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Original article

Diabetes in patients with incident acute myocardial infarction: characteristics, frequency, treatment and complications in a population-based sample

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ABSTRACT

Objective: To investigate predictors of a diabetes diagnosis after an acute myocardial infarction (AMI) and to examine characteristics, preventive measures, treatment and complications of diabetic AMI patients.
Methods: AMI patients registered by the Myocardial Infarction Registry Augsburg between 2017 and 2019 (n = 1.712) received a postal questionnaire in 2023 with questions on diabetes status, diabetes care and diabetes related complications (response: 50.1 %). Logistic regression models were calculated to identify predictors related to a subsequent diabetes diagnosis after first-time AMI. For diabetic patients, important characteristics of diabetes care and the frequency of complications were examined. Additionally, it was examined which diabetic AMI patients were aware of the interconnection between diabetes and AMI.
Results: A total of 200 patients (27.4 %) that responded to the survey had diabetes, 40 of them received the diagnosis after first-time hospitalized AMI. Body mass index (BMI) [OR: 1.13 [1.05–1.21], p value: 0.001] and blood glucose levels [OR: 1.01 [1.00–1.02], p value: 0.007] at hospital admission were independent predictors of a diagnosis of diabetes during follow-up. Three quarters of diabetic AMI patients knew their current HbA1c value (median 6.9 %; IQR: 6.2–7.4 %). Only 40 (23 %) patients with diabetes were aware of the interconnection between diabetes and AMI.
Conclusion: BMI and admission blood glucose were predictors of diabetes after AMI. Based on HbA1c values, overall glycemic control needs improvements in many patients. Less than a quarter of diabetic AMI patients were aware of the relationship between diabetes and AMI which emphasizes the need for specific education of these patients.

Introduction

Diabetes mellitus is a major risk factor for the development of coronary artery disease (CAD) and acute myocardial infarction (AMI) [1,2]. However, diabetes not only increases the risk of developing CAD or AMI, but also impairs the prognosis after AMI [3–5]. Nevertheless, many AMI patients with diabetes or disturbed glucose tolerance are not diagnosed with this diseases and unaware of their condition [6], indicating a specific need for improvement. A good disease management, and most important a sufficient (but not necessarily a very strict) blood glucose control are essential especially in patients suffering from both, diabetes and CAD [7–10]. However, even in individuals with sufficient medication- or insulin-based diabetes control, long-term secondary diseases like nephropathy, retinopathy and neuropathy are quite common [11–13]. The aim of this analysis was therefore to study independent predictors of a subsequent diabetes diagnosis after an incident AMI and to examine important characteristics, preventive measures, treatment, and complications of diabetic patients after hospitalized AMI.

Material and methods

Study population

The present study was based on data from a postal follow-up survey on AMI patients recorded by the Augsburg Myocardial Infarction Registry between 2017 and 2019. The registry was established in 1984 as a part of the MONICA-project (Monitoring Trends and Determinants in Cardiovascular disease) and is characterized by a population-based approach with complete enrollment of all cases of coronary death and non-fatal AMI in the study region of Augsburg, Germany (city of Augsburg and the two adjacent counties, approximately 680.000 inhabitants). Inclusion criteria for AMI patients are a primary residence in the

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study region and being 25 years of age or older at time of infarction. Methods of case identification, diagnostic classification of AMI and data quality control can be found elsewhere [14].

The methods of the registry including this follow-up survey were approved by the ethics committee of the Bavarian Medical Association (Bayerische Landesärztekammer, Bavarian Chamber of Physicians). The study was conducted in accordance with the Declaration of Helsinki. All patients gave written informed consent. The study was registered at the German Register of Clinical Studies (DRKS, project number DRKS00029042).

Postal follow-up survey

In April 2023, all survivors of a hospitalized AMI (incident or recurrent) recorded between 2017 and 2019 (n = 1.712) by the Myocardial Infarction Registry received a postal questionnaire. Overall, 857 (50.1 %) patients returned the questionnaire immediately or after a postal reminder. A total of 855 patients did not fill out the questionnaire. Thereof 67 patients had died, another 104 had moved with unknown address, and finally 42 stated that they were not willing or unable to answer the questions. The remaining patients did not respond at all to the survey or the postal reminder. For the present analysis, only patients with a first-time hospitalized myocardial infarction (incident AMI) were considered (n = 742), 115 patients with myocardial reinfarction were excluded. Further 12 patients were excluded due to an unclear diabetes status, so the final sample included n = 730 patients. All inclusions and exclusions are displayed in Fig. 1 (flow chart). Median time between first-time AMI and completing the questionnaire was 4.8 years [IQR: 3.3 −6.4 years].

Next to general sociodemographic information (age, gender, marital status, education), the postal survey included questions about the current body mass index (BMI) and waist circumference, important lifestyle habits (physical activity, diet), hypertension and intake of antihypertensive medication, family history of diabetes, and a physician diagnosis of diabetes mellitus. Patients with such a diagnosis were further asked about the type of diabetes (type 1 or type 2), treatment (diet, medication, insulin) and the implementation of the following preventive measures (yes/no): alcohol reduction, physical activity, weight reduction, diet changes, regular medical check-ups and participations at disease management programs (DMPs). Additionally, diabetic patients were asked whether they know their normal HbA1c values, and if so, the exact value of the latest HbA1c value had to be specified. Finally,

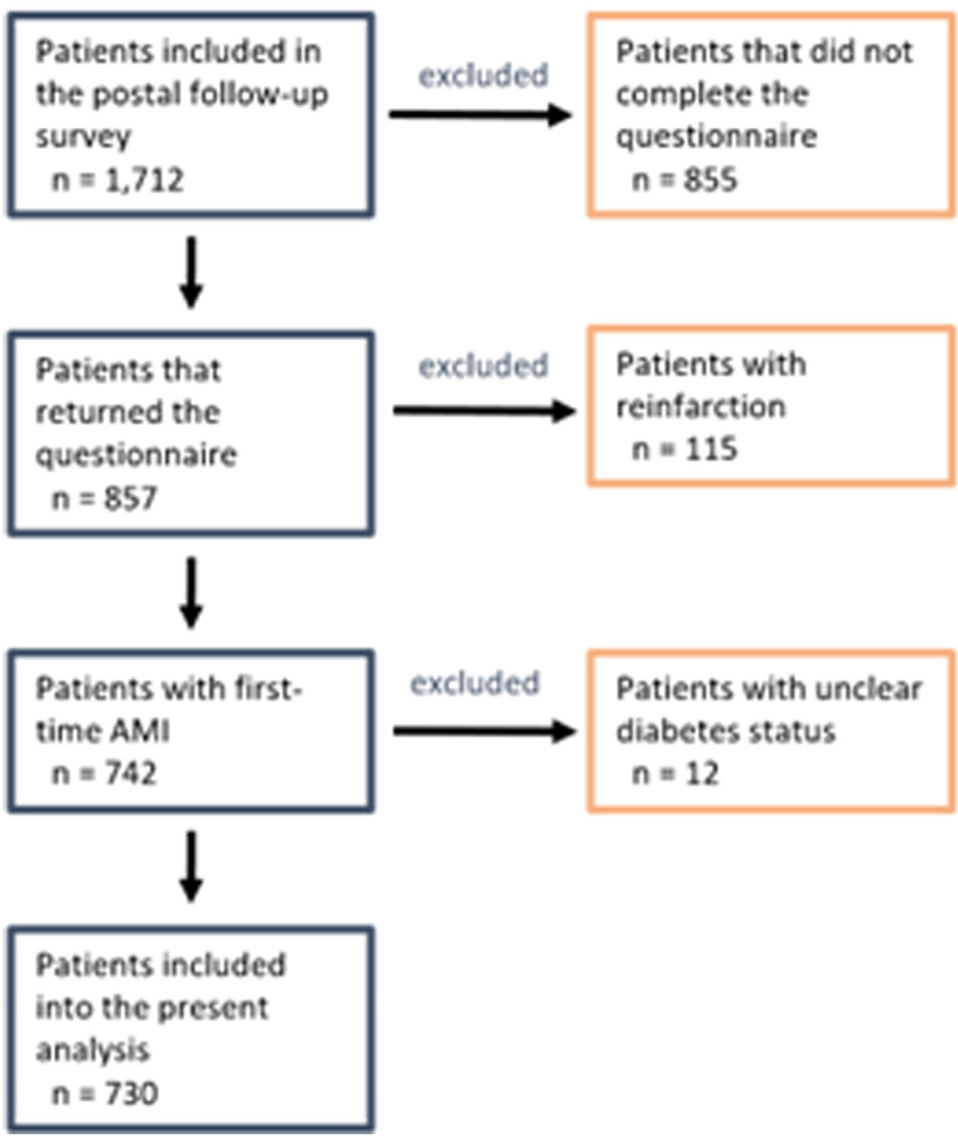

Fig. 1. Flow chart represents all inclusions and exclusions with a final sample size of 730 patients.

patients were asked whether they believe that there is a connection between their diabetes disease and AMI. The corresponding questions of this first part of the follow-up survey were self-created and not validated.

After these topics, the follow-up survey continued with two validated questionnaires regarding mental health, which were the Patient Health Questionnaire (PHQ-9) [15,16] and the German version of the Mental Health Literacy Scale (MHLS-GER) [17−19].

Important data concerning the acute event (first-time hospitalized AMI) was recorded within the scope of the routine data collection of the Augsburg Myocardial Infarction Registry (obtained by patient interview or extracted from medical records). Recorded information included: AMI type (STEMI/NSTEMI), percutaneous coronary intervention (PCI, yes/no), bypass therapy (yes/no), comorbidities at the acute event (hypertension, hyperlipidemia, impaired renal function), typical chest pain symptoms (yes/no), prehospital time in minutes and laboratory values (peak CK-MB levels [U/L], admission glucose levels [mg/dl]).

Statistical analysis

Continuous variables were described as means ± standard deviations (SD) or median and inter-quartile range (IQR); categorical variables were reported as absolute and relative frequencies. For continuous variables, subgroup differences were tested using t-test or Mann-Whitney U-Test and ANOVA or Kruskal-Wallis test, respectively. For categorical variables chi-squared tests were applied.

To identify predictors of a subsequent diabetes diagnosis in non-diabetic, first-time AMI patients, a parsimonious logistic regression model was calculated. Initially considered potential predictors were sex, age, admission glucose, BMI, diabetes family history (direct history: parents, siblings, children; indirect family history: distant relatives), type of infarction (STEMI/NSTEMI), smoking status and hypertension. Using backwards elimination, the variable with the highest p value was removed in a step-by-step manner until only predictors with significant p values remained in the final model. Sex and age were forced to stay in the model at all times.

For significant predictors identified in the parsimonious logistic regression model, we performed a receiver operating characteristic (ROC) analysis and calculated the Area under the curve (AUC). P values for the comparison between two different ROC curves were calculated using bootstrapping.

For patients with a diagnosis of diabetes, further logistic regression models were calculated to identify patients with a specifically high chance of being not aware of a potential interconnection between their diabetes disease and AMI (outcome). The outcome variable was coded with 1 if the patient stated to be aware of the relation between diabetes and AMI and with 0 if he was not sure about this connection (answers 'no' and 'dont know' combined). First, univariable logistic regression models were calculated including one of the following exposures: sex, age, education (high education = "Abitur" [diploma from German secondary school qualifying for university admission] or university degree; low education), marital status and a further variable indicating whether the diabetes diagnosis was before or after the incident AMI. Finally, a multivariable-adjusted logistic regression model was calculated including all the above mentioned variables.

For all statistical analyses, an alpha level of 0.05 was defined as statistically significant. All statistical analyses were performed with the R program version 4.3.2.

Results

Of a total of 730 patients, 160 had prevalent diabetes, meaning they had a diagnosis of diabetes before AMI. Furthermore, 40 out of 570 patients (7.0 %) were diagnosed with incident diabetes in the time between their first-time AMI and follow- up (median: 4.8 years, IQR: 3.3 −6.4 years) and 530 patients had no diagnosis of diabetes until the follow-up survey. While patients with prevalent diabetes were younger (mean age: 60.8 years) than the other two groups (mean age non-diabetic patients: 65.1, mean age patients with incident diabetes: 67.9 years), there were no significant differences regarding sex and education (see Table 1). Patients with prevalent diabetes were the most likely of having a family history of diabetes, while there were only small differences between the other two patient groups in this regard. Patients without diabetes had the lowest BMI (median BMI: 26.6 kg/m²), followed by the group of AMI patients with prevalent diabetes (median BMI: 28.2 kg/m²) and the group with incident diabetes (median BMI: 29.6 kg/m²). Diabetes before the event went along with a higher frequency of comorbidities (hypertension, hyperlipidemia, impaired renal function [determined at the time of the acute event]), and the patients without a diabetes diagnosis until follow-up survey were the least likely to suffer from these comorbidities. Interestingly, AMI patients with prevalent diabetes were the least likely to present with typical chest pain (75 %),

Table 1
Baseline characteristics of the total sample stratified for patients with diabetes diagnosed before AMI, diabetes diagnosis after incident AMI and patients without diabetes diagnosis until the follow-up survey.

	Diabetes before AMI (n = 160)	*Diabetes after AMI* (n = 40)	*No diabetes* (n = 530)	P Value	N*
Female	42 (26.2)	7 (17.5)	121 (22.8)	0.450	730
Age (mean, SD)	67.9 (10.0)	60.8 (9.6)	65.1 (11.3)	<0.001	730
High education	31 (19.4)	12 (30.0)	111 (21.2)	0.339	723
BMI	28.2 (25.7–32.2)	29.6 (26.8–32.1)	26.6 (24.3–29.4)	<0.001	729
Family history of diabetes (parents, children or siblings)	72 (47.4)	12 (30.8)	119 (22.7)	<0.001	716
Family history of diabetes (distant relatives)	25 (16.4)	3 (7.7)	34 (6.5)	0.001	716
Hypertension	140 (87.5)	28 (70.0)	349 (65.8)	<0.001	730
Hyperlipidemia	117 (73.1)	21 (52.5)	269 (50.8)	<0.001	730
Renal Function				0.001	730
normal	111 (69.4)	31 (77.5)	438 (82.6)		
slightly impaired	41 (25.6)	9 (22.5)	84 (15.8)		
severely impaired	6 (3.8)	0 (0.0)	2 (0.4)		
missing value	2 (1.2)	0 (0.0)	6 (1.1)		
Typical chest pain at AMI	120 (75.0)	35 (87.5)	451 (85.1)	0.009	730
Prehospital time in minutes	201.0 (85.5–867.0)	163.5 (76.2–735.0)	172.5 (79.2–603.5)	0.586	643
Type of infarction: STEMI	54 (36.0)	17 (43.6)	226 (45.6)	0.117	685
Admission glucose (mg/dl)	177.5 (143.0–226.2)	133.5 (117.0–168.2)	122.0 (107.0–142.0)	<0.001	714
Peak CK-MB levels (U/L)	50.0 (28.0–120.0)	131.0 (57.0–321.5)	69.5 (34.0–162.8)	<0.001	622
PCI (at AMI)	138 (86.2)	37 (92.5)	451 (85.3)	0.442	729
Bypass therapy (at AMI)	17 (10.8)	2 (5.0)	50 (9.5)	0.541	723

* Number of cases with valid information for this variable

Table 2
Results of the parsimonious logistic regression model evaluating the association between different characteristics at the acute event and a subsequent diagnosis of diabetes. Only BMI and admission glucose were significantly associated with a future diagnosis of diabetes. The variables sex and age were forced to stay in the final model.

	OR [95 % CI]	*P value*
Age	0.98 [0.95–1.01]	0.180
Sex (female)	0.78 [0.32–1.89]	0.579
BMI	1.13 [1.05–1.21]	0.001
Admission glucose	1.01 [1.00–1.02]	0.007

while the frequency of this most typical symptom was similar in the two remaining groups (patients with incident diabetes:87.5 %, non-diabetic patients: 85.1 %). The three groups did not differ significantly regarding prehospital time or type of infarction (STEMI/NSTEMI). There was also no significant difference in invasive treatment procedures (PCI and bypass therapy). According to peak CK-MB levels, the patients with incident diabetes had the most severe infarctions, followed by the patients without diabetes diagnosis. As to be expected, patients with prevalent diabetes had the highest admission blood glucose levels (median: 177.5 mg/dl), followed by patients with incident diabetes (median: 133.5 mg/dl) and the patients without diabetes (122 mg/dl).

In fact, admission blood glucose levels were predictive of a subsequent diagnosis of diabetes after infarction. Table 2 shows the results of a logistic regression model predicting a diagnosis of diabetes after incident AMI (parsimonious model). Next to blood glucose, BMI was also significantly associated with a future diagnosis of diabetes. Interestingly, age and sex did not show significant associations, but were forced to stay in the model anyway. Fig. 2 displays the ROC curves for BMI (AUC = 0.6815 9 and admission glucose (AUC = 0.6407).

Out of 200 AMI patients with prevalent or incident diabetes until follow-up survey, 7 stated to have diabetes type 1 and 163 had type 2 diabetes, for 30 patients there was no information on diabetes type (Table 3). More than two thirds of male and female patients with diabetes received oral diabetes medication, and 36.6 % were treated with insulin. Diabetes-related complications were quite common with cataracts affecting more than 40 % of the patients. The vast majority of patients implemented preventive measure such as more physical activity, weight loss and diet changes in response to their diabetes diagnosis. Although more than 80 % of the patients attended regular check-up examinations, only a minority participated in a 'disease management program' (DMP). Almost 3 out of 4 patients with diabetes who responded to the survey knew their current HbA1c value; the median HbA1c value of these patients was 6.9 % (IQR: 6.2–7.4 %). Nevertheless, only 23 % of the patients believed that there was an interconnection between their diabetes disease and AMI (34.5 % didn't believe there was a relationship and 42.5 % stated they dont̕ know).

Table 4 presents the results of the logistic regression models assessing the association between patient characteristics (independent variables) and whether the patient suggested a relation between diabetes mellitus and AMI (binary outcome: 1 = 'yes' and 0 = 'no' or 'dont̕ know'). None of the examined independent variables 'age', 'sex', 'education', 'married', 'type of infarction' or 'diabetes diagnosis before AMI' was significantly associated with the outcome; neither in the unadjusted logistic regression models nor in the multivariable adjusted model.

Discussion

This study evaluated data obtained by a postal follow-up survey of AMI patients registered by the Augsburg Myocardial infarction registry and found, that BMI and admission glucose (both determined at time of infarction) are predictors of a subsequent diagnosis of diabetes in patients without previously known diabetes. Many patients with diabetes suffered at least from one complication, with cataract being the most frequent one. More than 70 % of the diabetic AMI patients were aware of their latest HbA1c value. These patients had an HbA1c median value of 6.9 % (IQR: 6.2–7.4 %). However, only 23 % of AMI patients with diabetes were conscious of a potential relationship between a diabetes mellitus disease and the risk of AMI.

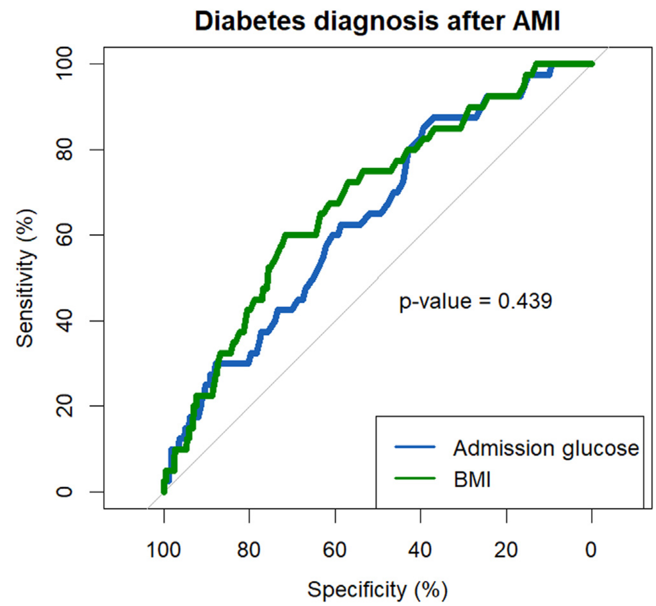

Fig. 2. ROC curves for a diagnosis of diabetes in AMI patients without previously diagnosed diabetes. The green curve displays the predictive ability of BMI with an AUC of 0.6815 [95%CI: 0.5956–0.7607] and the blue curve shows the predictive ability for admission glucose (AUC: 0.6407 [95%CI: 0.5547–0.7298]). The p value was obtained using bootstrapping.

Predictors of diabetes diagnosis after incident AMI

As previous studies from this registry demonstrated, there is a relevant amount of AMI patients with unknown diabetes or pre-diabetes and consequently a relevant underdiagnosis of diabetes in AMI patients [6]. Moreover, diabetes and coronary artery disease share common risk factors like obesity and smoking [20]. Both circumstances would suggest, that in the years after a first-time AMI, many patients without previously known diabetes receive a diabetes diagnosis or develop this condition.

In a previous publication from this Registry, admission blood glucose was an independent predictor of diabetes after incident AMI [21], a result we confirmed by this study. Even though blood glucose levels can be temporarily elevated in acute, severe diseases even in healthy individuals (stress hyperglycemia) [22,23], blood glucose disturbances at hospital admission remained a significant predictor of subsequent diagnosis of diabetes. High BMI is known to be a major risk factors for diabetes [24] and, in line with this, it was a significant predictor of diabetes after first-time AMI in the present study. It is well established, that a family history of diabetes represents a genetic predisposition and is therefore also a strong predictor of an increased diabetes risk [25,26]. And indeed, we found that patients with a diagnosis of diabetes before AMI were by far the most likely to have a positive family history. Contrary to this, a positive family history of diabetes was not significantly associated with a subsequent diabetes diagnosis in patients without diabetes at time of incident AMI; a circumstance which might be explained by a lack of power due to the limited sample size.

Table 3
Disease characteristics, complications and preventive measures of AMI patients with diagnosed diabetes mellitus (before or after AMI).

	Total sample (n = 200)	Male (n = 151)	Female (n = 49)	P Value	N*
Age (mean, SD)	66.4 (10.3)	65.9 (10.1)	68.1 (10.9)	0.217	200
Type of diabetes				0.919	200
Type 1	7 (3.5)	5 (3.3)	2 (4.1)		
Type 2	163 (81.5)	124 (82.1)	39 (79.6)		
Type unknown	30 (15.0)	22 (14.6)	8 (16.3)		
Diabetes diagnosis **after** AMI	40 (20.0)	33 (21.9)	7 (14.3)	0.344	200
Knowledge of the usual blood glucose and HbA1c values**	114 (73.5)	86 (72.9)	28 (75.7)	0.902	155
Latest HbA1c value	6.9 (6.2–7.4)	6.9 (6.2–7.4)	6.5 (6.3–7.2)	0.855	102
Suspected relationship between diabetes and AMI***				0.221	174
Yes	40 (23.0)	31 (23.5)	9 (21.4)		
No	60 (34.5)	41 (31.1)	19 (45.2)		
Dont know	74 (42.5)	60 (45.5)	14 (33.3)		
Current treatment					
Any treatment	190 (95.0)	143 (94.7)	47 (95.9)	1.000	200
Special diet	19 (9.5)	16 (10.6)	3 (6.1)	0.517	200
Oral medication	135 (69.2)	102 (68.9)	33 (70.2)	1.000	195
Insulin therapy	68 (36.6)	53 (38.1)	15 (31.9)	0.555	186
Complications					
Diabetic kidney disease	17 (13.1)	12 (12.2)	5 (15.6)	0.849	130
Diabetic retinopathy	19 (15.6)	11 (12.2)	8 (25.0)	0.153	122
Cataract	59 (43.1)	43 (41.3)	16 (48.5)	0.603	137
Diabetic foot syndrome	23 (18.0)	19 (19.4)	4 (13.3)	0.628	128
Diabetic polyneuropathy	25 (20.7)	18 (19.6)	7 (24.1)	0.789	121
Preventive measures					
Drinking less alcohol	77 (55.8)	59 (54.6)	18 (60.0)	0.752	138
More physical activity	124 (77.5)	91 (74.6)	33 (86.8)	0.175	160
Weight reduction	114 (73.1)	82 (70.1)	32 (82.1)	0.211	156
Diet changes	122 (77.7)	90 (75.6)	32 (84.2)	0.377	157
Regular check-up examinations	133 (82.1)	100 (80.6)	33 (86.8	0.529	162
Disease management program (DMP, yes/no)					
DMP Diabetes	54 (35.1)	40 (33.6)	14 (40.0)	0.621	154
DMP KHK	40 (28.4)	30 (27.5)	10 (31.2)	0.851	141

* Number of cases with valid information for this variable
** Do you know your usual blood glucose and HbA1c values?
*** Do you think your diabetes and your heart attack are related?

Table 4
Results of the logistic regression models evaluating the association between important patient characteristics (independent variables) and a suspected relationship between the diabetes disease and AMI (outcome). The outcome variable was encoded as binary variable (1 = suspected relationship between the diabetes and AMI, 0 = no suspected relationship or 'don't know'). The regression model included all patients with a diagnosis of diabetes at time of the follow-up survey (n = 200).

	Unadjusted models		Multivariable adjusted model (including all independent variables)	
	OR (95 % CI)	p value	OR (95 % CI)	p value
Age	0.99 [0.95–1.02]	0.411	0.96 [0.93–1.00]	0.071
Sex -female	0.89 [0.38–2.06]	0.783	0.89 [0.34–2.30]	0.809
Low Education	0.79 [0.35–1.81]	0.582	0.90 [0.35–2.32]	0.823
Family status -not married	1.23 [0.59–2.56]	0.585	1.10 [0.48–2.52]	0.822
Type of infarction - STEMI	1.45 [0.68–3.09]	0.341	1.34 [0.61–2.94]	0.469
Diabetes diagnosis before AMI	2.38 [0.86–6.56]	0.094	2.82 [0.97–8.18]	0.057

Diabetes management and complications in AMI patients

The data of our follow-up survey suggests, that about three quarters of all AMI patients with diabetes know their current HbA1c, meaning they have an overall awareness of their medication-based diabetes and blood glucose control. This arguably high number indicates that most diabetic AMI patients are actively involved in the treatment of their diabetes disease. It must be considered though, that this number might be biased upwards, as non-responders of the follow-up survey are likely to be less interested in their diseases and have an overall lower health awareness, so we suspect that the number of diabetic AMI patients knowing their current HbA1c might well be substantially lower in the non-responders.

HbA1c is a commonly used marker for monitoring long-term blood glucose, as it represents the average glucose levels over the past weeks and months [27]. The *2023 ESC Guidelines for the management of cardiovascular disease in patients with diabetes*, recommends to aim for HbA1c values of less than 7 % by tight, but not necessarily intensive glycemic control [28]. That means that only half of the patients in this study (median HbA1c value was 6.9 %) would meet these therapeutic goals, indicating a need for improvements regarding glycemic control in a relevant proportion of patients. In a recent observational study, Choi et al. reported that diabetic AMI patients with HbA1c values between 6.6 and 7.0 % had the lowest all-cause mortality compared to all other groups with either higher or lower HbA1c (U- or J-shaped association) [7] . The median HbA1c found in this study lies precisely in this range, so the overall glycemic control in this study sample might be described as adequate, but with the need for improvements in a significant number of patients.

A vast majority of the patients stated that they have implemented one or more preventive measures like to be more physically active as a consequence to their diabetes diagnosis. This is especially important, as lifestyle adaptations like diet change [29] or weight reduction [30,31] are known to reduce HbA1c and positively affect the course of the disease. More than 80 % of the patients indicated that they have regular follow up examinations be carried out. Despite these circumstances and the apparently good efforts in tertiary prevention, typical diabetes-related complications were not seldom, without significant differences between men and women. This emphasis the importance of preventing the disease in the first place and treatment at an early stage of the disease, especially in individuals with existing coronary artery disease or after AMI.

Patients ́ suspected interplay between diabetes and AMI

Diabetes is a strong risk factor for the development of coronary artery disease and myocardial infarction [1,2]. This is also expressed by that fact, that over 30 % of AMI patients recorded by the Augsburg Myocardial Registry have a diagnosis of diabetes at the time of (incident) hospitalized AMI [32], which is substantially higher than the prevalence of around 10 % in the corresponding adult population [33]. Surprisingly, the present study demonstrated that not even every fourth AMI patient with diabetes is well aware of this important interconnection between diabetes and AMI (42.5 % were unsure about this question). This reveals a striking lack of knowledge in a high proportion of diabetic AMI patients. This is all the more surprising, as the majority of these patients is actively involved in the handling and treatment of the diabetes disease. It clearly indicates the need for comprehensive education of patients with co-existing diabetes and AMI, as basic knowledge about the specific interaction between the two diseases are a crucial part of disease-specific health literacy. Prior studies have suggested that extensive knowledge about diabetes and coronary artery disease and a high health literacy can improve the course of the disease and long-term prognosis substantially [34–38]. As the present study also demonstrated, this lack of knowledge is independent of age and sex, as well as level of education and type of infarction (STEMI, NSTEMI). Consequently, physicians and especially family doctors may intensify their efforts in educating all patients after AMI and/or with diabetes mellitus, regardless of any specific patient characteristic. This would contribute to an overall improved understanding of the fundamentals of the disease and would encourage a well-informed, responsible patient.

Strengths and limitations

A major strength of this study is the relatively high number of included AMI patients recorded by the population-based Acute Myocardial Infarction Registry Augsburg, which minimizes selection bias. A postal follow-up survey was conducted approximately 5 years after incident AMI. For each patient, a large number of information regarding the acute event was collected within the established routine of the registry and the extensive follow-up survey provided valuable information about a subsequent diagnosis of diabetes and important characteristics of diabetes care (including treatment and complications).

Nevertheless, there are some limitations to mention. About half of the addressed patients within the follow-up survey was not able or willing to respond, which could have led to a relevant bias. Especially patients with severe AMI that have died before postal follow up could not be considered in this analysis and could have impacted the results. Moreover, time between recorded AMI and follow-up was not equal for each patient with a total range of 3.3 to 6.4 years, which might have affected the results as well. For some analyses, the sample size might have been insufficient to detect relevant differences and associations. Moreover, for the regression analyses, we might not have considered all relevant factors and/or confounders (including important unmeasured variables). As up to 2019 the registry only considered patients younger than 85 years, so results may not be applicable to older age groups. Likewise, results may not be valid for different regions and for all ethnicities.

Conclusion

BMI as well as admission glucose are independent predictors of a new diagnosis of diabetes mellitus after incident AMI. Secondary diseases are quite common in diabetic AMI patients with cataract being the most frequently occurring. Although a high percentage of AMI patients with diabetes were aware of their current HbA1c levels and met guideline requirements with a median HbA1c of 6.9 %, many diabetic AMI patients failed to meet these standards. Less than a quarter of AMI patients with diabetes were well aware of the potential interconnection between their diabetes mellitus and AMI, which strongly emphasizes the importance of a comprehensive education especially of patients suffering from both, diabetes mellitus and AMI.

Authors ́ contribution

TS and CM conceived the study. TS performed the statistical analysis and drafted the manuscript. CM supervised the analysis. SF, PR and JL contributed to data acquisition and revised the manuscript. All authors approved the final manuscript.

Data availability

The datasets generated during and/or analysed during the current study are not publicly available due to data protection aspects but are available in an anonymized form from the corresponding author on reasonable request.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Not applicable reports financial support was provided by German Federal Ministry of Health. Not applicable reports was provided by Helmholtz Center Munich German Research Center for Environmental Health. Not applicable reports was provided by University Hospital Augsburg. Not applicable reports was provided by University of Augsburg Faculty of Medicine. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Timo Schmitz: Writing – original draft, Visualization, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Simone Fischer:** Writing – review & editing, Validation, Supervision. **Philip Raake:** Writing – review & editing, Supervision, Resources. **Jakob Linseisen:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization. **Christine Meisinger:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

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