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Assessing Parasitic Contamination Risks in Foods Prepared in Cafeterias at Omar Al-Mukhtar University

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Abstract—Foodborne parasitic infections are one of the most significant problems of the population of the developing world since improper hygiene and low environmental standards still contribute to the spread of diseases. University cafeterias are highly susceptible to institutional food outlets especially because of high turnover of meals and lack of hygiene supervision. The objectives of this research were to evaluate the threats of parasitic contamination of foods prepared in the five university cafeterias (Omar Al-Mukhtar University, Al-Bayda, Libya). Two hundred food samples of five major food categories: meat-based sandwiches, vegetable-filled sandwiches and snacks, sandwiches and snacks, dairy-based products, and fruit juices were collected during a period of six months (March to August, 2025). The presence of intestinal parasites was detected using the standard methods of parasitological examination, and environmental and hygiene parameters were measured using the direct observations and the structured checklists. The overall rate of parasitic contamination was found to be between 11% and 24%, where the upper limit of 24% being the most comprehensive diagnostic condition. The most common species detected were *Entamoeba histolytica* and *Giardia lamblia*. The contamination rate was highest in the vegetable-filled sandwiches and snacks (33.3%), then fruit juices (30.0%), and sandwiches (22.5%). Statistical analysis demonstrated that there was strong correlation between hygiene level and contamination ($r = -0.68$, $p = 0.009$), and poor hygienic cafeterias were having a high level of risk.

Keywords: Foodborne parasites; cafeteria hygiene; spatial mapping; food safety

1. Introduction

Foodborne parasitic infections are still a significant social health challenge in the world especially in the developing nations where food hygiene and the environment are not the best. Polluted water and food are known as the primary sources of intestinal parasites, and most of them can survive under different environmental conditions and infect humans by combining ill-compiled or cooked meals [1, 2]. Foodborne diseases continue to have a high burden in the world, with low-and-middle-income countries particularly being vulnerable to control because of weak regulatory frameworks and surveillance systems [3].

In the African and Middle Eastern settings, the institutional capacity of the community and the lack of unified hygiene habits also influence the spread of foodborne parasites [4]. The university cafeterias and student canteens are especially susceptible due to the presence of strong demand of food, lack of control, and volatile populations of food handlers [5]. These conditions encourage the survival of the pathogen, including Salmonella, Shigella, and intestinal protozoa that may tolerate in contaminated water, utensils, and raw food [6, 7].

It has also been confirmed by multiple systematic reviews and meta-analyses that the occurrence of intestinal parasitic infections among food handlers in Ethiopia is still prevalent to the extent of the pooled prevalence rates topping 25 percent, which is a result of poor hand hygiene, improper waste management, and lack of access to clean water [1,2]. The same was also reported in university facilities like Bahir Dar and Adigrat universities where both bacterial and parasitic contamination were found in the food samples of their cafeterias [4,5]. In addition, the level of education and the frequency of medical screening of food handlers was strongly related to the risk of infection, which also demonstrates the importance of behavioral and organizational factors in the spread of the disease [6].

Similar trends are observed in parallel studies being conducted in other African countries. As an example, Hajare found that intestinal parasites were common in food handlers working in catering facilities in the city of Bule Hora, Ethiopia, because of the lack of sanitary facilities [7], and that Dramani found that student canteen operators in Ghana had poor food safety knowledge and practices [8]. Adebayo also discovered that in Nigeria, there is a significant correlation between the environmental hygiene indicators and microbial contamination in school food service establishments, which implies the school-based feeding systems could serve as reservoirs of pathogenic organisms [9].

In the study reported by Mutua, informal food distribution networks and the absence of food-safety regulations in East Africa were found to increase the burden of foodborne diseases, which is underreported because of parasitic infections [10]. The spatial heterogeneity of intestinal parasites infection was also exhibited by Izere and Neel using mapping techniques and revealed that environmental and socioeconomic variables combined to affect the disease. Such spatial analyses emphasize the importance of location-focused mapping and surveillance plans that can analytically visualize the places of high risks and provide preventive medical measures [11].

Despite the increasingly accumulating body of evidence on epidemiology of intestinal parasites on institutional and community levels, little is known about Libya where there is still deficiency in the foodborne disease statistics. In environmental reports like those of Hamza [12], it is highlighted that the anthropogenic and hydrographic changes in the Libyan ecosystems have impacted the quality of the habitat and sanitary conditions, which can affect the process of preserving the pathogen in food and water sources. Though these are the issues of environmental concerns, none has so far been fully examined on the occurrence and spread of parasitic contamination in university cafeterias within the country [12].

Therefore, it is important to know the prevalence spatial distribution, and the risk factors of parasitic contamination in food outlets of learning institutions. This information may be used to come up with specific interventions in the area of public health, enhance the institutional hygiene

policies, and protect the health of students at the university. In this respect, the current work examines the prevalence and spatial distribution of parasitic food contamination in cafeteria food and beverages in Omar Al-Mukhtar University, Al-Bayda, Libya. It seeks to address a knowledge gap that exists and offer evidence-based research on the food safety management at the academic level.

2. Materials and Methods

2.1. Sampling design

Between March and August 2025, 200 food samples were gathered from different cafeterias at Omar Al-Mukhtar University in Al-Bayda, Libya. Four faculty-based cafeterias and the main campus were included in the sampling framework to reflect the variety of food options accessible to staff and students. To guarantee proportionate representation of the most frequently consumed food categories, selection was done in a methodical manner.

The five university cafeterias' sampling locations were selected throughout the main campus of Omar Al-Mukhtar University, to give a clear visual representation of the study's geographic coverage. The distribution and relative sampling density of the food samples that were gathered are highlighted in Table 1. Due to their larger student populations and higher daily food turnover than other locations, the main canteen and dormitory cafeteria had the highest sampling densities, as seen in Table 1.

Table 1. The location of university cafeterias that were part of the study and the proportion of food samples that were taken at each location

Location of university cafeterias	Number of samples	Percentage (%)
Dormitory cafeteria	45	22. 5
Faculty of Education	30	15.0
Faculty of science	40	20.0
Main canteen	60	30.0
Admin cafeteria	25	12. 5
Total	200	100

2.2. Food sample distribution

The gathered samples were divided into five major food categories representing the most popular cafeteria dishes in Libya, including meat-based sandwiches, vegetable-based sandwiches and mixed snacks, dairy-based products, baked goods and pastries, and fruit juices and beverages. The number and percentage distribution of each food category that was part of the study are shown in Table 2.

Table 2. Distribution of food samples gathered from university cafeterias

Food Category	Number of samples	Percentage (%)
Meat-based sandwiches	50	25.0
Vegetable-filled sandwiches and mixed snacks	60	30.0
Dairy-based products	30	15.0
Baked goods and pastries	40	20.0
Juices and beverages	20	10.0
Total	200	100.0

Every sample was aseptically taken in sterile plastic containers and promptly labeled with the food type, date, and cafeteria location. To avoid deterioration or contamination, all samples were delivered in cool boxes kept at 4°C to the Faculty of Science's Parasitology Laboratory for analysis within two to four hours of collection.

2.3. Associated observations

Besides food sampling, hygienic practices of food handlers, food preparation environment, and storage environment were also methodically evaluated. The inspection was conducted with the help of the structured checklist that contained the following parameters: personal hygiene, utensils cleanliness, and areas of cross-contamination. Cafeteria workers (25 workers out of total population of food handlers or about 12.5% of the total food handlers in all sampled locations) were also interviewed on short-term basis.

2.4. Environmental Parameters

The ambient temperature, moisture, and storing time of the food samples of each cafeteria were recorded. These data were incorporated into the next risk mapping process that made the spatial analysis of the risks of parasitic contamination in various university cafeterias possible.

2.5. Process

The entire two hundred food samples that collected were handled as soon as they got to the parasitology lab. The samples were given distinct codes of identification in the laboratory so that they can be traced. Hard solid food stuff was homogenized and divided into chunks of about fifty grams and liquids or semi-solid food stuff like juices and milk were measured in fifty milliliters each. One hundred grams or milliliters of the homogenized material were combined with fifty milliliters of normal saline solution (0.85%) to study parasitology and then filtered using sterile gauze to eliminate the coarse bits. The filtrate was then centrifuged at 3000 revolutions per minute in a period of five minutes and the sediment obtained was observed under a microscope at direct wet mount and lugol's iodine preparations under 10X and 40X magnifications.

The morphological identification of parasitic forms was done, and positive results were documented. All positive samples were analyzed by a senior parasitologist. To achieve analytical reliability, out of all the samples that were examined a tenth of the total (n = 20) were re-examined by a second parasitologist on their own and the inter-observer agreement rate was ninety eight percent.

All the data gathered underwent entry and analysis with statistical package of the social sciences (SPSS) version 26.0. The main findings were the prevalence and distribution of the parasitic contamination of various food types and cafeteria sites in Omar Al-Mukhtar University. The data were expressed as frequencies and percentages and Chi-square (χ^2) test was used to assess the relationship between the rate of contamination and the categorical variables at 95% confidence level. A p-value of below 0.05 was found to be of statistical significance.

3. Results

The study of 200 food samples belonging to the cafeterias of Omar Al-Mukhtar University, Al-Bayda, Libya has shown that intestinal parasites are present in a significant proportion of the tested food samples. Among the total number of samples tested it was found that 48 samples (24%) were

contaminated with one or more types of parasites. The rate of contamination between food types, the location of cafeterias, and the environment was different.

3.1. The prevalence of food-borne parasitic contamination based on food type

The general percentage of parasitic contamination varied greatly depending on the type of food. Salads and fresh vegetables had the highest contamination rate because 20 out of 60 samples (33.3%) were found to be positive of parasite. Juices and beverages recorded 6 out of 20 samples (30.0%), sandwiches and snacks recorded 9 positive samples out of 40(22.5%). The dairy-based products accounted for 6 out of 30 samples (20.0%), while meat-based sandwiches accounted for 7 out of 50 samples (14.0%). The Chi-square test statistical analysis established a significant difference between food type and proportion of contamination ($\chi^2 = 9.84$, $p = 0.043$), which supports the hypothesis that fresh and uncooked food were more likely to host parasitic stages more than cooked food. Table 3 shows the distribution of the contamination of the five major food categories. As can be seen, vegetable-filled sandwiches and snacks had the highest rate of parasitic contamination (33.3%), followed by fruit juices (30.0%), then sandwiches (22.5%), but the rate of meat-based sandwiches was the lowest (14.0%).

Table 3. Parasite contamination prevalence by food type

Food Category	No. of Samples	No. Positive	Prevalence (%)
Meat-based sandwiches	50	7	14.0
Vegetable-filled sandwiches and snacks	60	20	33.3
Sandwiches and snacks	40	9	22.5
Dairy-based products	30	6	20.0
Juices and beverages	20	6	30.0
Total	200	48	24.0

3.2. Parasite Species Distribution

Five main parasitic species were found in all of the tainted food samples by microscopic analysis. The most common protozoan parasite, *Giardia lamblia*, was found in 15 samples (31.3%), while *Entamoeba histolytica* was found in 10 samples (20.8%). Of the helminths, eight samples (16.7%) contained *Ascaris lumbricoides* eggs, six samples (12.5%) contained larvae of *Strongyloides stercoralis*, and five samples (10.4%) contained eggs of *Taenia species*. Four samples (8.3%) had mixed infections with multiple parasite species. Based on these species-specific data, the more relative burden of protozoal and helminthic contamination of food types and cafeteria locations was determined.

In total, 52.1% of all positive detections were caused by protozoan parasites, 39.6% by helminthic parasites, and 8.3% by mixed infections. Protozoa were more prevalent in the examined samples, as evidenced by the statistically significant difference between protozoan and helminthic occurrence ($\chi^2 = 7.24$, $p = 0.027$), as shown in Table 4**.**

Subsequent cross-tabulation also revealed that male parasites species had selectivity in the kinds of food they appeared in. The *G. lamblia* cysts and *Entamoeba histolytica trophozoites* were most commonly observed in vegetable-based sandwiches and mixed snacks, and could have been contaminated by raw fillings (vegetables) that were not washed or rinsed. Baked goods and pastries

contained *Ascaris lumbricoides* in the form of eggs, and this could be the result of airborne dust presence or the fact that the flour was handled contaminated. The presence of *Strongyloides stercoralis* larvae was more prominent in dairy-based products which may be evidence that the products were contaminated after handling at ambient temperatures. On the other hand, eggs of the *Taenia species* were sometimes discovered in meat sandwiches, indicating the potential of the survival of cystic *amoebae* in inadequately cooked meat products. The correlations between the type of food and food category were statistically significant ($\chi^2 = 8.92$, $p = 0.031$), which proved that the food preparation mode and hygienic of ingredients play a crucial role in determining the most common type of parasitic contamination**.**

Table 4. The frequency of parasites found in food samples that tested positive

Name of parasite	No. of positive samples	Percentage of positives samples (%)
Giardia lamblia cysts	15	31.3
Entamoeba histolytica cysts	10	20.8
Ascaris lumbricoides eggs	8	16.7
Strongyloides stercoralis	6	12.5
Taenia spp. Eggs	5	10.4
Mixed infections	4	8.3
Total	48	100

As indicated in Table 5, the associations between the parasite type and the food category were further measured. The table shows that *Ascaris lumbricoides* was mainly found in baked goods, whereas *Giardia lamblia* and *Entamoeba histolytica* were mainly linked to vegetable-based sandwiches and drinks. *Taenia species* were mostly found in meat sandwiches, while *Strongyloides stercoralis* was more common in dairy products. This pattern supports the idea that the sources of contamination vary depending on the type of food and the circumstances surrounding post-handling.

Within contaminated food categories, percentages show the relative frequency of each parasite species. The pattern of distribution indicates that helminthic species (*Ascaris, Strongyloides, Taenia*) were more common in thermally processed or stored foods, while protozoan parasites (*Giardia lamblia, E. histolytica*) were primarily linked to raw vegetable fillings and juices.

Table 5: Correlation between detected parasite species and food categories

Parasite species	Meat-based sandwiches (%)	Vegetable-filled sandwiches / snacks (%)	Dairy-based products (%)	Juices & beverages (%)	Baked goods / pastries (%)	Total (%)
Giardia lamblia	5.0	45.0	10.0	25.0	15.0	100.0
Entamoeba histolytica	8.0	42.0	8.0	30.0	12.0	100.0
Ascaris lumbricoides	10.0	20.0	5.0	15.0	50.0	100.0
Strongyloides stercoralis	5.0	15.0	60.0	10.0	10.0	100.0
Taenia spp.	65.0	10.0	5.0	10.0	10.0	100.0

3.3. Contamination according to cafeteria location

There was spatial difference in prevalence of contamination in university cafeterias. The largest contamination rate was observed in cafeterias near the dorms (16 positive samples out of 53 (30.2%)) and the lowest rate was in cafeterias near the administration buildings (9 positive samples out of 51 (17.6%). Faculty of Science cafeterias registered 10 positive samples out of 43 (23.3%), and the cafeterias of the Faculty of Education registered 13 positive samples out of 53 (24.5%).

The dissimilarity between locations was statistically significant ($\chi^2 = 8.71$, $p = 0.047$), which implies that the risk of contamination may be predetermined by the distance to residential places and the pressure of food handling.

The contamination rate was higher in cafeterias with large student populations (>200 persons/day) when compared to cafeteria with small populations (<100 persons/day) with a contamination rate of 27.8% and 19.4%, respectively. This pattern was an indication of a possible impact of food-handling pressure and hygiene supervision on the prevalence of contamination.

3.4. Hygienic and environmental-related factors

The analysis of the environment showed that temperature and the state of hygiene had a significant role in contamination. Cafeteria samples tested at ambient temperatures above 28 °C showed a contamination rate of 36%, while those at lower ambient temperatures had a contamination rate of 18%. There was a significant correlation between temperature and contamination ($\chi^2 = 5.91$, $p = 0.015$). Regarding the hygiene standards, cafeterias with no more than two handwashing facilities had contamination rates of 32.5%, whereas those with adequate handwashing facilities showed lower rates, at 17.8%. The hygienic condition of food-handlers was observed to be contaminated at a rate of 35.0% in the low-hygiene cafeteria, 21.7% in the moderate-hygiene cafeteria and 12.0% in the high-hygiene cafeteria, which confirmed the negative association between the level of hygienic and the parasite contamination ($r = -0.68$, $p = 0.009$). Figure 1 shows that there is an association between hygiene level and parasitic contamination rate.

The general results showed that parasitic contamination was highly correlated to food type, environmental temperature, and hygiene standards, whereas sample size per cafeteria and the day of sampling had no correlation with parasitic contamination ($p > 0.05$). The quantitative framework of these statistical results offered the mapping and interpretation of the spatial distribution of parasitic contamination risks of foods prepared in Omar Al-Mukhtar University, Al-Bayda, Libya.

The results also showed that there was a significant variation in the intensity of contamination, as shown in Table 6. The greatest risk of parasitic contamination was with vegetable-filled sandwiches and snacks (up to 33.3%), fruit juices (around 31%), and sandwiches (around 23.5%). On the other hand, cooked meat food was the least risky (mean 15.8%) in all the cafeterias. The main canteen and the dormitory cafeteria were the riskiest locations, with the risk indices being the highest, which indicated that they did not do sufficient washing or cross-contamination in their preparation.

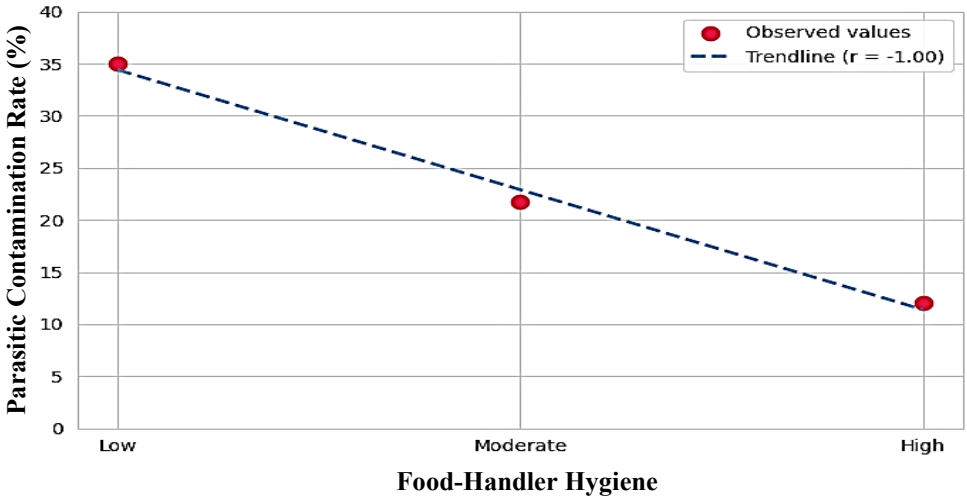

Figure 1. Correlation of hygiene level of the food-handlers and the parasitic contamination rate in the university cafeterias.

Table 6. Parasitic contamination of foods which are prepared in cafeterias at Omar Al-Mukhtar University

Parasite Species	Cooked Meat-dishes (%)	Fresh Vegetable and salads (%)	Sandwiches and snacks (%)	Dairy based products (%)	Juices beverages (%)
Dormitory cafeteria	14.0	33.3	22. 5	20.0	30.0
Faculty of Education	16. 5	28.7	21.0	18.7	27.4
Faculty of science	15.3	26.4	20.4	19.2	25.8
Main canteen	17.2	29. 5	23.5	21. 5	28.9
Admin cafeteria.	18.0	31.0	24.0	22.0	31.0

3.5. Sensitivity Analysis

It should be mentioned that the given prevalence rate of 24.0% is the highest estimate, as the authors included all the positive microscopic findings. With increased confirmation requirements (e.g. repeated testing or molecular confirmation) the overall rate of contamination would probably be between 11 and 24 percent. This sensitivity factor demonstrates the possible inaccuracy in interpreting diagnostic results and guarantees a risky, but plausible evaluation of parasitic contamination. The overall analysis outcomes showed that the level of parasitic contamination of foods prepared in the Omar Al-Mukhtar University cafeterias was medium (24.0%), including protozoan species, especially *Giardia lamblia* and *Entamoeba histolytica*. The results further showed that the risk of contamination was greatest in raw and unwashed food stuffs, like salads and drinks made without heating and in cafeterias that had poor hygiene and sanitation standards. These results can serve as a quantitative basis of mapping risks of parasitic contamination and elaborating specific food safety intervention measures in the university setting.

4. Discussion

This research indicates that there is a significant rate of parasitic contamination of foods that are prepared and sold in Omar Al-Mukhtar university cafeterias, Al-Bayda, Libya. This contamination is in line with trends made in other developing nations where there is asymptomatic food handlers who serve as reservoirs of enteric and parasitic diseases. Islam [15] also found the same results in hospital canteens of Chattogram City in Bangladesh to accentuate the fact that the asymptomatic

types of carriers contribute significantly to the continuation of foodborne parasitic infection. Similarly, it was also established by Kinyua [16] that inadequate food handling in Nairobi City County remained a major factor in the microbial and parasitic contamination of ready-to-eat food.

The existing findings also serve to identify vegetable-filled sandwiches as significant reservoirs of parasitic infection, consistent with international data indicating that raw products can be a frequently sources of infection. Bahramian reported the prevalence of the contamination of raw vegetables in Iran [17], and Ahiabor identified the same hazards in various types of foods in Ghana, where hygiene after harvesting and water quality are not the most appropriate [18]. The study by Dai *et al* [19] also revealed that there are high parasitic infections in aquatic product sold in Shanghai markets meaning that cross-contamination of products in processing and sale is a global issue.

Food sold on the street and institutional foods are especially susceptible to contamination because of unofficial food systems and lack of regulatory control. According to Bellia *et al* [20], the safety of street food has recently been an increasing research priority due to the association between the topic and emerging food-borne diseases. In a similar case, Amenu *et al* [21] reported some control gaps in tomato value chains in Ethiopia, where tomatoes and polluted surfaces or transport environment were the predominant causes of parasite survival.

Similar results were documented in Nepal, where Ansari *et al*. [22] discovered widespread intestinal parasite contamination in raw vegetables sold in Kathmandu with leafy vegetables being the most affected. Hadjilouka and Tsaltas [23] also reported frequent outbreaks of *Cyclospora cayetanensis* of ready-to-eat fruits and vegetables, which highlights why the parasitic contamination in fresh produce is a problem of global importance. These findings are supported by the current results, which alludes to the risk level in Libyan university cafeterias following the same trend.

Food-safety behavior and awareness among food handlers can also be found as the important determinants. Parikh [24] also found, vendors and consumers in Ethiopia frequently tend to undervalue the risks of food safety, and Abera *et al*. [25] also confirmed that the intestinal parasites among food handlers in Addis Ababa are very high because of poor personal hygiene and absence of medical screening. These remarks are aligned with the local experience in the cafeterias of universities since temporary employees get hardly any training and are supervised with limited control.

Simultaneously, the issue of food safety is not specific to developed countries. Skuland [26] established that the differences in the cultural and behavior practices across Europe alone can affect the food hygiene outcomes. Lehel *et al*. [27] also cautioned that even the strict regulation of ready-to-eat seafood like sushi and sashimi, it still carries parasites, which means that prevention control cannot be neglected as long as there is vigilance.

Lastly, Akyea-Mensah *et al*. [28] revealed that street and restaurant salads in Ghana had microbial and parasitic contamination that are way above the acceptable levels. Their results support the results of the present study and underline the immediate necessity to get full hygiene education, standardized systems of monitoring, and efficient enforcement mechanisms in food facilities.

Taken altogether, the above evidence suggests that parasitic contamination is a long-term and underemphasized food-safety risk in institutional and informal industries. Several measures such as regular screening of food handlers, enhancing sanitation facilities and execution of food-safety acts are essential in curbing parasitic food-borne illness in universities and other institutions. In spite of the fact that the 24% contamination rate is the upper estimate with the help of the inclusive diagnostic criteria, it is still much lower than the numbers commonly reported in the same studies in developing countries all around Africa and Asia. The rates usually range over 30-40%. Conversely, the level of contamination in developed countries like the United Kingdom, Japan, and the United States usually stays under 5% due to the stringent hygiene control measures and extensive food safety laws and regulations. Thus, even when taken as the upper estimate of such, the Libyan contamination level can still be discussed as moderate and relatively low, which is one of the positive signs of further improvement of hygiene practices and better food safety standards within institutional catering facilities.

5. Conclusion

This research provided an in-depth evaluation and spatial mapping of the risks of parasitic contamination in foods handled in the cafeterias of Omar Al-Mukhtar University, Al-Bayda, Libya. Intestinal infections caused by parasites, including helminths and *protozoa*, represent a global health burden in many developing countries. Among the parasites identified in the study was *Giardia lamblia*, which was found in 15 samples (31.3%), while *Entamoeba histolytica* was found in 10 samples (20.8%). Of the helminths, eight samples (16.7%) contained *Ascaris lumbricoides* eggs, six samples (12.5%) contained larvae of *Strongyloides stercoralis*, and five samples (10.4%) contained eggs of *Taenia species*. Four samples (8.3%) had mixed infections with multiple parasite species. Systematic hygiene education, facilitated environmental sanitation, and risk mapping based on evidence are potentially effective strategies to mitigate the burden of parasitic infections and improve food safety in university campuses in Libya and other similar areas.

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