



Research Article

A Study of the Risk Factors Associated with the Death of Surabaya Embarkation Hajj Pilgrims in 2023

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ABSTRACT

The Hajj pilgrimage is a highly sought-after act of worship among followers of Islam. The observed increase in the number of Indonesian pilgrims corresponds with the observed increase in the number of pilgrims at risk of death. In 2023, the highest number of deaths in Indonesia occurred at the Surabaya embarkation point. The objective of this study is to identify the factors associated with the death of pilgrims embarking from Surabaya in 2023, based on data from the SISKOHATKES database. A quantitative approach with a retrospective cohort design was employed, analyzing 17,211 pilgrims selected through purposive sampling. Data were assessed using chi-square tests and Cox regression analysis. The findings indicate that age, hypertension, and diabetes mellitus are the most significant factors associated with mortality. These variables showed a statistically significant impact on death, with the following risk ratios: age (p -value = 0.000; RRa = 5.3), hypertension (p -value = 0.000; RRa = 3.7), and diabetes mellitus (p -value = 0.000; RRa = 18.7). The study concludes that age, hypertension, and diabetes mellitus are the primary risk factors for pilgrim mortality from Surabaya in 2023. It is recommended that the Hajj healthcare program adopt a comprehensive strategy encompassing promotive, preventive, curative, and emergency response measures to mitigate these risks.

Keywords: Death, hajj pilgrims, risk factors

INTRODUCTION

Hajj is a highly esteemed act of worship among adherents of Islam. As the fifth pillar of Islam, the Hajj is an obligatory act for Muslims who are physically and financially able to perform it (Idris & Nurwahyuni, 2022). Indonesia, the most populous Muslim-majority country, has the highest number of Hajj pilgrims globally. This increase in Hajj participation corresponds with a rise in the number of seriously ill pilgrims at risk of death. Data from 2012 to 2017 indicate that 2.6 million Hajj pilgrims required medical attention, with a ratio of 197 cases per 1,000 pilgrims (Gaddoury & Armenian, 2023). It is well-documented that each year approximately 60-70% of Hajj pilgrims are classified as high-risk, making them more susceptible to requiring medical treatment or facing death during the pilgrimage (Huda et al., 2022).



The Indonesian Ministry of Health's Hajj Health Center has reported fluctuations in the number of Hajj pilgrim deaths in Saudi Arabia over recent years. In 2019, 473 pilgrims died, while in 2022, the number decreased to 89 due to the COVID-19 pandemic, which led to the suspension of the Hajj pilgrimage from 2020 to 2022 and the imposition of restrictions by Saudi Arabia and other countries. However, in 2023, the number of Hajj pilgrim deaths surged to 816—the highest recorded in the past decade and the most significant increase since 2019 (Kemenkes RI, 2019; Kemenkes RI, 2023).

It is well-known that several predominant diseases affect Hajj pilgrims, particularly the elderly. These include degenerative, chronic, and metabolic conditions. In 2023, the Indonesian government introduced the 'Haji Berkeadilan dan Ramah Lansia' (Equitable and Elderly-Friendly Hajj) initiative, which is expected to increase elderly participation in the pilgrimage. However, the long and strenuous journey places physical stress on elderly pilgrims, exacerbating existing health problems. Research conducted in West Java Province identified three significant risk factors for death among Hajj pilgrims: age, hypertension, and diabetes mellitus, each with a p-value <0.05, indicating a statistically significant association (Idris & Nurwahyuni, 2022). This research definitively shows that the age group >60 years has an *Odds Ratio* (OR) value of 6.619, which means that those aged >60 years have a 6.62 times risk of increasing death among Hajj pilgrims. The research of Yezli et al. (2021) states that diabetes mellitus can cause damage to blood vessels and other body organs and has a 4.3 times risk of death compared to pilgrims who do not have diabetes mellitus. Furthermore, hypertension was linked to a higher risk of all-cause inpatient mortality (OR=1.34) (Gaddoury & Armenian, 2023).

Age and gender have been identified as significant factors in Hajj pilgrimage mortality rates. The majority of deceased pilgrims were over the age of 60, accounting for 138 individuals (81%), with male pilgrims comprising 103 cases (60%). Cardiovascular disease remains the leading cause of death, with 23 cases (33%) in 2019, 16 cases (70%) in 2022, and 49 cases (29%) in 2023. Other major causes included septic shock (30 cases, 23%) and respiratory diseases (29 cases, 17%) (Balai Besar Kearantinaan Kesehatan Surabaya, 2022; Balai Besar Kearantinaan Kesehatan Surabaya, 2023).

The challenges of organizing Hajj in Indonesia are shown by the condition of the pilgrims who are at high risk from age and comorbidities in every year (Vestability, 2021; Idris & Nurwahyuni, 2022). These factors require urgent attention to ensure the safety and well-being of Hajj pilgrims. The Indonesian government must prioritize providing comprehensive guidance, services, and health protection for pilgrims, as good health is essential for the successful completion of the Hajj pilgrimage. Despite the annual occurrence of pilgrim deaths, research specifically focusing on the Surabaya embarkation point remains limited. Therefore, this study is crucial to understanding the risk factors associated with mortality during the Hajj pilgrimage by examining the relationship between age, hypertension, and diabetes mellitus among pilgrims departing from Surabaya.

MATERIAL AND METHODS

This study is a quantitative, analytic observational approach using a retrospective cohort study design. The independent variables include age, hypertension, and diabetes mellitus, while the dependent variable is pilgrim mortality. Mortality in this study refers to pilgrims officially declared deceased as indicated by a Certificate of Death (CoD). Age is defined as the length of life of the pilgrims recorded during the third medical examination. Hypertension

refers to pilgrims diagnosed with Essential (primary) hypertension (I10) or Secondary hypertension (I15). Diabetes mellitus is defined as a diagnosis of Insulin-dependent diabetes mellitus (E10) or Non-insulin-dependent diabetes mellitus (E11) (CDC, 2021).

The study population consisted of all Surabaya embarkation pilgrims in 2023, with a total of 38.360 pilgrims. The total number of samples amounted to 17.211 using *purposive sampling* technique with inclusion and exclusion criteria. The study included Surabaya embarkation pilgrims recorded in the Integrated Hajj Computerization System for Health (SISKOHATKES) with complete data, as well as those with a health diagnosis of hypertension, diabetes, or no known health issues. Exclusion criteria included pilgrims with incomplete data, those diagnosed with diseases other than hypertension or diabetes mellitus, and those with hypertension or diabetes mellitus combined with other health conditions.

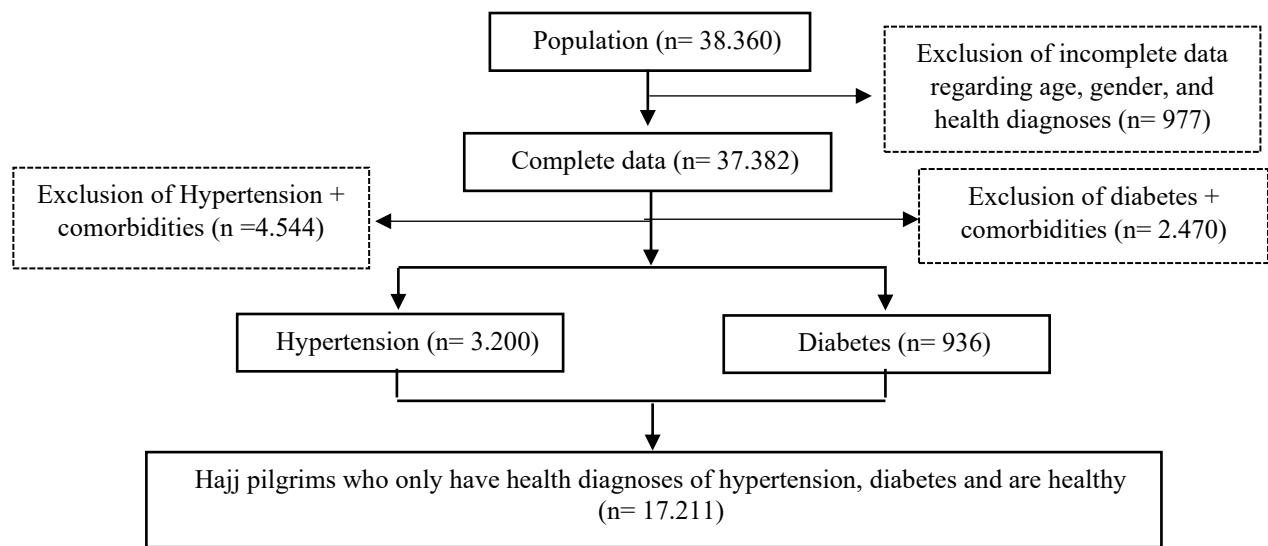


Figure 1. Flow of Research Sample Selection

This study was conducted at the Surabaya Health Quarantine Center. Data were collected through documentation from the Hajj Health Center of the Ministry of Health of the Republic of Indonesia, using the SISKOHATKES system. This research has been reviewed by the Health Research Ethics Commission of the Faculty of Dentistry, Universitas Airlangga, and has been granted ethical approval with certificate number 1271/HRECC.FODM/XI/2023. The *chi-square* test and *cox* regression are used for data analysis to determine the relationship between several independent variables and the rate of an event over time. However, the researchers were unable to measure the exact time of the event, leading to the aggregation of these variables at a single time point.

RESULTS AND DISCUSSION

Result

Frequency Distribution of Hajj Pilgrims Characteristics

Table 1 presents the frequency distribution of the dependent and independent variables, as well as the characteristics of Hajj pilgrims embarking from Surabaya in 2023. The univariate analysis of 17,211 samples indicates that 74 pilgrims (0.4%) died, while 17,137 (99.6%) survived. In terms of gender distribution, 8,738 pilgrims (50.8%) were female, and 8,473 (49.2%) were male. The majority of the pilgrims were aged ≤ 60 years (68.2%), while 5,477 pilgrims (31.8%) were aged

>60 years. Regarding health conditions, 3,200 pilgrims (18.6%) had a diagnosis of hypertension, while 14,011 (81.4%) did not. Additionally, 963 pilgrims (5.6%) were diagnosed with diabetes mellitus, while 16,248 (94.4%) were not.

Table 1. Characteristics of Hajj Pilgrims Embarkation Surabaya Year 2023

Characteristics	N	%
Hajj Pilgrim Deaths		
Xdr	63	/ -3
Mh	06-026	88-5
Sex		
L ` m	7-362	38-1
Edl ` kd	7-627	4/ -7
Age		
= 5/ xd` q` nk	4-366	20-7
¶ 5/ xd` q` nk	00-623	57-1
Hypertension		
Xdr	2-1/ /	07-5
Mh	03-/ 00	70-3
Diabetes mellitus		
Xdr	852	4-5
Mh	05-137	83-3

Results of Risk Factor Analysis of Hajj Deaths

Table 2 indicates that individuals in the >60 years age group experienced a higher mortality rate (77%) compared to those in the ≤60 years age group (23%). The results of the chi-square statistical test indicated a statistically significant association between age and death of Surabaya embarkation pilgrims, with a p-value of 0.000 ($p < 0.05$) and a *Crude Risk Ratio* (RR_C) value of 7.183 (95% CI: 4.183-12.335). This implies that pilgrims aged >60 years have a greater chance of experiencing death by a factor of 7.183 times.

The results of the analysis showed that there was a significant association between hypertensive disease and death of pilgrims. Although the number of deaths was higher in the group without hypertension (66.2%), the statistical test showed significance with a p-value of 0.001 ($p < 0.05$) and a RR_C value of 2.234 (95% CI: 1.382-3.611). This means that pilgrims with hypertension have a higher risk of death by 2.234 times compared to pilgrims who do not suffer from hypertension.

As for diabetes mellitus with the death of pilgrims also shows a significant relationship. Hajj pilgrims who died were more likely to have diabetes mellitus (41.9%). The results of the *fisher's exact test* analysis showed that diabetes mellitus and pilgrim death were associated with a p-value of 0.000 ($p < 0.05$) and a RR_C value of 12.164 (95% CI: 7.700-19.214). This means that the group of pilgrims with diabetes mellitus has a risk of 12.164 times to experience death when compared to pilgrims who do not have diabetes mellitus.

Table 2. Risk Factor Analysis of Death of Hajj Pilgrims Embarkation Surabaya Year 2023

Variables	Hajj pilgrim deaths				<i>P-value</i>	RR _c (95% CI)	<i>P-value</i>	RR _a (95% CI)
	Yes		No					
	n	%	n	%				
Age								
= 5/ xd' q nlc	57	77	5.420	31.6	0.000	7.183	0.000	5.333
≤ 60 years old	17	23	11.717	68.4		(4.183-12.335)		(3.075-9.247)
Hypertension								
Yes	25	33,8	3.175	18.5	0.001	2.234	0.000	3.699
No	49	66,2	13.962	81,5		(1.382-3.611)		(1.999-6.848)
Diabetes Mellitus								
Yes	31	41,9	932	5.4	0.000*	12.164	0.000	18.725
No	43	58,1	16.205	94.6		(7.700-19.214)		(10.441-33.584)

*Fisher's Exact Test

Following the *chi-square* test, it was determined that all independent variables, namely age, hypertension, and diabetes mellitus, were eligible for the *cox* regression test due to a p-value <0.25. The *cox* regression model revealed that the diabetes mellitus variable is the most significant risk factor for death among pilgrims, with an *Adjusted Risk Ratio* (RR_a) value of 18.725 (95% CI: 10.441-33.584). This indicates that individuals with diabetes mellitus are at an 18.7-fold higher risk of mortality compared to those without diabetes mellitus. The age group of >60 years exhibited a 5.3-fold increased risk of mortality compared to the age group of ≤60 years. Those with hypertension exhibited a 3.7-fold increased risk of mortality compared to those without hypertension.

Relationship Between Age and Hajj Deaths

Law No. 13 of 1998 defines individuals aged 60 years and above as elderly (Kemenkes RI, 2022). Among Indonesian Hajj pilgrims, more than 50% fall into the "high risk" category, consisting of those aged over 60 or with comorbidities (Kemenkes RI, 2018). In Surabaya, elderly pilgrims accounted for 15,773 of the total departures in 2023, the largest group (Balai Besar Kekarantinaan Kesehatan Surabaya, 2023). Studies show that pilgrims aged over 60 have a significantly higher risk of death compared to younger groups, with an increased risk factor of 5.333 to 6.62 times (Idris & Nurwahyuni, 2022). The physical demands of Hajj rituals, including prolonged walking, combined with age-related vulnerabilities like fatigue, dehydration, and heart strain, contribute to critical health risks for this group (Pane et al., 2019).

The long waiting period for Hajj in Indonesia, often ranging from 11 to 47 years, means many pilgrims are elderly by the time of departure, further increasing their risk (Idris & Nurwahyuni, 2022). Elderly pilgrims face higher mortality rates, with deaths ranging from 187 to 778 per 100,000 pilgrims (Febriyanti & Adisasmita, 2023). Research from Makkah Hajj Hospital shows that 85.1% of deaths were among those over 50, with nearly a third over 70 years old (Gaddoury & Armenian, 2023). Age-related declines in physical and immune function, along with increased susceptibility to non-communicable diseases like cardiovascular disease, diabetes, and cancer, heighten the risks for elderly pilgrims during Hajj (Gayatri et al., 2022; Fatihaturahmi et al., 2023). These findings highlight the importance of tailored health interventions for elderly pilgrims to address their unique needs and reduce the risks associated with the pilgrimage.

Relationship between Hypertension and Hajj Mortality

The findings indicated a correlation between hypertension and the mortality of Surabaya embarkation pilgrims in 2023. The results of statistical tests indicate that there is a 3.699-fold increased risk of death in pilgrims with hypertension compared to those without. This research is supported by Ardiana, Utami, et al., (2023), which reported a higher mortality rate among pilgrims with hypertension (0.29%) than those without (0.21%), with a statistically significant p-value <0.001 . Similar patterns were observed in West Java Province in 2019, where the mortality rate for pilgrims with hypertension was 0.3% compared to 0.2% for those without, indicating a 1.85-fold increased risk of death (Idris & Nurwahyuni, 2022). The study indicated that individuals with a history of hypertension exhibited a 1.85-fold increased risk of mortality.

The Hajj journey exposes pilgrims to physical and environmental stressors, including time zone changes, intense physical activity, and extreme heat, which can lead to insufficient rest and elevated blood pressure (Pusparina et al., 2020). These conditions make managing preexisting health issues challenging and may exacerbate them (Yezli et al., 2021). Uncontrolled hypertension accelerates mortality risk, particularly when complications affect vital organs (Bulu et al., 2021). Although not directly fatal, hypertension significantly increases the risk of life-threatening conditions such as stroke, coronary heart disease (CHD), and organ damage (Suciana et al., 2020).

Hypertension can trigger strokes through ruptured microaneurysms, causing fatal brain hemorrhage (Silaen & Ramadhani, 2019). It also contributes to CHD via mechanisms like endothelial dysfunction, atherosclerosis, and left ventricular enlargement, which disrupt the heart's oxygen supply-demand balance, increasing the likelihood of myocardial infarction (Naim et al., 2021). At Makkah Hajj Hospital, myocardial infarction accounted for nearly half of all Hajj-related deaths, while cardiovascular disease and hypertension contributed to 57.9% of ICU admissions. Hypertension specifically increased the risk of hospitalization-related death, with an odds ratio of 1.34 (Gaddoury & Armenian, 2023).

Relationship Between Diabetes Mellitus and Hajj Deaths

In addition to hypertension, which remains a significant concern among Hajj pilgrims, particularly the elderly, diabetes mellitus is another prevalent condition. One of the causes of death for Hajj pilgrims is diabetes mellitus (Alrufaidi et al., 2023). The results of this study indicate a correlation between diabetes mellitus and mortality among Hajj pilgrims embarking in Surabaya in 2023 (p-value = 0.000). These findings align with those of Huda et al. (2022), who observed a significant association between diabetes mellitus and the mortality of Hajj pilgrims at the Sultan Hasanuddin Makassar embarkation (p-value = 0.003). Furthermore, Hajj pilgrims in West Java Province with a history of diabetes mellitus are at a 2.22 times higher risk of mortality compared to pilgrims without a history of diabetes (Idris & Nurwahyuni, 2022). In this study, diabetes mellitus was identified as the dominant risk factor, with age and hypertension also playing a significant role. Hajj pilgrims with diabetes mellitus exhibited an 18.725-fold increased risk of mortality compared to pilgrims without diabetes mellitus.

The peak period of the Hajj pilgrimage, known as Armuzna (Arafah, Muzdalifah, and Mina), is marked by intensive physical and spiritual activities. The post-Armuzna phase in 2023 recorded a mortality rate of 202 deaths per 100,000 pilgrims, making it the leading contributor to Hajj-related fatalities (Febriyanti & Adisasmita, 2023). The pilgrimage presents unique challenges for individuals with diabetes mellitus, as it involves a demanding schedule of rituals that can disrupt

essential medical routines (Alyazidi et al., 2023). Diabetic pilgrims who neglect proper nutrition while relying on medication are prone to hypoglycemia, which can lead to severe complications such as stroke, diabetic coma, and death (Priyanto et al., 2022; Shaikh et al., 2020).

Diabetes mellitus was identified as the leading cause of death at Makkah Hajj Hospital, accounting for 710 (31%) of all fatalities in 2023 (Gaddoury & Armenian, 2023). Hospitalized diabetic pilgrims had a 44% increased risk of mortality, with an OR = 1.44 (95% CI: 1.27–1.63). Foot injuries were a frequent issue, often requiring surgical intervention due to long walking distances (5–15 km daily) in extreme temperatures of 50–60°C, which caused burns and heightened the risk of infections (Shaikh et al., 2020). Changes in dietary habits, including irregular meal times, further exacerbate the risks faced by diabetic pilgrims, contributing to complications and increased mortality (Algeffari, 2019). These findings underscore the importance of targeted health strategies to manage diabetes during the physically demanding Hajj pilgrimage.

CONCLUSION AND SUGGESTION

It can be concluded that age, hypertension, and diabetes mellitus are significant risk factors associated with the mortality of Surabaya embarkation pilgrims in 2023. These findings provide valuable insights for the broader community and the Surabaya Health Quarantine Center regarding the characteristics of pilgrims and the health risks contributing to Hajj-related deaths. Pilgrims are advised to mitigate these risks by maintain health by managing underlying conditions before, during, and after the Hajj pilgrimage. High-risk individuals should undergo regular health checks, adjust physical activity to their health status, ensure adequate rest, and maintain a balanced diet—bringing snacks to prevent hypoglycemia due to delayed meals. These findings underscore the importance of improving health protection for Hajj pilgrims through an integrated approach that combines promotive, preventive, curative, and emergency response measures. This strategy should be coordinated with the Ministry of Religious Affairs' data service system to ensure comprehensive monitoring and intervention for at-risk pilgrims.

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