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Risk factors for diarrheal diseases among pilgrims during Arba'een mass gathering: a case-control study

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Abstract

Background A significant portion of the Muslim community participates in the Arba'een pilgrimage, with participant numbers increasing each year. There have been relatively few studies on the health of Arba'een Mass gathering (MG). Researching the prevalence and distribution of diseases among Arba'een pilgrims is essential to recognize any outbreaks and take timely responses to contain them. The current study aimed to identify exposures and risk factors for diarrheal disease in pilgrims who referred to the clinics located in Iraq among the Arba'een MG in 2023.

Methods This case-control study randomly selected 200 outpatients (100 cases and 100 controls) who were referred to Iraq clinics. Cases were patients with gastrointestinal symptoms (diarrhea), while controls were randomly selected from unaffected pilgrims at the same time for the cases. The study groups matched for age, and sex. Face-to-face interviews using a reliable field based checklist of the Center for Disease Control and Prevention of Iran's Ministry of Health to collect potential exposures and risk factors for diarrheal disease. Multiple logistic regression was used to estimate the crude and adjusted odds ratio (AOR) for the risk of diarrhea with a 95% confidence interval (CI).

Results The average age of the participants was 38.6 years. Diarrhea in 100% and fever in 81% were the most common clinical symptoms in patients. Having underlying diseases was not associated with an increased risk of diarrhea disease ($P > 0.05$). Regarding risk factors for diarrheal, the final analysis after adjusting for potential confounders indicated that consumption of insanitary (unpackaged) drinking water (AOR = 1.95; 95% CI: 1.05–3.6; $P = 0.024$), inappropriate hand washing (AOR = 3.82; 95% CI: 1.7–8.6; $P = 0.001$), ritual foods (AOR = 2.56; 95% CI: 1.3–5.2; $P = 0.004$), and public toilets (AOR = 1.46; 95% CI: 1.04–4.3; $P = 0.038$) were significantly increased the likelihood of diarrheal disease.

Conclusions Contamination of water sources, food, inadequate and poor hand washing were the most common sources of diarrheal diseases among Arba'een pilgrims. The results indicate that the potential occurrence of outbreaks, especially water- and foodborne diseases, threatens participants in the Arba'een MG. It is recommended to provide risk assessment, improve pilgrims' awareness, pre- and post-screening, vaccination, compliance with personal hygiene,

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improvement of the environment, provision of sanitary water and food sources and hygienic disposal of sewage, laboratory diagnosis to identify the common types of pathogens in Arba'een MG.

Keywords Arba'een, Mass gathering, Water- and foodborne diseases, Outbreaks

Background

Arba'een is an annual religious pilgrimage; a Mass gathering (MG); in Iraq, attracting approximately 17 to 20 million participants [1, 2]. It commemorates the return of Hussein ibn Ali's family to Karbala. This marks the 40th day after the massacre of the grandson of Prophet Muhammad, his relatives, and companions. Millions of pilgrims and residents, predominantly Shia Muslims, honor this day by walking from cities across Iraq and Iran towards the shrine of Imam Hussein in Karbala, located 100 km southeast of Baghdad and 80 km from Najaf [3–6].

During the Arba'een pilgrimage, the Najaf-Karbala route is the most frequented and widely attended international route. This route provides ongoing services like accommodation and food throughout the journey. These services are offered by volunteers from Iraqi citizens and various nationalities [6]. Participants of Arba'een arrive from numerous countries worldwide, particularly those with a Muslim majority. However, the majority of visitors hail from low to middle-income countries. Consequently, many individuals encounter health risks and possess poor health literacy [7, 8].

Every MG poses potential global health risks. During the Hajj pilgrimage, respiratory and diarrheal infections are the most prevalent infectious diseases, impacting 50 to 93% of participants [9]. In the Grand Magal of Touba, the largest MG in West Africa, individuals who visited healthcare centers in Touba had exhibited a significantly lower prevalence of respiratory symptoms (4.6%) and a similar prevalence of gastrointestinal symptoms (5.3%) [10]. A recent review study highlighted that infectious disease outbreaks and the inadequate management of Iraq's health system regarding waste collection and disposal are the most significant health challenges in Arba'een MG [7]. Currently, a study by Azizi et al. indicated that Arba'een pilgrims are vulnerable for infectious and respiratory diseases [11].

The health and hygiene conditions of participants in the MG of Arba'een may vary, as the distributed foods among them is often prepared on the streets or in temporary tents. Poor hygiene in food preparation and serving is prevalent in these gatherings [12, 13].

Gastrointestinal infections may be more common than respiratory infections during Arba'een, amid concerns about unhygienic food and water sources. The history of cholera outbreaks in Iraq, particularly in 2016, raises significant concerns about the potential for such infections during Arba'een [14]. Cholera was widespread during

large-scale gatherings, as evidenced by an outbreak in Senegal during the 2005 Grand Magal of Touba [15]. Furthermore, studies on the Hajj pilgrimage indicate that such MG events pose a risk for the spread of antibiotic-resistant bacterial infections locally and globally [16–18]. This is a significant concern, especially considering the poor awareness among pilgrims regarding proper antibiotic use, as documented during the Hajj [19].

Currently, there are no established regulations concerning health and safety during Arba'een, and limited research have been conducted on public health concerns. To our knowledge, there has been few studies on the health risks associated with Arba'een [20–22]. A study investigated complications and mortality rates in Karbala during Ashura, a minor and localized pilgrimage. This study focused on participants in three different state hospitals in the city. A seven-fold increase in febrile disorders and a twofold increase in chronic diseases and injuries were noted compared to the pre-event phase [23].

Health system preparedness can reduce the public health risks associated with Arba'een [7]. To support the development of policies and preventive measures for participants and pilgrims of Arba'een, we conducted a case-control study aimed to identify sources of contamination and risk factors associated with diarrheal diseases and gastrointestinal symptoms among Arba'een pilgrims.

Methods

Study population

A case-control study was conducted to identify risk factors and sources of contamination associated with water- and foodborne diarrheal diseases among pilgrims visiting field clinics during the Arba'een pilgrimage in Iraq in 2023. The study population included individuals with diarrhea and gastrointestinal symptoms who attended field clinics along the Arba'een pilgrimage route from Najaf to Karbala in Iraq in 2023.

Study groups and matching

The case group consisted of patients exhibiting gastrointestinal symptoms related to diarrheal disease who attended field clinics during the Arba'een pilgrimage in Iraq. The control group was randomly selected from unaffected and asymptomatic Arba'een pilgrims from the main route of the march at the same time for the cases. Case and control groups were matched in frequency based on the day of the clinic visit, age, and sex. Both groups exhibited an equal distribution of age and gender.

Sample size

According to prior studies [24, 25] and our pilot study, the sample size for the case-control design was calculated based on the prevalence of exposure ($p_1=0.4$) and ($p_2=0.1$) in cases and controls, respectively, to contaminated water and food. Furthermore, the odds ratio ($OR=4$) indicated a fourfold increase in the likelihood of gastrointestinal symptoms and disorders in cases compared to controls. The estimated sample size, considering for a type I error of 5% and power of 80%, consisted 200 individuals, 100 for each group.

Data collection and measurements

Face-to-face interviews with patients and controls were used to obtain the valid exposures and risk factors for diarrheal disease. The Center for Disease Control and Prevention of Iran's Ministry of Health provided a validated checklist to collect data on epidemiology, risk factors, and possible sources of contamination in the spread of foodborne and waterborne illnesses. Risk factors included demographic and baseline characteristics, as well as underlying diseases. Sources of the outbreak encompassed water source consumption, toilets and sewage disposal, hand washing, and food sources, particularly ritualistic food offerings, syrups, and liquids. This checklist is used for epidemiological evaluation, potential outbreak sources and identification of risk factors and contaminated sources of waterborne and foodborne diseases in the health system of Iran [26, 27]. In addition to the demographic characteristics and underlying diseases, we collected all possible sources of contamination and exposures, including food and drink and sanitary facilities (toilet) and correct hand washing in the participants of the case and control groups. The interviews lasted at least 20 min and were conducted after the outpatient visits in the clinics. We used patients' companions to obtain

reliable information about their exposures in the past three days.

Handwashing after using the toilet is defined as washing with soap or detergent for at least 10–15 s based on the WHO guideline [24]. Data was collected through face-to-face interviews and close observation by a skilled epidemiologist from the healthcare system [28].

Analysis

The data analysis was conducted using STATA version 14 software. The normality of the data was assessed using Q-Q plots. The researchers utilized the independent t-test to determine the relationship between quantitative factors that follow a normal distribution and the study result, specifically the incidence of diarrhea. The researchers employed the chi-square test to assess the categorical and binary variables. The study utilized multiple logistic regression to calculate the crude and adjusted odds ratios (AORs) for the risk of gastrointestinal disease (diarrhea) with a confidence level of 95%.

Results

In total, 200 individuals (100 patients with diarrhea and 100 healthy individuals) participated in this case-control study. According to Table 1 shows the baseline characteristics and underlying diseases of the participants by the study groups. The mean age of the participants was of 38.6 years. Since the study groups were matched for gender and age, there was no significant difference in either age or gender ($P>0.05$). Participants in the case and control groups did not show significant differences in their medical history of underlying diseases ($P>0.05$).

Table 2 illustrates the clinical symptoms of patients with diarrhea (case group). All patients were diagnosed with diarrhea (100%). The most common subsequent

Table 1 Demographic characteristics and underlying diseases of the participants by study groups

Variable	Groups (n = 200)		Total (n = 300)	P-value	
	Control (n = 100)	Case (n = 100)			
Age	Mean ± SD	39.0 ± 16.1	38.2 ± 16.8	38.6 ± 14.4	0.719
Sex	Female	58	49	108	0.202
	Male	41	51	92	
Marital status	Single	23	31	54	0.267
	Married	69	65	134	
	Widow/divorced	8	4	12	
Diabetes	No	92	93	185	0.788
	yes	8	7	15	
Hypertension	No	87	84	171	0.547
	yes	13	16	29	
Fatty liver	No	93	97	187	0.774
	yes	7	6	13	
Smoking	No	88	85	173	0.535
	yes	12	15	27	

Table 2 Common signs and symptoms of patients with diarrhea

Common signs/symptoms	Patients with diarrhea and digestive syndrome	%
Diarrhea	100	100%
Fever	81	81%
Vomiting	72	72%
Anorexia	69	69%
Abdominal pain	45	45%
bloody diarrhea	13	13%

symptoms included fever (81%), anorexia (72%), and vomiting (69%).

Table 3 presents the risk factors associated with diarrhea incidence and sources of diarrheal contamination, analyzed through multiple logistic regression using crude and adjusted ORs in patients attending field clinics during the Arba'een MG. Our results indicated that factors such as not consuming packaged drinking water (AOR=1.95; 95% CI: 1.05–3.6; $P=0.024$), inappropriate hand washing after toilet (AOR=3.82; 95% CI: (1.7–8.6); $P=0.001$), consumption of ritualistic food offerings (AOR=2.56; 95% CI: 1.3–5.2; $P=0.004$), and the use of public toilets (AOR=1.46; 95% CI: 1.04–4.3; $P=0.038$) significantly increased the risk of diarrhea.

Discussion

The Arba'een pilgrimage is an annual event that draws numerous individuals from various Muslim and non-Muslim countries. It begins near the Iranian border and culminates in Karbala, Iraq. Throughout the Arba'een pilgrimage, the Najaf-Karbala route experiences the highest volume of traffic. The annual participation rate of pilgrims (walkers) in this journey shows a steady upward trend. To our knowledge, there has been limited research on the health hazards associated with Arba'een. Currently, no system is in place to actively register and monitor diseases [7, 29, 30]. Therefore, it is imperative to conduct health and research assessments, ensure compliance with personal and environmental hygiene practices, establish disease surveillance systems, provide treatment and clinical care, and perform patient laboratory testing [21, 29].

In this case-control study, inadequate handwashing, consumption of unsanitary and contaminated food and water, contaminated water sources, and improper sewage disposal were identified as some of the most significant factors associated with diarrhea and gastrointestinal symptoms in patients. Undoubtedly, improving and establishing sanitary facilities, preventive and therapeutic measures, and policymaking can prevent the occurrence of any epidemic and outbreak of potentially epidemic diseases. There are evidences that indicate outbreaks of food and water-borne diseases in MGs such as Hajj. For example, in the study of Al-Jodi et al.,

Table 3 Risk factors associated with diarrhea in Arba'een pilgrims using multiple logistic regression analysis

Variable	Groups (n = 200)		Crude OR p-value	AOR; 95% CI P-value	
	Control (n = 100)	Case (n = 100)			
Water source consumption	Package water (sanitary)	44	29	1	1
	Any water available	55	71	1.91 (1.09–1.52) 0.025	1.95 (1.05–3.6) 0.024
public toilets	Personal use (hotel/residence/guest house)	17	12		1.46 (1.04–4.3)
	General (sanitary)	46	33	1.85 (0.97–2.99) 0.065	0.038
Hand washing	General (unsanitary)	37	55		
	Appropriate and always with soap	37	22	1	1
	Relatively appropriate and most with soap	43	40	1.56 (0.79–3.09) 0.198	1.62 (0.77–3.4) 0.203
	inappropriate	20	38	3.19 (1.5–6.8) 0.003	3.82 (1.7–8.6) 0.001
Food source	Iranian	57	53	1	1
	Both (Iran and Iraq)	43	47	1.18 (0.68–2.05) 0.335	1.3 (0.67–1.7) 0.570
Syrups and liquids	yes	35	33	1.09 (0.61–1.96) 0.765	1.17 (0.64–2.1) 0.881
	no	65	67	1	1
Ritualistic food offerings	yes	64	82	1.52 (1.17–1.98) 0.007	2.56 (1.3–5.2) 0.004
	no	36	18	1	1

Adjusted for age, sex, and underlying disease including diabetes, hypertension, and smoking

consumption of contaminated rice was identified as the source of the outbreak [31]. Review studies among Hajj pilgrims revealed a pooled prevalence of 2% for diarrheal diseases with the highest prevalence of 23% among a group of French pilgrims in 2013 [32]. Consistent with our study, hand hygiene and hand disinfection have been recommended in previous evidence to prevent diarrheal diseases [32, 33].

Despite advancements in infectious disease control, such as cholera, outbreaks can still happen, especially at MGs. During the Arba'een pilgrimage, Iran stands out as one of the most significant countries, and its healthcare system must be prepared to meet patient needs. In a study that was conducted using the syndromic care system among Iranian Arbaeen women, the number of 2,232 cases of acute watery diarrhea and 641 cases of cholera among pilgrims returning to Iran. The study found a significant correlation between reported cases of acute watery diarrhea in the syndromic care system and the number of confirmed cholera cases. This study indicated that the syndromic care system can help predict the emergence of infectious diseases in large religious gatherings [25].

In another study, the most frequently reported symptom by 1,842 Arba'een pilgrims (63.3% male, 36.7% female) was cough (25.6%). Toilet facilities often lacked piped water (32.1%) and soap (26.1%), while shared hand towels (17%) were commonly found. This study suggested that to reduce the risk of respiratory infections, including COVID-19, during Arba'een or other MGs, it is essential to provide running water, soap, and options for hand hygiene, such as hand dryers or hand sanitizers [8].

In another study involving 191 individuals (143 male, 58 female), the most prevalent respiratory symptoms were nasal discharge (22.6%) and cough (22.5%). Diarrhea was reported by 12.6% of the participants, and a strong correlation was found between the country of origin and consumption of street (commercial) food by Arba'een participants [2].

The primary challenge during MGs is the absence of systematic operational capacities, including risk assessment, coordination mechanisms, standardized procedures, institutional capabilities, regulations, budgets, skilled personnel, public information, awareness, and participation, which can alleviate public health impacts and economic losses. Effective management of health risks, particularly infectious diseases, during MGs necessitates planning. This planning encompasses risk identification, communication, analysis, assessment, prevention, and monitoring. However, each aspect may be specific to the MG and must be addressed accordingly [34–36].

Preventing non-communicable and infectious diseases in MGs requires assessing and managing risks before, during, and after the event, as demonstrated in

pilgrimage planning [37, 38]. Ideally, the primary prevention of human infections caused by emerging infectious diseases involves effective control of pathogens at their source. Since it is not feasible to eliminate all emerging pathogens at the source, secondary interventions (e.g., pharmaceutical or non-pharmaceutical) are necessary to reduce the spread of infections during MGs. However, further studies are needed to assess the effectiveness of such interventions [39, 40]. In addition to lowering the rates of morbidity and mortality associated with human infections during MGs, decreasing the circulation of pathogens and exposure to humans may also mitigate global health security risks [41].

If host communities and healthcare systems are well-prepared for the Arba'een pilgrimage and can mitigate their risks, the impact of emergencies and crises on health can be significantly diminished. Conducting risk assessment and management during the planning of the Arba'een MG can aid in the formulation of effective health policies. Strategic risk assessment entails collecting, coordinating, and analyzing data to identify current risks, anticipate potential issues, prioritize concerns, and create a foundation for targeted policy implementation and corrective actions [7, 42]. A system to assess the impact of public health policies and estimate the likelihood of success is essential. These processes are well documented for regularly scheduled events, such as Hajj and the Olympics [43].

Qualitative studies involving interviews with policymakers and other stakeholders about their experiences with public health risks related to infectious diseases during Arba'een highlighted concerns such as deficiencies in healthcare infrastructure, weak control of infectious disease risk factors, low understanding among pilgrims of health hazards, and the ineffectiveness of health education as challenges for the healthcare system in controlling contagious diseases during the Arba'een pilgrimage [42, 44].

Limitations and strengths

This case-control study identified exposures and risk factors for diarrheal disease among Arba'een pilgrims. However, our study had several limitations. The primary limitation was the potential for recall bias when evaluating exposures and risk factors in the study groups. To address this issue, we conducted face-to-face interviews utilizing a standardized questionnaire from the health system, with experienced interviewers from the health sector. Secondly, we randomly selected controls from among pilgrims (the same source population) on the same day and matched their age and gender to ensure that the case and control groups were homogeneous concerning potential confounding variables to address this issue. Additionally, we carried out multiple logistic

regression analysis to estimate the adjusted odds ratio for the risk of diarrheal disease.

The next issue pertained to the sample size of the study. Although the sample size of the current study was smaller, the high prevalence ratio of the study outcome (diarrheal disease) among clinic clients, along with a significant prevalence difference between the case and control groups, indicated that a smaller sample size was sufficient to establish the relationship between risk factors and potential exposures related to diarrheal disease. Since most variables and risk factors exhibited a statistically significant relationship, the study's power was adequate to identify this relationship. However, it is advisable to conduct studies with a larger sample size and access to laboratory diagnostic facilities. In the current study, laboratory diagnostic facilities were not available in outpatient clinics. The information and findings presented are the most comprehensive evidence derived from face-to-face interviews with outpatients.

Conclusions

Contamination of water sources, food, and poor hand hygiene (non-adherence to hand hygiene) were the most significant sources of diarrheal diseases among Arba'een pilgrims. The study results showed that the likelihood of potential outbreaks of infectious diseases, especially water and foodborne diseases, threatens participants in the Arba'een mass gathering.

It is suggested to consider the following things to maintain and ensure the health of the participants in the vast Arba'een gathering:

Risk identification and assessment, development of preventive measures such as pre-and post-screening [28], vaccination, compliance with personal hygiene and use of masks, improvement of the environment, provision of sanitary water and food sources and hygienic disposal of sewage and accommodation, enhancing laboratory diagnosis and supervisory systems, and implementation of the care system for communicable and non-communicable diseases, especially the use of the syndromic care system; as using several symptoms that are similar and related to the disease instead of a definite diagnosis, and as a result, early identification of the disease and quick response to possible outbreaks [34, 45].

Furthermore, it is recommended that future studies carry out a thorough follow-up investigation to identify the common types of pathogens contaminating food and water sources, enhance preventative measures, and safeguard public health during such MGs.

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Author contributions

All authors were involved in designing the study. HA developed the original idea and protocol, conducted, analysis, interpretation, and drafted the manuscript. EDE, BN, ShG FA, and ES contributed to the protocol development and interpretation of the data, and data collection and contributed to the manuscript development and review. All authors approved the final submitted version.

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Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study is a case-control (not-clinical trial). The study was approved by the ethics committee under code IR.RCS.REC.1401.007 by the Iranian Red Crescent Society. Written informed consent was obtained from all participants before the survey.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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