with a mean per capita serving size of 0.22 ± 0.008 kg (Table 1). These values are comparable to national consumption estimates and reflect the role of poultry as a regularly consumed protein source rather than a staple food [1,2].



Frozen chicken was the predominant form consumed (88%), indicating the significance of domestic cold storage and thawing. Household refrigeration and freezer performance and appropriate thawing methods help to keep microbiological safety and product quality under control through a pattern of increased reliance upon these factors. Lack of temperature control in frozen storage and improper thawing conditions which have been shown to permit pathogen survival and, in some cases, growth, have been found to heighten potential exposure risks during household food preparation [9, 11, 14].

Storage Conditions

Household storage temperatures are summarized in Table 2. The associated risk perspectives are indicative and based on international guidelines, not direct measurement of microbial contamination. Results were above the recommended temperatures for safe storage for raw poultry, based on the regulations stated in international food hygiene guidelines, which typically recommend refrigeration at or below 4°C and frozen storage at -18°C or below [14]. Chilling at temperatures above these values may weaken the effectiveness of cold preservation in limiting microbial survival and proliferation through prolonged storage time. Half of respondents failing to report appliance temperatures also reveals poor monitoring of cold storage conditions domestically. Such low-level awareness may reflect the absence of temperature displays, irregular power supply, or limited consumer knowledge regarding recommended storage practices. Similar challenges in maintaining and monitoring household cold chains have also been observed in studies from France and Canada, where refrigerators often operated beyond the recommended range and end users hardly knew about the actual storage temperatures [15, 16]. Collectively, these results suggest that temperature control at suboptimal temperatures, coupled with low temperature awareness, are significant areas of vulnerability in the domestic food safety chain.

While this study did not include microbiological testing, these reported storage scenarios may be associated with increased risk of microbial growth according to international guidelines [14, 15, 16]. The findings should be interpreted as indicative, not definitive, evidence of food safety risk.

Thawing Practices

Thawing practices (Table 3) reveal behaviors that may be associated with potential microbial growth. Risk annotations are interpretive and not empirically confirmed. The Results on thawing practices indicated that 95.7% of respondents thawed chicken before cooking, with an average thawing time of 3.5 ± 0.2 hours. Among these, 71% left the chicken at room temperature until preparation, 6.7% thawed chicken overnight at room temperature, 3.6% used a microwave, and 18.9% moved chicken from the freezer to the fridge before leaving it at room temperature. A



minority (5.8%) chose "I don't know" or other methods (Table 3). The trends are consistent with international reports of household poultry handling — ambient thawing is commonly used either for convenience, lack of time, or freezer space constraints [10, 17]. From a microbiological perspective, thawing at room temperature provides a suitable environment that may allow growth of pathogenic species like *Salmonella* spp. and *Listeria monocytogenes*, which have been shown to proliferate rapidly in a 5°C to 60°C temperature range [18, 19].

While this study did not include laboratory microbiological assessments, these findings are consistent with previously reported risks from bacterial multiplication as domestic thaws are performed. The prolonged thawing at room temperature and reuse of communal utensils (reported in 33% of households) may add even more weight to the possibility of cross-contamination, an aspect which is a major cause of household foodborne outbreaks. Taken together, these findings suggest that current household thawing practices in Khartoum State may allow conditions conducive to bacterial growth according to general food safety guidance. Which has implications for tailored consumer education as well as for the use of safer thawing methods, and the recommendation for refrigeration or cold-water thawing according to international food safety regulations [14, 18].

Cross-Contamination and Cooking Practices

One-third of households (33%) said they used the same utensils for raw chicken and ready-to-eat foods. This practice is widely recognized as a potential pathway for cross-contamination in domestic settings. While this study did not include microbial transfer directly, this behavior may be associated with increased likelihood of pathogen spreading including *Salmonella* spp. and *Campylobacter* spp. [11, 12, 20]. The high reported data seen in this study points to a possible low compliance with hygienic separation in food preparation which aligns with household food safety survey findings from sub-Saharan African countries where sharing of utensils and surface contamination are frequently reported risk factors [21, 22].

Reported cooking durations (Table 4) in cooking chicken reveal that there is considerable variability in household cooking practices, because internal temperatures were not measured, these durations serve only as an indicative measure of potential microbial inactivation. Cooking time alone is an imperfect proxy for safety, as it depends on portion size, method and heat distribution. Nearly half of the sampled households (46.0%) reported cooking chicken for approximately 30 minutes, while 11.3% reported cooking for 15–25 minutes. These durations may be insufficient to reliably achieve the minimum internal temperature of 74 °C required for effective inactivation of common poultry-associated pathogens such as *Salmonella* spp. and *Campylobacter* spp., particularly when cooking whole birds or larger portions [14, 24, 26].



The mean reported cooking duration for chicken was 37 ± 1.08 minutes. Even though prolonged cooking might lessen microbial load, time itself is an imperfect measure of safety. The inactivation of pathogens can be achieved by means of the provision of proper internal temperatures within and across the meat. This lack of reporting internal temperature measurements is an example of a household practice prevailing in African contexts, where doneness is usually not determined through thermometry but through visual evidence or estimated time [19, 23].

The coincidence of both high-risk handling practices and dependence on cooking duration as a safety measure indicates both the same possible compounded risk of foodborne illness. Even when cooking seems good enough, cross-contamination either before or after heat treatment might counter its protective power. These results emphasize the need for targeted consumer education that emphasizes utensil and surface hygiene, the effective separation of raw and ready foods, and an increasing understanding of optimal cooking practices. Household-specific interventions are essential for reducing the burden of poultry-associated foodborne diseases.

Serving

Households, on average, left chicken at room temperature for 47 ± 13 minutes before serving. Prolonged ambient exposure may increase potential for microbial proliferation, particularly if initial handling or cooking were inadequate. Furthermore, the wait and ambient-temperature thawing methods increase the potential for pathogen growth, especially by *Salmonella spp.* and *Listeria monocytogenes*, highlighting the role of targeted education to diminish the duration at which microorganisms reproduce [18, 19].

Structural and contextual factors

Structural and contextual factors are very important in household poultry handling practices in urban Khartoum State. Disruptive electricity supply, malfunctioning freezer, inadequate access to thermometers, and poor water supply for cleaning surfaces and utensils might create barriers to following recommended techniques to meet food safety standards. Such structural obstacles are the likely causes of human actions like ambient thawing, irregular refrigeration and reuse of utensils. Hence, unsafe methods could not be explained purely by consumer ignorance, but were a product of complicated sociocultural, economic and infrastructural factors in Sudan [3, 4, 25, 27]. Therefore, any consumer education should be complemented by low-cost, context-sensitive interventions, such as visual indicators of doneness and community-based messaging through radio or local workshops [3, 25, 28, 29].

Overall Implications

This study illustrates household practices, including inconsistent temperature control, extensive ambient thawing for long periods of time, and reported cross-contamination behaviors. Such behaviors have so far not been definitively linked,



causally or otherwise, to foodborne illness by this study, but the data from food safety experts do align with those seen in studies that relate to poultry-associated food safety [8–12]. More importantly, this study contributes to empirical evidence from an urban Sudanese setting where available data on domestic food handling practices has not been extensive.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

This study demonstrates that households in urban Khartoum State frequently consume chicken, predominantly frozen, yet often practice suboptimal storage, thawing and hygiene measures. Key risks identified include reliance on ambient thawing, inconsistent refrigeration/freezer temperatures, and cross-contamination through shared utensils. Cooking time alone is commonly used as a safety measure, but without internal temperature verification, microbial inactivation may be incomplete. These practices collectively may allow potential exposure to foodborne pathogens such as *Salmonella spp.* and *Listeria monocytogenes*. To mitigate these risks, targeted consumer education programs are recommended.

While this study provides foundational data on chicken consumption and handling practices, future studies might include knowledge, attitudes, and practices components to complement this study findings and support the design of targeted educational interventions. Furthermore, assess the influence of socioeconomic status or education level. These variables are highly relevant and warrant investigation. Furthermore, future studies should also incorporate microbiological testing of domestic poultry to quantify contamination levels and validate risk models.

This study aims to open the door for such research, which can help tailor targeted food safety interventions for different demographic groups.

LIMITATIONS

This study has several limitations. First, the convenience sampling strategy (in-person and online) may have introduced selection bias, excluding households without internet access, smartphones, or literacy, and limiting generalizability to all urban households in Khartoum State. Second, all data on poultry handling, storage, thawing, and cooking practices were self-reported, which may be affected by recall bias, guessing, or social desirability bias. Notably, nearly 50% of participants could not report refrigerator or freezer temperatures, restricting the reliability of risk interpretations. Finally, the study is purely descriptive, without analytical statistics to examine associations by household size, presence of children, education level, income, or appliance ownership.



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Authors' contributions

David Iskander: Responsible for conceptualization, data curation, formal analysis, investigation, methodology, writing – original draft. Mehdi Triki and Adil M.A. Salman: for literature discussion, review and editing, formal analysis, investigation, methodology. Mohamedelfatiah Ismael: project administration, resources and supervision.

Declaration

Ethical approval: this research was approved by the Ethics Review Committee (ERC) of the University of Bahri (Approval No: UBV7) on 2021-02-12 in accordance with the (Declaration of Helsinki/ General Data Protection Regulation (GDPR)).
Clinical trial number: not applicable.

Consent to participate: informed consent was obtained, and the authors attest that the participants were aware of the study's purpose, risks, and benefits.

Consent to publish: participants consented to the anonymous use of their responses for analysis and publication in accordance with the approved protocol. No personally identifiable information is included in the manuscript.

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Data availability statement: the data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.



Table 1: Household demographic characteristics and chicken consumption patterns in sampled households in Urban Khartoum State, Sudan

| Variable | Average (AVG) | SE | Response (%) | 95% CI |
|--|---------------|----------|--------------|------------|
| Number of family members | 5.4 | 0.07 | 100% | [4.9, 5.6] |
| Number of family members \leq 12 years old | 1.26 | 0.06 | 100% | [1.1, 1.4] |
| Number of family members \geq 65 years old | 0.55 | 0.03 | 100% | [0.4, 0.6] |
| Number of chickens consumed per meal | 1.2 | 0.02 | 100% | [1.1, 1.2] |
| Estimated amount of chicken consumed by individual per meal (kg) | 0.22 kg | 0.008 kg | 100% | - |
| Number of chickens consumed per month | 5.3 | 0.2 | 100% | [4.9, 5.7] |

Table 2: Distribution of self-reported household refrigerator and freezer temperatures (%) in sampled households in Urban Khartoum State, Sudan, and associated food safety Indicative Risk Perspective

| Temperature (°C) | Refrigerator (%) | Freezer (%) | Indicative Risk Perspective* |
|------------------|------------------|-------------|---|
| Do not know | 47 | 48 | High – Lack of temperature awareness might prevent effective control of microbial growth and increases risk of unsafe storage conditions [14, 18]. |
| 9 | 10 | — | Very High – Temperature well above recommended refrigeration limits; may allow of <i>Salmonella spp.</i> and <i>Listeria monocytogenes</i> [14, 19]. |
| 6 | 16 | — | High – Above safe refrigeration threshold (≤ 4 °C); might supports survival and slow growth of pathogens [14, 18]. |
| 4 | 27 | — | Low – At upper limit of recommended refrigeration; generally acceptable but offers minimal safety margin [14, 24]. |
| -2 | — | 15 | High – Inadequate freezing; temperature is likely insufficient to stop microbial survival and enzymatic activity [18, 26]. |
| -4 | — | 16 | High – Suboptimal frozen storage; pathogens may survive for extended periods [18]. |
| -8 | — | 10 | Moderate – Slows microbial activity but does not meet recommended frozen storage standard (≤ -18 °C) [18, 26]. |
| -10 | — | 3 | Moderate to Low – Improved inhibition of microbial activity but still above optimal freezing temperature [18]. |
| -14 | — | 8 | Low – Approaches safe frozen storage but remains above international recommendations [18, 26]. |

*Note: Risk perspective is interpretive and based on international food safety guidelines. It is not measured microbiologically

Table 3: Thawing practices and duration of chicken meat in sampled households in Urban Khartoum State, Sudan and associated food safety Indicative Risk Perspective

| Thawing Practice | Percentage (%) | Mean Thawing Duration (hours ± SE) | Indicative Risk Perspective* |
|---|----------------|------------------------------------|--|
| Outside freezer at room temperature | 71.7 | 3.5 ± 0.2 | Prolonged exposure to temperatures between 5 °C and 60 °C may create favorable conditions and could allow rapid growth of Salmonella spp. and Listeria monocytogenes [18, 19]. |
| Transfer from freezer to fridge before putting it at room temperature | 18.9 | 12.2 ± 0.5 | Initial refrigeration might delay microbial growth; however, subsequent room-temperature may allow pathogen proliferation [16]. |
| Microwave | 3.6 | ≥0.5 ± 0.1 | Rapid thawing may reduce time in the danger zone, but uneven heating may allow survival of pathogens if not followed by immediate cooking. |
| Other / "I don't know" | 5.8 | 6.8 ± 0.6 | Undefined thawing methods potentially prevent assessment of temperature control and microbiological risk. |

*Note: Risk perspective is interpretive, based on general food safety recommendations and international food safety guidelines



Table 4: Cooking Duration of chicken in sampled households in Urban Khartoum State, Sudan, and associated food safety Indicative Risk Perspective

| Cooking Duration (minutes) | Number of Respondents | Percentage (%) | Indicative Risk Perspective* |
|----------------------------|-----------------------|----------------|--|
| 15–25 | 25 | 11.3 | Likely High –insufficient to achieve internal temperatures necessary to kill pathogens [14]. |
| 30 | 102 | 46.0 | Likely Moderate – likely Adequate for small pieces but may be marginal for whole poultry [14, 24]. |
| 35–40 | 31 | 14.0 | Likely Low –achieves $\geq 74^{\circ}\text{C}$ internal temperature; most pathogens eliminated [14, 24]. |
| 45–50 | 35 | 15.2 | Likely Very Low –Extended cooking might ensure pathogen inactivation [24, 26]. |
| 60 | 29 | 12.1 | Likely Very Low –Overcooking; may allow minimal microbial risk [14, 24]. |
| 70 | 3 | 1.4 | Very Low – Overcooked; likely negligible risk [14, 24]. |
| Total | 225 | 58 | – |

*Note: Risk perspective is interpretive based on general food safety recommendations and international food safety guidelines. Actual microbial safety depends on cooking method, bird size, and internal temperature, which were not measured

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