



# Analyzing the trend of mortality due to traffic and nontraffic accidents: a study in the north of Iran

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**Background:** Examining the raw and standardized mortality rates is the primary strategy for improving life expectancy and human health in society through identifying risk factors and dealing with the factors that cause them.

**Objectives:** This study examined the trend of mortalities due to traffic and nontraffic accidents.

**Methods:** This cross-sectional study examines the registered mortalities during the years 2016–2022 in the form of a census in the health department's death registration and classification system. Mortality was analyzed as raw and standardized mortality in each 100 000 population.

**Results:** Out of 18 265 deaths during 2016–2022, 1305 (7.15%) were related to accidents and incidents. The age-standardized total mortality rate in the first year was 32.9, and in the final year of the study, it was 33.3 per 100 000 people; although there are fluctuations, this trend is upward ( $P.trend = 0.021$ ). Also, the age-standardized traffic death rate in the first year is 19, and in the final year is 12 per 100 000 people; this decreasing trend was not statistically significant ( $P.trend = 0.061$ ). The incidence of age-standardized intentional nontraffic deaths was 1.7 in the first year of the study interval and 9.8 in the last year in 100 000 people, which showed an upward trend ( $P.trend < 0.001$ ).

**Conclusion:** In light of the generally increasing trend of accidents, especially nontraffic accidents, universal and well-rounded measures are necessary for safety matters and reducing mortality.

**Keywords:** accidents and incidents, mortality, traffic and non-traffic

## Introduction

An important requirement in health-related planning of any society is the statistics and information on the death of that society<sup>[1]</sup>. The WHO defines an accident as an unexpected and unplanned event that can lead to injury. Injuries are generally divided into two categories: intentional and unintentional injuries. Unintentional accidents mainly include injuries caused by road accidents, poisoning, falls, drowning, and similar cases. Intentional accidents include harm to oneself, including suicide, or harm to others, including interpersonal violence, murder, etc.<sup>[2]</sup>. Accidents are the second leading cause of disabilities and

## HIGHLIGHTS

- Injuries are generally divided into two categories: intentional and unintentional.
- Road accidents in Iran are the second cause of death and the main cause of years of life lost.
- Determining the crude and standardized mortality trend in society, identifying risk factors, and dealing with the factors that cause them are the main strategies for increasing life expectancy and improving human health.
- Death based on different age and gender groups can also show how healthcare delivery and economic benefits vary between different groups of society.

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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Annals of Medicine & Surgery (2024) 86:3242–3248

Received 9 February 2024; Accepted 28 March 2024

Published online 19 April 2024

<http://dx.doi.org/10.1097/MS9.0000000000002043>

are one of the conditions that cause physical and mental problems and even death in some cases; every year, more than five million people lose their lives because of injuries caused by accidents worldwide<sup>[3]</sup>. The Global Burden of Disease study in 2022 estimated that 738 million people died in 2017 due to traffic accidents, and according to the latest reports, road traffic injuries are the eighth cause of mortality around the world. In recent years, the number of deaths caused by road accidents has been decreasing in high-income countries and stable in low-income countries and middle-income countries<sup>[4]</sup>. Low-income and middle-income countries, including Iran, have a 93% share of total road accident mortalities<sup>[5]</sup>; road accidents in Iran are the second cause of death and the main cause of years of life lost because of early death and the leading cause of injury<sup>[6]</sup>. Determining the crude and standardized mortality trend in

society, identifying risk factors, and dealing with the factors that cause them are the main strategies for increasing life expectancy and improving human health<sup>[7]</sup>. Death based on different age and sex groups can also show how healthcare delivery and economic benefits vary between different groups of society. These causes indicate the level of growth and development of the society<sup>[8]</sup>. Also, variations in mortality in different parts, such as urban vs. rural areas or between men and women, could indicate the equal or unequal distribution of resources, income, and services<sup>[9]</sup>.

Accidents have been investigated in different dimensions in studies. A survey conducted by Yousefzadeh *et al.*<sup>[10]</sup> in Gilan province showed that the main common causes of accidents are road traffic accidents (74.7%) and falls (98.4%). In another study in Iran, the average age of people was 30 years, and more than three-fourths (75.5%) of the cases were reported to be men<sup>[11]</sup>. The study of Zheng *et al.*<sup>[12]</sup> in California, USA, demonstrated that most incidents happened in individuals with an average age of 26 years. The results of Botchey *et al.*<sup>[13]</sup>'s study showed that road traffic accidents were the major cause of accidents (36.8%), and the most vulnerable group was the young population with an average age of 28 years. In Nigeria, more than 70% of accidents were caused by men<sup>[14]</sup>.

Determining mortality and its related causes in society to identify risk factors and deal with the factors that cause them is the primary strategy for increasing life expectancy and improving human health<sup>[7]</sup>. To compare mortality information at the international level, the WHO has provided rules and guidelines related to correctly completing the death certificates<sup>[15]</sup>. One of the most essential information recorded in the health system is information related to mortality, which can be reported in raw and standardized forms<sup>[16]</sup>. The crude mortality ratio is the ratio that can be expected from the division of all deaths in the study group by the number of deaths in the standard population with current death rates<sup>[17]</sup>. This study evaluated the trend of deaths caused by traffic and nontraffic accidents over 7 years. The years of change in the trend during the study period have been investigated and identified, the results of which can be helpful for the country's health policymakers to reduce casualties, and findings of our study could guide policymakers to make evidence-based decisions and design programs to improve survival. Also, the study results can effectively help health service managers and policymakers pay more attention to preventing injuries caused by traffic and nontraffic accidents. Considering the burden of this problem in society, the present study analyzes crude and standardized mortality trends due to accidents so that the relevant officials can take appropriate actions to plan for reducing accidents and the burden they cause.

## Methods

Our primary objective in this study was to analyze the trend of mortality due to traffic and nontraffic accidents. We investigated the trend of crude and age-standardized traffic mortality rates and the trend of crude and age-standardized nontraffic intentional and unintentional mortality rates.

### Study design

The current survey is a retrospective cross-sectional study, which was carried out after the Ethics Committee issued the code of ethics, and an introduction letter was obtained from the Research

and Technology Vice-Chancellor in coordination with the Health Vice-Chancellor of the University of Medical Sciences.

### Data collection and variables

All data related to the deaths during the years 2016–2022, recorded in the system of registering and classifying the causes of death of the health department according to the 10th edition of the International Classification of Diseases and Mortality (ICD-10), was extracted and examined by census method. Deaths caused by accidents included road traffic and nontraffic accidents (drowning, electrocution, falling, collision with objects, poisoning, etc.). The sources of obtaining the causes of death are the 'system of registration and classification of causes of death' in the health department (Ministry of Health and Medical Education), based on the valid death certificates from the mortuary, forensic medicine, hospitals, and all experienced doctors that are trained to register the causes of death. The inclusion criteria in this study were all reported deaths during 2016–2022 in the cause of death registration and classification system. The work has been reported per the strengthening the reporting of cohort, cross-sectional, and case-control studies in surgery (STROCSS) criteria<sup>[18]</sup>.

### Statistical analysis

To calculate and compare the mortality rates from accidents, estimating the population from 2016 to 2022 was necessary. It was estimated by calculating the population growth of the 2016 census. The city had 531 930 population in the national census of 2016. Also, according to the need for the population age groups of 2016–2022, the age groups of the mentioned years were estimated using the difference between the age groups of the census years and the population estimate. Crude and age-standardized rates (ASR) with a 95% CI were presented. To calculate the ASR, the world standard per 100 000 population was used<sup>[19]</sup>. Also, age groups were considered in 5-year intervals. After collecting and checking the data in terms of coding quality, mean and SD were utilized to describe quantitative variables. We used frequency and relative frequency to report qualitative variables. SPSS version 22 was used to perform descriptive analysis, and STATA version 14 was used to calculate ASR. Later, the mortality trend between the mentioned years, based on the mentioned factors, was investigated and analyzed using the Cochran-Armitage-Trend test. We considered ( $P < 0.05$ ) to be significant.

### Ethical approval

This study was done after receiving the ethical code. Registered data were used. All methods were performed following the relevant guidelines and regulations of the Declaration of Helsinki.

## Results

Of the 18 265 deaths that occurred during the years of 2016–2022, 1305 (7.15%) cases were related to accidents and incidents, the total average age was  $44.77 \pm 22.7$  years, the mean and SD of age regarding mortalities due to accidents and incidents in the group of road traffic accidents was equal to  $46.05 \pm 22.07$ , and in the group of nontraffic accidents, it was equal to  $43.35 \pm 23.49$ . The frequency and percentage of the causes of deaths due to accidents were categorized into three sections: traffic, nontraffic (intentional), and nontraffic (unintentional) in

the way that about half of the deaths, 686 (52.57%), were caused by road traffic accidents and the other half was nontraffic, from nontraffic death cases; 439 (33.64%) cases were unintentional and 180 (13.79%) cases were intentional.

Table 1 shows the age-standardized mortality. The highest frequency was in 2021, with a frequency of about 35 per hundred thousand people. The age-standardized incidence rate in the first year of the study was about 32.9, and at the end year, about 33.3 per hundred thousand people. Although there have been fluctuations, there has been an upward trend in general. Also, the Cochran Armitage test results showed a statistically significant trend ( $P_{trend} = 0.021$ ).

Chart 1 indicates that the year 2016 had the highest number of raw traffic fatalities per hundred thousand people. At the beginning of the study, the age-standardized incidence of traffic accidents was ~19, and by the end of the study, it had decreased to about 12 per hundred thousand people. Although there were fluctuations in between, this downward trend was not statistically significant ( $P_{trend} = 0.061$ ).

Based on Chart 2, the rate of intentional nontraffic age-standardized deaths increased significantly from about 1.7 per 100 000 people in the first year of the study to about 9.8 per 100 000 people in the final year of the study, with fluctuations observed in between ( $P_{trend} < 0.001$ ).

According to Chart 3, the crude and age-standardized mortality rate per hundred thousand population of nontraffic (non-intentional accidents), the year 2021 had the highest frequency in terms of crude mortality rate per hundred thousand population, the incidence rate in the first year was about 11.8, and in the final year, it was about 10.6 per 100 000 people, although there were fluctuations in between the overall trend was upward ( $P_{trend} = 0.146$ ).

According to the research, the mortality rate caused by road traffic factors has decreased in females ( $P = 0.029$ ) but remained unchanged in males ( $P = 0.375$ ). Additionally, the mortality rate has decreased in the rural population ( $P = 0.048$ ), while no significant trend was observed in the urban population ( $P = 0.589$ ) (Table 2).

In the study of intentional nontraffic deaths, the crude and age-standardized mortality rates in females ( $P < 0.001$ ) and males ( $P < 0.001$ ) generally had a significant upward trend. The crude and age-standardized mortality rates in the urban population ( $P < 0.001$ ) and rural population ( $P < 0.001$ ) generally had a significant increasing trend (more information is given in Table 3).

**Table 1**  
**Crude and age-standardized mortality rate due to accidents in study subjects per hundred thousand population during 2016–2022 (number = 1305)**

Year	Frequency	Crude mortality	Age-standardized mortality	95% CI
2016	197	35.5	32.9	37.7–28.1
2017	164	29.6	27.3	31.7–22.9
2018	166	29.9	26.9	31.1–22.6
2019	173	31.2	28.2	32.6–23.9
2020	166	29.9	28.4	32.9–23.9
2021	231	41.7	35.7	40.5–30.9
2022	208	37.5	33.3	38.0–28.6

**Table 2**  
**Crude and age-standardized mortality rate due to road traffic accidents by sex and residential status per hundred thousand population in 2016–2022**

Year	Frequency	Sex				Residence				
		Male		Female		Urban		Rural		
		Crude mortality	Age-standardized mortality	Crude mortality	Age-standardized mortality	Crude mortality	Age-standardized mortality	Crude mortality	Age-standardized mortality	
2016	111	27.6	26.1	12.3	12.5	13.1	12.6	23.6	23.6	21.6–35.6
2017	100	25.8	23.5	10.2	10.2	14.0	13.4	23.6	21.7	15.7–27.8
2018	100	26.9	24.8	9.1	8.0	10.9	9.6	27.9	25.9	19.4–32.4
2019	103	26.5	22.8	10.5	10.3	13.1	12.0	26.2	22.9	17.0–28.8
2020	90	26.5	25.2	5.8	5.6	9.9	10.2	24.9	22.6	16.6–28.5
2021	101	26.9	22.9	9.4	8.6	13.1	11.6	25.3	21.6	15.9–27.4
2022	81	22.2	19.5	6.9	6.3	12.1	10.7	18.0	16.0	11.0–21.2

$P$ -value trend for men = 0.375,  $P$ -value trend for women = 0.029,  $P$ -value trend for urban population = 0.589,  $P$ -value trend for rural population = 0.048.

According to Table 4, in cases of unintentional nontraffic deaths, there was no significant trend in the crude and age-standardized mortality rate for females ( $P=0.710$ ) and males ( $P=0.055$ ) in general. However, there was a significant increasing trend in the crude and age-standardized mortality rate for the rural population ( $P=0.008$ ).

### Discussion

In the current study, most of the reported mortalities happened due to road traffic accidents; more than 50% of the people were men aged less than 50 years, and the pattern of the crude and age-standardized mortality rate of accidents was upward; this trend in intentional and unintentional nontraffic accidents is also ascending. The trend of death because of road traffic accidents for women and the rural population has been upward. Regarding nontraffic accidents, this trend has been significant and upward for men and women and has also been significant based on residence status.

This study's findings show that the crude and age-standardized mortality rate trend of accidents was upward; this trend is also upward in intentional and unintentional nontraffic accidents; it has been demonstrated that the year 2019–2020 had the lowest number of mortalities because of accidents; this finding is in line with the study conducted by Qureshi *et al.*<sup>[20]</sup>, who pointed out that mandatory social quarantine in the city of Missouri resulted in the reduction of the amount of road traffic accidents. Considering the outbreak of COVID-19 beginning in 2019 and the initial lack of knowledge about this virus, early quarantines of people can justify this decrease in 2019–2020. The study by James *et al.*, who used the Global Burden of Disease Study results in 2017, noted that the age-standardized incidence rate of road injuries was rising between 1990 and 2017 while the crude death rate declined. Regionally, age-standardized mortality rates declined in all but two regions, South Asia and South Latin America, where rates did not have a meaningful change<sup>[21]</sup>. This suggests that crude road traffic fatality rates have improved in some regions in recent decades, but there is considerable geographic heterogeneity.

In the current study, road traffic accidents carried the highest rate of deaths among all accidents; it is mentioned in a survey conducted by Jamali *et al.*<sup>[22]</sup>, which evaluated the 14-year trend of pedestrian mortality that ages over 65 and accidents in urban areas had a direct relationship with pedestrian death. In a research conducted by Yazdani *et al.*<sup>[23]</sup>, who examined the epidemiology of fatal traffic accidents in Sari City for a year, they pointed out that the number of people who lost their lives in traffic accidents in Sari City was 112 in 2014, which was higher than other incidents. The study by Dennis Zheng and colleagues, who investigated the causes of death in Uganda for 4 years (2016–2019), indicated that falls in 36% of cases and road traffic injuries in 35% of cases were the main mechanisms of trauma<sup>[12]</sup>. Based on the findings of the present study, injury to a person in a road traffic accident is the most common cause of death, which is similar to the results of most studies in this field<sup>[24]</sup>. The survey conducted by Askarishahi *et al.*<sup>[25]</sup>, who examined the trend of death due to road accidents in Iran over 12 years, pointed out that an average of 27 people per 100 000 people died in driving accidents from 2006 to 2017. The high statistics of this category of death remind us that many deaths are

**Table 3**

**Crude and age-standardized death rate due to intentional nontraffic accidents by sex and residential status per hundred thousand population between 2016 and 2022**

Year	Frequency	Sex						Residence					
		Male			Female			Urban			Rural		
		Crude mortality	Age-standardized mortality	95% CI	Crude mortality	Age-standardized mortality	95% CI	Crude mortality	Age-standardized mortality	95% confidence interval	Crude mortality	Age-standardized mortality	95% CI
2016	11	2.9	2.5	0.7–4.3	1.1	0.9	0.0–2.0	1.2	1.6	0.3–3.0	2.1	1.9	0.2–3.5
2017	13	3.6	3.1	1.1–5.1	1.1	1.2	0.0–2.6	1.9	1.7	0.3–3.1	2.6	2.7	0.5–4.8
2018	20	5.0	4.0	1.9–6.2	2.2	2.0	0.4–3.7	1.9	1.6	0.3–2.9	6.0	5.1	2.3–7.8
2019	11	3.9	3.4	1.4–5.5	0.0	0.0	0.0–0.0	0.9	0.8	0.0–1.7	3.4	3.0	0.9–5.1
2020	26	3.9	3.6	1.4–5.7	5.4	5.4	2.8–8.7	4.0	4.1	1.8–6.4	5.6	5.4	2.3–8.5
2021	40	8.2	6.8	3.9–9.7	6.2	6.2	2.4–7.0	7.2	5.2	3.0–7.3	7.3	6.8	3.5–10.1
2022	59	16.1	14.6	10.2–18.9	5.1	5.1	2.2–7.6	8.4	8.0	4.9–11.2	13.7	12.2	7.9–16.5

*P*-value trend for men <0.001, *P*-value trend for women <0.001, *P*-value trend for urban population <0.001, *P*-value trend for rural population <0.001.

Table 4

Crude and age-standardized mortality rates due to unintentional nontraffic accidents by sex and residential status per hundred thousand population from 2016 to 2022

Year	Frequency	Sex						Residence					
		Male			Female			Urban			Rural		
		Crude mortality	Age-standardized mortality	95% CI	Crude mortality	Age-standardized mortality	95% CI	Crude mortality	Age-standardized mortality	95% CI	Crude mortality	Age-standardized mortality	95% CI
2016	75	18.3	15.5	11.0–19.9	8.7	8.1	4.7–11.5	12.7	11.2	7.6–14.8	14.6	12.6	8.2–17.0
2017	51	14.0	12.8	8.6–17.0	4.4	3.6	1.4–5.7	7.2	7.0	4.0–10.1	12.0	9.9	6.0–13.7
2018	46	11.1	10.0	6.3–13.8	5.4	4.6	2.2–7.2	6.5	5.7	3.1–8.3	10.7	9.6	5.7–13.5
2019	59	15.4	14.2	9.8–18.5	5.8	5.7	2.8–8.6	9.0	8.3	5.2–11.4	12.9	12.2	7.6–16.8
2020	50	13.6	12.6	8.4–16.8	4.4	4.0	1.7–6.4	5.9	5.9	3.1–8.6	13.3	11.8	7.4–16.2
2021	90	25.1	22.1	16.7–27.6	7.3	6.2	3.4–9.0	10.6	9.2	6.0–12.5	24.0	21.0	15.2–26.8
2022	68	18.3	15.5	11.1–19.9	6.2	5.7	2.8–8.7	8.4	6.7	4.1–9.3	17.6	16.0	10.8–21.1

P-value trend for men = 0.055, P-value trend for women = 0.71, P-value trend for urban population = 0.43, P-value trend for rural population = 0.008.

caused by social and cultural conditions and require social and cultural policies to promote health. Based on the WHO report in 2015, the mortality rate because of road accidents was 40 cases per 100 000 in Iran in 2005; it reached 24 cases per 100 000 in 2014 and had a downward trend<sup>[26]</sup>. In spite of the improvements made in recent years in the field of road accident prevention, it is still the main cause of injuries and the second cause of death in Iran<sup>[27]</sup>. There are still many obstacles to preventing road accidents in Iran. The mass production of cars in the last two decades, which has not been accompanied by progress in other aspects of injury prevention, like environmental and behavioral changes, has caused an increase in traffic accidents. Askarishahi *et al.*<sup>[25]</sup>'s study showed that an average of 27 people per hundred thousand population were killed in driving accidents during 2006–2017.

According to this study, young people constitute a large number of victims of accidents, both in traffic and nontraffic. In terms of the age-specific mortality rate, the mortality rate generally increases with age. This trend was statistically significant, and these findings are similar to the results of Alberdi and Majercik, who stated in their studies that the age-standardized mortality rate increases with age<sup>[28,29]</sup>. Peterson *et al.*<sup>[30]</sup> point out that in older adults ( $\geq 75$ ), unintentional falls and suicide are the most important external causes of death. Another study by Seid *et al.*<sup>[31]</sup> stated that older age is a statistically significant predictor of mortality among victims; they also reported that road accidents are a significant public health issue and that urgent preventive measures for road accidents and urgent treatment of victims are necessary to decrease morbidity and mortality among them. Since the studied cases are often of working and production age and many of them are part of the active workforce of the society, their injuries impose serious social and economic costs compared to other groups, so more attention should be paid to preventing injuries in this age group. In the article of Bäckström *et al.*<sup>[32]</sup>, they found out that during the years 1999–2012, the mortality due to injuries in the working age group decreased and increased in people 64 years and older; these findings indicate that the mortality issue because of unintentional injuries should be specifically addressed. Correct planning and solutions, such as adopting appropriate regulations and cultural development regarding the use of vehicles, especially at a young age, are warranted, and more attention should be paid to increasing people's knowledge, especially concerning prevention strategies. Among other strategies, not driving long distances can have promising effects in decreasing accidents<sup>[33,34]</sup>.

Our research revealed that the crude and age-standardized mortality rate due to traffic accidents in women and the rural population had a decreasing trend. However, no significant trend was observed in men and the urban population. Generally, the frequency of injuries in males is higher than in females, similar to most articles published in other countries<sup>[35–38]</sup>. Also, in the survey conducted by Askarishahi *et al.*<sup>[25]</sup>, who investigated the trend of death due to road accidents in Iran over 12 years, they pointed out that most victims of accidents were men. In the review of other studies in Iran, Sarbaz *et al.*<sup>[39]</sup>'s study aimed to evaluate the epidemiology of traffic accidents in patients referred to the trauma department of Mashhad hospitals, and in a 1-year survey, most of the subjects involved in traffic accidents were men (75%). The study of Michael Alemayehu *et al.*<sup>[40]</sup> in 2023 pointed out that in a 5-year period

(2015-2019) in Ethiopia, more than 70% of deaths from accidents occurred in men. In the present study, men tend to have a higher number of deaths caused by accidents than women. In Iran, men are more vulnerable to accidents due to the country's socio-cultural conditions. They tend to drive more, face more occupational threats, and suffer injuries from violent incidents. This phenomenon is common in most low-income countries and middle-income countries compared to high-income countries. Also, less than 30% of women in Iran have a driver's license<sup>[41]</sup>, which explains part of the mentioned sex mortality differences in vehicle drivers since the number of male drivers is higher.

The study by Faghihi *et al.*<sup>[42]</sup>, which examined the rate and causes of death in 5 years (2004–2008), indicated that the rate of death in the rural population was twice that of the urban population. Rural roads, which are mostly dirt, without traffic signs, and devoid of urban road standards regarding the condition of lights, speed bumps, and other issues, can be the reasons for this result.

A limitation of our study is that because of the unavailability of variables, we only analyzed the data based on sex, age, and place of residence.

## Conclusion

According to the findings, from 2016 to 2022, we see a large share of mortality due to traffic accidents as well as an increasing trend of deaths caused by nontraffic accidents, considering that this trend of mortality is increasing and these trends are more evident in young groups, it is suggested that universal and multilateral measures in safety matters and reducing deaths through education, improving road infrastructure, car safety, monitoring, creating solid and deterrent laws, using up-to-date technology and promoting safety culture and, most importantly, mental health training should be encouraged by policymakers to reduce accidents, especially nontraffic accidents.

## Ethical approval

This study was done after holding the ethical code of IR.MUBABOL.REC.1402.058 from Babol University of Medical Sciences. Registered data were used. All methods were performed in accordance with the relevant guidelines and regulations of the Declaration of Helsinki.

## Consent

Not applicable.

## Sources of funding

This research did not receive any specific grant from any funding academic center, public/commercial, or not-for-profit sector.

## Author contribution

H.A.N. and M.A.J.: conceived and designed the study; F.F. and Z.F.: collected the data; H.A.N. and M.J.: analyzed the data; Z.F. and S.N.H.: wrote the paper; H.A.N.: revised the paper; M.A.J.: supervision; H.A.N. and M.A.J.: approval of the final

manuscript. The manuscript was approved for publication by all authors and jointly decided to publish it.

## Conflicts of interest disclosure

The authors declare that they have no conflicts of interest.

## Research registration unique identifying number (UIN)

Not applicable.

## Guarantor

Mohammad Ali Jahani: Corresponding author.

## Data availability statement

The data set is in the possession of the responsible author and will be provided upon reasonable request.

## Provenance and peer review

Not commissioned, externally peer-reviewed.

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