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Newly diagnosed diabetes and outcomes after acute myocardial infarction in young adults

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ABSTRACT

Objective To examine prevalence and characteristics of newly diagnosed diabetes (NDD) in younger adults hospitalised with acute myocardial infarction (AMI) and investigate whether NDD is associated with health status and clinical outcomes over 12-month post-AMI.

Methods In individuals (18–55 years) admitted with AMI, without established diabetes, we defined NDD as (1) baseline or 1-month HbA1c≥6.5%; (2) discharge diabetes diagnosis or (3) diabetes medication initiation within 1 month. We compared baseline characteristics of NDD, established diabetes and no diabetes, and their associations with baseline, 1-month and 12-month health status (angina-specific and non-disease specific), mortality and in-hospital complications.

Results Among 3501 patients in Variation in Recovery: Role of Gender on Outcomes of Young AMI Patients study, 14.5% met NDD criteria. Among 508 patients with NDD, 35 (6.9%) received discharge diagnosis, 91 (17.9%) received discharge diabetes education and 14 (2.8%) initiated pharmacological treatment within 1 month. NDD was more common in non-White (OR 1.58, 95% CI 1.23 to 2.03), obese (OR 1.72, 95% CI 1.39 to 2.12), financially stressed patients (OR 1.27, 95% CI 1.02 to 1.58). Compared with established diabetes, NDD was independently associated with better disease-specific health status and quality of life (p≤0.04). No significant differences were found in unadjusted in-hospital mortality and complications between NDD and established or no diabetes.

Conclusions NDD was common among adults≤55 years admitted with AMI and was more frequent in non-White, obese, financially stressed individuals. Under 20% of patients with NDD received discharge diagnosis or initiated discharge diabetes education or pharmacological treatment within 1 month post-AMI. NDD was not associated with increased risk of worse short-term health status compared with risk noted for established diabetes.

Trial registration number NCT00597922.

INTRODUCTION

Diabetes is highly prevalent among individuals hospitalised with acute myocardial infarction (AMI) and is associated with increased risk for cardiovascular complications and short-term and long-term mortality.[1–3] However, nearly 30% of patients with AMI over age 55 years have undiagnosed diabetes.[4–6] In many previous studies, newly diagnosed diabetes (NDD) was linked to worse prognosis after AMI compared with individuals without diabetes, but these results were observed in predominantly older male (>55 years old) populations.[7–9] Early diagnosis and treatment of diabetes in younger adults can reduce the risk of long-term complications, particularly for ischaemic heart disease.[10] Adoption of haemoglobin (HbA1c) measurement to complement fasting plasma glucose (FPG) and the oral glucose tolerance test (OGTT) may lead to earlier diagnosis of more patients with diabetes.[11 12] However, the prevalence, characteristics and outcomes of NDD in young adults (≤55 years) hospitalised with AMI is still unknown.

Because younger patients have a better survival rate and lower incidence of clinical events after AMI,[13] it is possible elevated HbA1c in young adults admitted with AMI may not be associated with unfavourable outcomes in the following year, although recognising and treating patients to prevent long-term complications is important. Accordingly, we examined the prevalence and characteristics of young adults (18–55 years) hospitalised with AMI who had NDD, using data from Variation in Recovery: Role of Gender on Outcomes of Young AMI Patients (VIRGO) study.

To better describe current NDD management strategies and explore opportunities for improvement, we also examined the proportion of patients with NDD who received diabetes discharge diagnosis or treatment within 1 month after AMI. We then identified patient characteristics independently associated with NDD in the setting of AMI. Finally, we determined whether patients with NDD had different outcomes compared with other young patients with AMI, with attention to disease-specific (angina symptoms, physical limitations due to angina, angina-specific quality of life) and non-disease-specific health status outcomes (physical/mental functioning and overall health) and clinical outcomes (mortality and in-hospital medical complications), during the first 12 months after AMI. Measuring these outcomes changes over time may help determine the prognostic significance of NDD on ischaemic outcomes after AMI in younger patients.

METHODS

Participants and study design

A detailed description of the VIRGO study design, inclusion and exclusion criteria, and interviewing

procedures has been published previously.[14] Briefly, VIRGO was a prospective, observational study designed to evaluate factors associated with worse outcomes among young men and women with AMI. A 2:1 ratio of women to men was used to increase the proportion of young women. A total of 3572 participants aged 18–55 years admitted to 103 US and 24 Spanish hospitals with AMI were enrolled from August 2008 through May 2012. The study included 3501 participants (2349 women, 1152 men), with 2985 participants from the USA and 516 from Spain. All study participants provided written informed consent for participation, baseline and follow-up assessment. Each participating hospital obtained institutional review board approval.

Patient and public involvement

Patients were involved in the design and conduct of the VIRGO study. We received input from young adults who had suffered AMI to understand their lived experience with AMI and assessed patient burden in completing study self-reported outcomes questionnaires. This information assisted us in designing study materials.

Data collection and variables

Baseline data on patient characteristics were collected from both medical records and standardised in-person interviews during index AMI admission. Follow-up telephone interviews were performed by trained staff at 1 and 12 months. Further details of patient data collected at baseline are in online supplemental eAppendix 1.

Diabetes status assessment

Patients with AMI were classified into three groups based on diabetes status: established diabetes, NDD, and no diabetes. Established diabetes was defined as having chart diagnosis of diabetes or glucose-lowering medications use at AMI presentation. NDD was defined as HbA1c≥6.5% at baseline or 1-month follow-up, in absence of established diabetes. Additional NDD cases were also diagnosed at discharge and 1-month follow-up if a patient had no history of diabetes but received (1) discharge diagnosis of diabetes or (2) initiation of glucose-lowering medications within 1-month post-AMI. Individuals treated with metformin monotherapy for polycystic ovary syndrome management, in absence of other criteria for diabetes, were not considered NDD.[15]

Outcomes measures

Health status outcomes

Primary outcomes were disease-specific and non-disease-specific health status. Disease-specific health status was assessed at baseline, 1 month and 12 months after AMI using the Seattle Angina Questionnaire (SAQ).[14] SAQ-angina frequency, SAQ-physical limitations and SAQ-quality of life domains were evaluated.[16] Domain scores ranged from 0 to 100, with higher scores indicating better disease-specific health outcomes. SAQ has been validated by psychometric testing and shown reliable in patients with AMI.[16]

Non-disease-specific health status was measured using the 12-item short-form health survey (SF-12) and Euro-Quality of Life Visual Analog Scale (EQ-5D-VAS).[14] The instruments' scores range from 0 to 100, with higher values being more favourable.[17 18] SF-12 assesses mental and physical functioning using mental and physical health composite scales and has documented reliability and validity.[17] EQ-5D-VAS records participants' self-rated overall health on a 20-cm vertical visual analogue scale, where 0 indicates 'the worse health you can imagine' and 100 indicates 'the best health you can imagine'.[18] The validity and reliability of EQ-5D has been assessed among individuals with AMI.[19]

Clinical outcomes

In-hospital mortality and 1-month and 1-year post-AMI mortality were collected by reviewing medical records. In-hospital medical complications during AMI admission, including reinfarction, heart failure, stroke/transient ischaemic attack and haemorrhagic complications were also obtained using chart review.

Statistical analyses

Descriptive statistics of variables, including baseline characteristics, health status scores and clinical outcomes, stratified according to diabetes status, were presented. Univariate and multivariate logistic regression analyses using a backward-elimination approach were performed to identify baseline characteristics that were independently associated with NDD among patients without established diabetes. We used univariate logistic regression analysis to evaluate differences in baseline characteristics between groups according to their diabetes status. We then combined all variables with a $p<0.15$ in the univariate analysis into a multivariate model and eliminated variables with the highest p value one at a time until all remaining variables in the model had a two-sided $p<0.05$. We reported ORs and p values.

A series of linear mixed-effects (LME) regression models, with and without adjustment for baseline covariates, were developed to investigate the association between NDD and the repeated measurements of health status during the 12 months after AMI, using patients with established diabetes as a reference group. A follow-up set of models was fit to compare NDD with those without diabetes. Details of LME models fitting information are provided in online supplemental eAppendix 2.

To investigate the association between mortality and diabetes status, we accommodated binary mortality variable (yes/no) collected longitudinally during hospitalisation, at 1- and 12 months with mixed-effects logistic regression models, with and without adjustment for baseline covariates. The same fixed effects and random effects were included as those in the LME models.

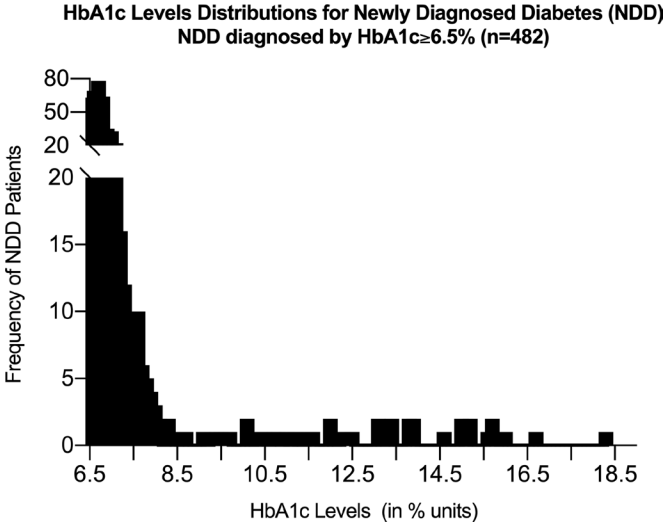

Figure 1 HbA1c levels distribution for newly diagnosed diabetes.

Table 1 Baseline characteristics of young patients with AMI, stratified by diabetes status

Baseline characteristics	Without diabetes (n=2008, 57.4%) (a)	P value* (b) vs (a)	Newly diagnosed diabetes (n=508,14.5%) (b)	P value† (b) vs (c)	Established diabetes (n=985,28.1%) (c)
Sociodemographics					
Age in year (SD)	46.5 (6.4)	**0.002**	47.5 (5.9)	0.555	47.7 (5.8)
Female (%)	1270 (63.3%)	0.954	322 (63.4%)	**0.001**	757 (76.9%)
Race		**0.001**		0.188	
White	1649 (82.1%)		381 (75.0%)		712 (72.3%)
Black	248 (12.4%)		90 (17.7%)		212 (21.5%)
Others	111 (5.5%)		37 (7.3%)		61 (6.2%)
Education status		**0.002**		0.057	
Less than high school	131 (6.7%)		13 (2.6%)		41 (4.2%)
Some high school	784 (39.9%)		202 (40.3%)		431 (44.4%)
More than high school	1048 (53.4%)		286 (57.1%)		498 (51.3%)
Cardiometabolic characteristics					
Body mass index >30 kg/m^2	767 (38.3%)	**0.001**	275 (54.2%)	**0.001**	667 (67.9%)
Peak glucose, median (IQR)	127.0 (38.0)	**0.001**	141.0 (48.0)	**0.001**	261.0 (162.0)
Initial systolic blood pressure (mm Hg), median (IQR)	140.0 (37.0)	**0.034**	143.0 (38.0)	0.241	144.0 (42.0)
Initial diastolic blood pressure (mm Hg), median (IQR)	87.0 (24.0)	0.124	88.0 (27.0)	**0.020**	86.0 (26.0)
LDL (mmol/L), median (IQR)	111.0 (51.0)	0.729	112.0 (56.0)	**0.008**	106.0 (54.0)
TG (mmol/L), median (IQR)	121.5 (95.0)	**0.001**	137.0 (105.5)	**0.001**	164.0 (154.0)
CVD risk factors					
Family history of CVD	1395 (69.5%)	**0.034**	382 (75.0%)	0.884	728 (74.1%)
History of hypertension	1096 (54.6%)	0.069	300 (59.1%)	**0.001**	821 (83.4%)
History of hypercholesterolemia	1648 (82.1%)	0.114	432 (85.0%)	**0.001**	922 (93.6%)
Smoking within last 30 days	1241 (61.8%)	0.878	316 (62.2%)	**0.002**	528 (53.7%)
Sleep apnoea	49 (2.5%)	0.366	16 (3.2%)	**0.001**	96 (9.8%)
Other comorbidities					
History of renal dysfunction	143 (7.2%)	**0.004**	56 (11.1%)	**0.004**	163 (16.6%)
History of heart failure	30 (1.5%)	**0.027**	15 (2.9%)	**0.001**	96 (9.8%)
Prior MI	242 (12.1%)	0.240	71 (13.9%)	**0.001**	230 (23.4%)
AMI treatment					
Coronary revascularisation (PCI/CABG)	1595 (79.4%)	**0.003**	433 (85.2%)	0.412	823 (83.6%)
Diagnostic angiography	1900 (94.6%)	**0.001**	498 (98.0%)	**0.001**	914 (92.8%)
Discharge medications					
Aspirin at discharge	1948 (98.3%)	0.459	492 (98.8%)	**0.032**	934 (96.9%)
Statin prescribed	1827 (93.4%)	0.054	471 (95.7%)	0.397	914 (94.7%)
Beta-blocker prescribed	1779 (95.1%)	**0.042**	459 (97.3%)	0.506	905 (36.6%)
ACE or ARB prescribed	1193 (65.8%)	**0.021**	329 (71.5%)	**0.005**	709 (78.3%)
Non-pharmacological interventions prescribed at discharge					
Diet counselling	1850 (92.1%)	0.659	471 (92.7%)	0.524	904 (91.8%)
Activity guidelines	1818 (90.5%)	**0.005**	480 (94.5%)	**0.001**	876 (88.9%)
Outpatient cardiac rehab prescribed	874 (43.5%)	0.132	240 (47.2%)	**0.035**	409 (41.5%)
Diabetes education	166 (8.3%)	**0.001**	91 (17.9%)	**0.001**	647 (65.7%)
Weight management counselling	753 (37.5%)	0.713	195 (38.4%)	0.065	427 (43.4%)
Smoking cessation counselling	1391 (69.3%)	0.339	363 (71.5%)	**0.001**	613 (62.2%)
Participated in in-patient cardiac rehab	519 (25.9%)	**0.010**	160 (31.5%)	0.162	276 (28.0%)
Clinical characteristics of AMI					
Coronary occlusion ≥50% (documented by coronary angiography)		0.233			**0.013**
Yes	1637 (81.5%)		438 (86.2%)		852 (86.5%)
No	244 (12.2%)		50 (9.8%)		56 (5.7%)
Unknown	127 (6.3%)		20 (4.0%)		77 (7.8%)
ST-segment elevation	1077 (53.6%)	0.188	289 (56.9%)	**0.001**	445 (45.2%)
Initial heart rate, median (IQR)	78.0 (23.0)	**0.003**	81.0 (25.0)	**0.001**	88.0 (26.0)
Peak troponin, median (IQR)	8.1 (31.5)	0.549	8.6 (25.3)	**0.001**	4.9 (20.4)
Ejection fraction <40%	189 (9.6%)	0.098	60 (12.2%)	0.818	119 (12.6%)
Time to presentation >6 hours	767 (38.3%)	0.999	193 (38.3%)	**0.001**	506 (51.6%)
Other clinical characteristics					
Baseline admission HbA1c (%), median (IQR)	5.6 (0.5)	**0.001**	6.3 (1.2)	**0.001**	8.5 (3.8)
1 month HbA1c (%), median (IQR)	6.0 (0.5)	**0.001**	6.8 (0.4)	**0.001**	7.6 (2.0)
Diabetes types					
Type 1	NA		NA		104 (10.6%)
Type 2	NA		NA		742 (75.3%)
Unknown	NA		NA		139 (14.1%)
Peak creatinine, median (IQR)	0.90 (0.3)	**0.004**	0.90 (0.3)	0.994	0.90 (0.4)
Psychosocial and behavioural characteristics					
Social support via ESSI	26.1 (5.3)	0.151	25.7 (5.4)	0.082	25.2 (5.7)

Continued

Table 1 Continued

Baseline characteristics	Without diabetes (n=2008, 57.4%) (a)	P value* (b) vs (a)	Newly diagnosed diabetes (n=508,14.5%) (b)	P value† (b) vs (c)	Established diabetes (n=985,28.1%) (c)
Stress via PSS	25.2 (9.6)	0.773	25.3 (9.8)	0.711	27.25 (9.9)
Depressive symptom via PHQ-9	6.9 (6.1)	**0.007**	7.8 (6.4)	**0.001**	9.34 (6.8)
Self-reported socioeconomic status					
Have health insurance	1631 (81.2%)	**0.014**	388 (76.4%)	0.213	780 (79.2%)
How difficult is it for you to get medical care when needed?		0.129		0.052	
Extremely difficult	172 (8.6%)		57 (11.2%)		109 (11.1%)
Some difficulty	310 (15.5%)		69 (13.6%)		182 (18.5%)
Little/no difficulty	1525 (75.9%)		382 (75.2%)		692 (70.4%)
Have your medical costs been an economic burden to you over the past year?		**0.047**		**0.001**	
Severe burden	207 (10.3%)		72 (14.2%)		187 (19.0%)
Some burden	352 (17.5%)		86 (16.9%)		241 (24.5%)
Little/no burden	1448 (72.2%)		350 (68.9%)		555 (56.5%)
Avoided healthcare services due to cost (Y/N)	517 (25.8%)	**0.001**	174 (34.3%)	0.273	365 (37.1%)
How often have you not taken a medication that your doctor prescribed because of the cost?		**0.009**			**0.001**
Always	67 (3.3%)		30 (5.9%)		52 (5.3%)
Sometimes	251 (12.5%)		74 (14.6%)		235 (23.9%)
Rarely to never	1689 (84.2%)		404 (79.5%)		696 (70.8%)

Data are given as mean (SD), median (IQR) or no. (%).
P value numbers in bold denote statistical significance at the p<0.05 level.
*Unadjusted p values were testing for differences in baseline characteristics between patients with AMI with newly diagnosed diabetes and no diabetes.
†Unadjusted p values were testing for differences in baseline characteristics between patients with AMI with newly diagnosed diabetes and established diabetes.
AMI, acute myocardial infarction; CABG, coronary artery bypass grafting; CVD, cardiovascular disease; ESSI, ENRICHD social support instrument; HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; MI, myocardial infarction; NA, not available; PCI, percutaneous coronary intervention; PHQ-9, Patient Health Questionnaire-9; PSS, Perceived Stress Scale; TG, triglycerides.

We performed additional analysis by NDD subgroups (HbA1c<8% and HbA1c≥8%) and sensitivity analyses of the study cohort. Further details of these analyses and information on missing data are in the online supplemental material (online supplemental eAppendix 3, online supplemental tables 1–7).

RESULTS

Prevalence of newly diagnosed diabetes

Among 3501 patients with AMI enrolled in VIRGO, 508 (14.5%) had NDD and 985 (28.1%) had established diabetes. The remaining 2008 were classified as having no diabetes (online supplemental figure 1). HbA1c values were available for 2756

Table 2 Univariate and multivariate analyses for the association between baseline characteristics and having newly diagnosed diabetes among young patients with AMI without established diabetes

	Univariate		Multivariate*	
Baseline characteristics	OR with 95% CI	P value	OR with 95% CI	P value
Sociodemographics				
Age in years (mean)	1.03 (1.01 to 1.04)	**0.003**	1.02 (1.00 to 1.04)	**0.018**
Race Others vs White	1.53 (1.22 to 1.93)	**0.001**	1.58 (1.23 to 2.03)	**0.0003**
Cardiometabolic risks				
Obesity yes vs no	1.91 (1.57 to 2.33)	**<0.0001**	1.72 (1.39 to 2.12)	**<0.0001**
Initial glucose, median (IQR)	1.01 (1.01 to 1.01)	**<0.0001**	1.01 (1.00 to 1.01)	**0.0004**
Peak glucose, median (IQR)	1.01 (1.00 to 1.01)	**<0.0001**	1.00 (1.00 to 1.01)	**0.012**
Initial systolic blood pressure (mm Hg), median (IQR)	1.01 (1.00 to 1.01)	**0.004**	Not selected	
Initial diastolic blood pressure (mm Hg), median (IQR)	1.01 (1.00 to 1.01)	**0.006**	Not selected	
Triglyceride (mmol/L), median (IQR)	1.00 (1.00 to 1.002)	**0.002**	Not selected	
CVD risk factors				
Family history of CVD	1.33 (1.06 to 1.66)	**0.012**	1.30 (1.03 to 1.65)	**0.028**
Other comorbidities				
History of renal dysfunction	1.62 (1.17 to 2.24)	**0.004**	Not selected	
History of heart failure	2.01 (1.07 to 3.76)	**0.029**	Not selected	
AMI treatment during hospitalisation				
Diagnostic angiography	2.83 (1.47 to 5.45)	**0.002**	2.68 (1.37 to 5.26)	**0.004**
Beta-blocker prescribed	1.83 (1.01 to 3.29)	**0.045**	Not selected	
ACE or ARB prescribed	1.28 (1.03 to 1.59)	**0.027**	Not selected	
Clinical characteristics of AMI				
Initial heart rate, median (IQR)	1.01 (1.00 to 1.01)	**0.009**	Not selected	
Self-reported socioeconomic status				
Without health insurance vs with	1.34 (1.06 to 1.69)	**0.014**	Not selected	
Avoided services due to cost (Yes vs no)	1.50 (1.22 to 1.85)	**0.0001**	1.27 (1.02 to 1.58)	**0.034**
Have you not taken a medication that your doctor prescribed because of cost?				
Always or sometimes (vs rarely to never)	1.37 (1.07 to 1.75)	**0.013**	Not selected	

P value numbers in bold denote statistical significance at the p<0.05 level.
*The adjusted ORs, 95% CIs and p values were estimated from a multiple logistic regression model with the use of backward elimination (All variables left in the final model were significant at the 0.05 level).

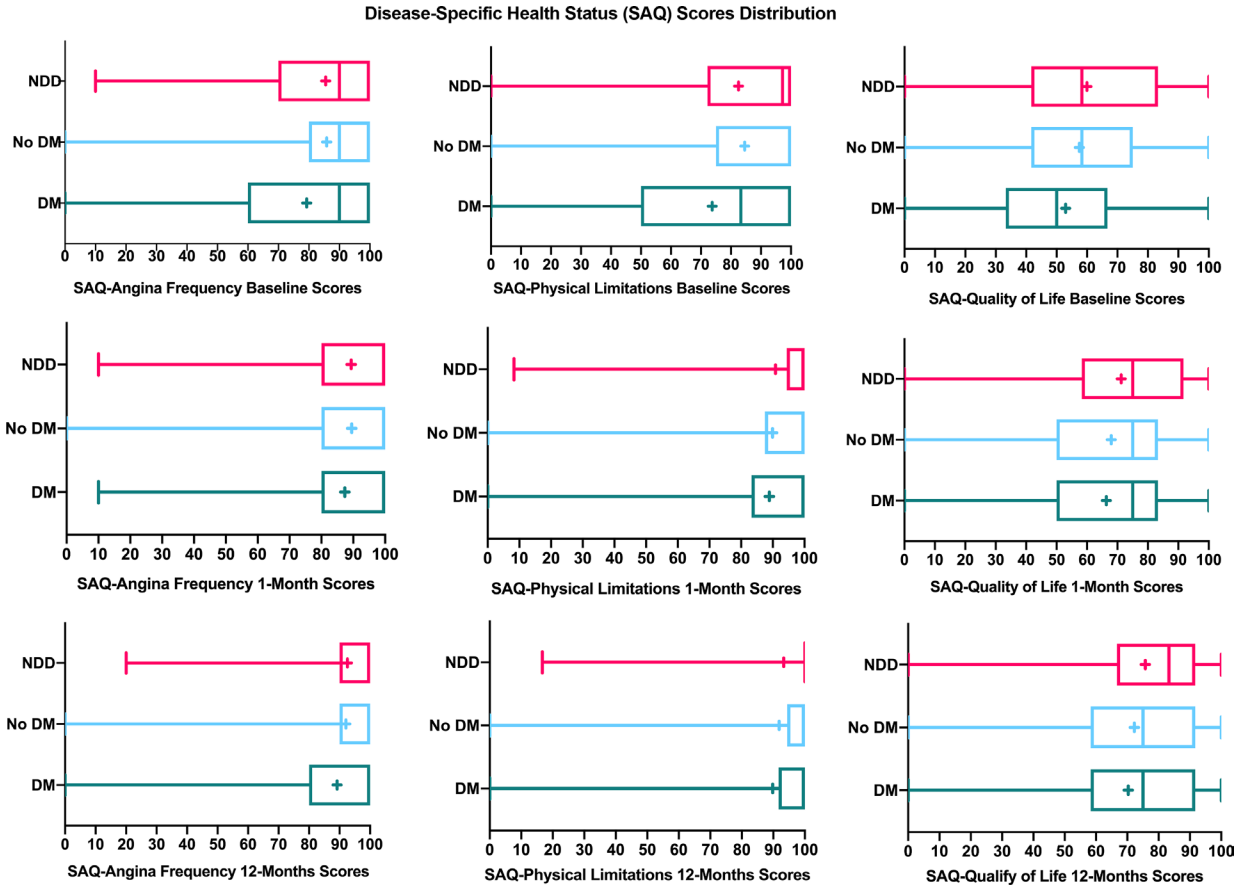

Figure 2 Disease-specific health status scores (SAQ) distribution over time after AMI in young adults, stratified by diabetes status. AMI, acute myocardial infarction; DM, established diabetes; NDD, newly diagnosed diabetes; SAQ, Seattle Angina Questionnaire; box plot showing mean score (+), median score (line within the box), interquartile range box, and the minimum and maximum score values (the ends of the whiskers).

of 3501 patients (78.7%) and elevated (HbA1c≥6.5%) for 482 patients with NDD (94.9% of 508 patients with NDD).

Among patients with NDD with elevated HbA1c, the distribution of HbA1c levels (range=6.5% to 18.3%) is shown in figure 1 and online supplemental figure 2. Two-thirds had HbA1c from 6.5% to <7.0%, 23.4% had levels of 7.0% to <8.0%, 1.5% were between 8.0% and 9.0%, and 8.3% were ≥9.0%. Of 508 patients with NDD, 35 (6.9%) had a new diabetes diagnosis at discharge, 91 (17.9%) received discharge diabetes education (table 1), and diabetes medication was initiated in 14 (2.8%) within 1-month post-AMI.

Sensitivity analysis comparing baseline characteristics between patients with and without missing HbA1c showed those without HbA1c values were significantly younger; had fewer cardiovascular (CVD) risk factors/comorbidities and lower peak glucose levels and were less likely to report barriers to access healthcare at baseline (p<0.001) (online supplemental table 2).

Patient characteristics

Baseline characteristics stratified by diabetes status are presented in table 1. Patients with established diabetes and NDD were comparable in age, race and education level, but CVD risk factors of patients with NDD were more similar to patients without diabetes. In these three diabetes status groups, baseline cardiometabolic characteristics and HbA1c levels followed a gradient from lowest (patients without diabetes) to highest (patients with established diabetes). Most aspects of treatment and clinical characteristics of AMI were similar among the three groups. However, patients with NDD were more likely to present with ST-segment elevation myocardial infarction and receive discharge counselling on activity and smoking than patients with established diabetes.

Differences in baseline characteristics between patients with diabetes with and without follow-up are shown in online supplemental table 1 and eAppendix 4. At 12-month follow-up, a significantly higher percentage of patients with NDD reported weight loss after AMI (online supplemental table 7).

Among patients with AMI without established diabetes, the odds of having NDD (versus no diabetes) increased significantly with increasing age or higher initial/peak glucose levels (table 2). Also, NDD was significantly more common in non-White patients (OR 1.58, 95% CI 1.23 to 2.03), those who were obese (OR 1.72, 95% CI 1.39 to 2.12), those who had a family history of CVD (OR 1.30, 95% CI 1.03 to 1.65) and those with self-reported avoidance of healthcare due to cost before admission (OR 1.27, 95% CI 1.02 to 1.58).

Longitudinal association between newly diagnosed diabetes and post-AMI health status

Overall, health status scores improved from baseline to 12 months in all three groups (figures 2 and 3). In the unadjusted analyses, the mean changes of health status scores from baseline to 1 and 12 months were similar between the NDD group and those without diabetes (with the exception of mental functioning) (table 3). For post-AMI angina frequency and disease-specific

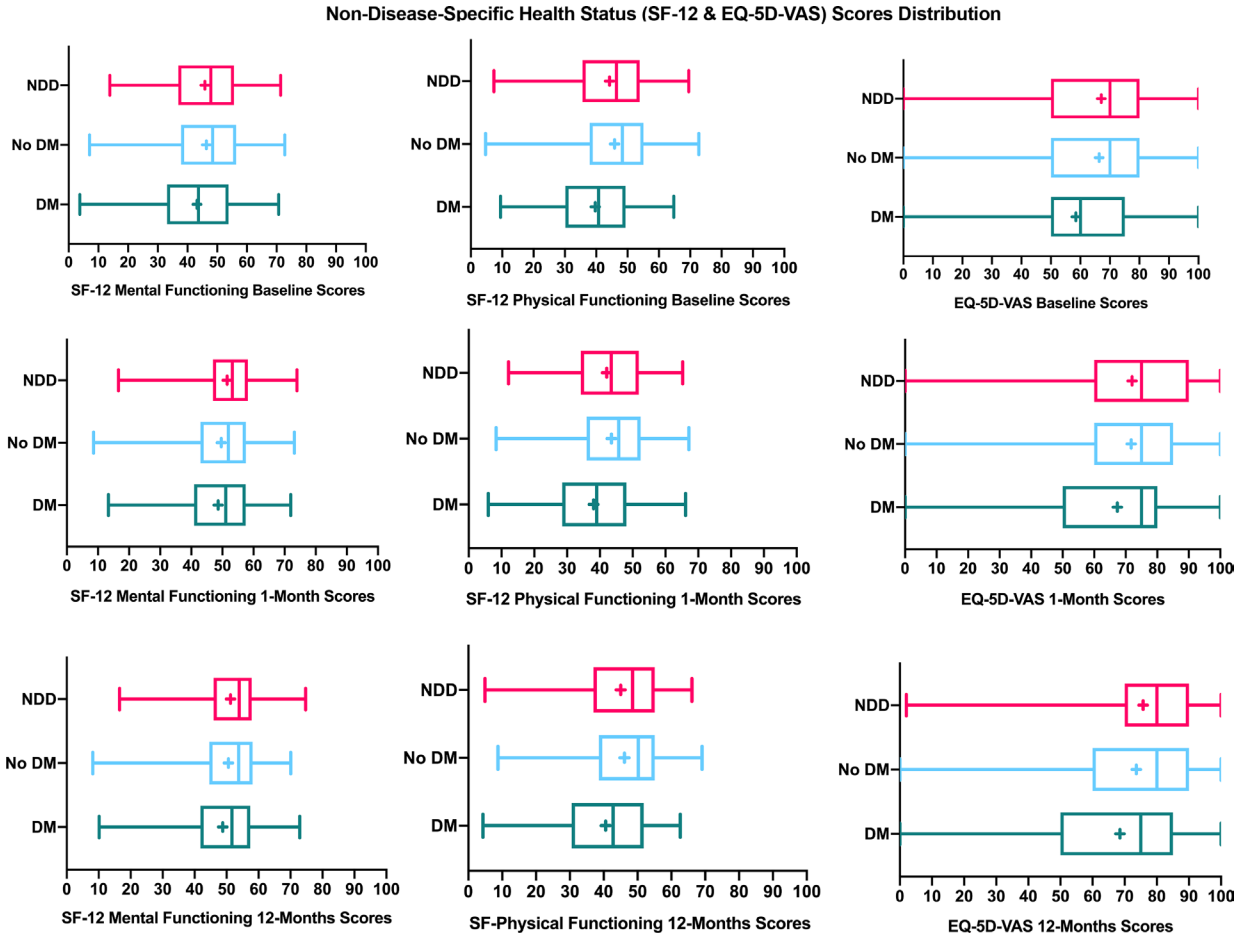

Figure 3 Non-disease-specific health status scores distribution over time after AMI in young adults, stratified by diabetes status. AMI, acute myocardial infarction; DM, established diabetes; NDD, newly diagnosed diabetes; box plot showing mean score (+), median score (line within the box), interquartile range box, and the minimum and maximum score values (the ends of the whiskers).

physical limitations, patients with NDD improved to a lesser extent and more slowly than patients with established diabetes during the 12-month follow-up (tables 3 and 4; p<0.03 for interactions of diabetes status and time, online supplemental figure 3).

We also analysed the independent associations between NDD and health status outcomes in LME models. After adjusting for baseline characteristics, NDD was associated with better disease-specific health status as measured by SAQ, and improved general health status measured by EQ-5D-VAS compared with established diabetes (table 4). In multivariable adjusted subgroup analyses, an HbA1c value of <8% in patients with NDD was associated with better disease-specific and general quality of life in young adults with AMI (p<0.01) (online supplemental table 5). NDD with an HbA1c value ≥8% was associated with increased risk of worse general health status (p=0.037) (online supplemental table 5).

Association between newly diagnosed diabetes and post-AMI clinical outcomes

The overall mortality rate over the 1-year follow-up for patients with NDD was lowest among the three groups (table 5). Subgroup analyses showed that 1-year mortality was not significantly different between patients with NDD with higher HbA1c (≥8%) and patients with established diabetes or no diabetes (online supplemental table 4).

Differences between groups for in-hospital medical complications are shown in table 5. Patients with NDD and those without diabetes demonstrated no significant differences in in-hospital complications. Subgroup analysis showed that reinfarction rate during hospitalisation was significantly higher in patients with NDD with higher HbA1c than in those with established diabetes (4.3% vs 0.9%, p=0.033) (online supplemental table 4).

DISCUSSION

In this multinational cohort of younger adults presenting to hospital with AMI, 14.5% had NDD. Notably, more than 80% of individuals with NDD had neither received a discharge diagnosis of diabetes nor initiation of diabetes education or pharmacological treatment within 1-month post-AMI. Thus, the application of a convenient test such as HbA1c in acute settings may help identify more individuals at risk for diabetes complications to facilitate treatment. Compared with patients without diabetes, patients with NDD were more likely to be non-White, obese and financially stressed. Although NDD patients' short-term health status was slightly better than patients with established diabetes, their in-hospital mortality and other complications were not significantly different than others with AMI. The relatively high prevalence of NDD found in this study suggests a clear need to improve detection of risk for diabetes among young patients presenting with AMI.

Table 3 Unadjusted change from baseline health status scores after AMI, stratified by diabetes status

	Without diabetes (n=2008, 57.4% of 3501 participants) (a)				Newly diagnosed diabetes (n=508, 14.5% of 3501 participants) (b)				Established diabetes (n=985, 28.1% of 3501 participants) Mean (SD) (c)		
Health status outcomes	Baseline mean (SD)	Follow-Up mean (SD)	Change from baseline mean (95% CI)	P value* changes in (b) vs (a)	Baseline mean (SD)	Follow-Up mean (SD)	Change from baseline mean (95% CI)	P value† changes in (b) vs (c)	Baseline mean (SD)	Follow-up mean (SD)	Change from baseline mean (95% CI)
1-month follow-up											
SAQ-Angina Frequency	85.84 (18.94)	89.51 (17.27)	4.03 (2.89 to 5.18)	0.685	85.50 (18.12)	89.36 (17.89)	3.54 (1.39 to 5.69)	**0.005**	79.33 (23.73)	87.39 (18.53)	8.56 (6.73 to 10.39)
SAQ-Physical Limitations	84.56 (22.93)	89.90 (19.09)	7.08 (5.82 to 8.34)	0.294	82.51 (24.96)	90.89 (18.54)	8.67 (5.98 to 11.36)	**0.001**	73.77 (28.72)	88.91 (20.94)	16.05 (13.95 to 18.16)
SAQ-Quality of Life	57.48 (22.84)	67.94 (24.57)	11.62 (10.20 to 13.04)	0.729	59.96 (25.29)	71.27 (24.41)	11.10 (8.42 to 13.78)	0.118	52.94 (25.25)	66.39 (26.40)	13.81 (11.75 to 15.88)
SF-12 Mental Functioning	46.36 (12.37)	49.61 (10.85)	2.77 (2.13 to 3.42)	**0.001**	45.84 (12.14)	51.54 (9.50)	5.65 (4.43 to 6.87)	0.370	43.21 (12.81)	48.61 (11.21)	4.95 (4.04 to 5.87)
SF-12 Physical Functioning	45.84 (11.65)	43.51 (11.28)	−1.98 (-2.61 to -1.35)	0.616	44.24 (11.82)	42.06 (11.78)	−2.31 (-3.47 to -1.16)	0.148	39.71 (12.06)	38.10 (11.75)	−1.28 (−2.11 to -0.45)
EQ-5D-VAS	66.34 (20.62)	71.75 (20.09)	16.82 (15.99 to 17.66)	0.888	67.06 (21.11)	72.04 (19.90)	16.94 (15.48 to 18.41)	0.078	58.49 (22.27)	67.37 (22.40)	18.64 (17.49 to 19.79)
12-month follow-up											
SAQ-Angina Frequency	85.84 (18.94)	92.06 (16.03)	6.66 (5.51 to 7.82)	0.623	85.50 (18.12)	92.56 (14.37)	7.26 (5.22 to 9.30)	0.111	79.33 (23.73)	89.21 (19.12)	9.60 (7.56 to 11.63)
SAQ-Physical Limitations	84.56 (22.93)	91.87 (17.98)	8.29 (6.97 to 9.61)	0.127	82.51 (24.96)	93.31 (16.03)	10.59 (7.94 to 13.23)	**0.005**	73.77 (28.72)	89.79 (21.62)	15.62 (13.31 to 17.93)
SAQ-Quality of Life	57.48 (22.84)	72.23 (22.51)	15.35 (13.90 to 16.79)	0.801	59.96 (25.29)	75.74 (22.01)	15.76 (12.91 to 18.61)	0.367	52.94 (25.25)	70.32 (24.88)	17.43 (15.18 to 19.69)
SF-12 Mental Functioning	46.36 (12.37)	50.61 (10.80)	3.88 (3.19 to 4.57)	0.096	45.84 (12.14)	51.27 (9.70)	5.09 (3.79 to 6.40)	0.979	43.21 (12.81)	48.81 (11.79)	5.12 (4.03 to 6.20)
SF-12 Physical Functioning	45.84 (11.65)	46.14 (11.55)	0.66 (0.00 to 1.32)	0.581	44.24 (11.82)	45.03 (12.21)	0.23 (-1.12 to 1.58)	0.532	39.71 (12.06)	40.61 (12.83)	0.76 (−0.19 to 1.70)
EQ-5D-VAS	66.34 (20.62)	73.61 (20.22)	8.09 (6.80 to 9.37)	0.965	67.06 (21.11)	75.73 (18.34)	8.03 (5.65 to 10.40)	0.202	58.49 (22.27)	68.55 (22.87)	10.05 (8.03 to 12.06)

P-value numbers in bold denote statistical significance at the p<0.05 level.
*Unadjusted p values were testing for differences in mean changes of health status scores between patients with newly diagnosed and without diabetes.
†Unadjusted p values were testing for differences in mean changes of health status scores between patients with newly diagnosed and established diabetes.
EQ-5D-VAS, Euro-Quality of Visual Analogue Scale; SAQ, Seattle Angina Questionnaire; SF-12, 12 Item Short Form Survey.

This study extends prior research in several ways. It is the first to examine the prevalence and characteristics of NDD among young people (≤55 years) admitted with AMI. Very few studies have evaluated NDD prevalence in this group. Our study, based on a diverse AMI population with a higher proportion of females, supports the relatively high prevalence of NDD in patients with AMI and extends the evidence to younger patients. Despite controversy surrounding the diagnostic role of HbA1c,[20] elevated HbA1c was found to be a better predictor of CVD and diabetic retinopathy, compared with FPG or OGTT.[21 22] Thus, NDD identified by elevated HbA1c and complemented by diabetes discharge diagnosis and treatment may represent a high-risk AMI subgroup and offers a unique opportunity to study the mechanisms of diabetes and micro/macrovascular disease development and potentially to prevent or delay complications.

Second, little data on self-reported socioeconomic status associated with NDD in young AMI populations are available. Sparse research evaluating patient characteristics independently associated with NDD focuses predominantly on clinical characteristics.[23] Multivariable analysis of patients with AMI in this study took into account financial barriers to healthcare services or medication and identified the independent association of self-reported avoidance of healthcare services due to cost and NDD in a racially diverse young adult population. Because financial barriers to healthcare were a strong predictor of adverse outcomes after AMI,[24] the avoidance of healthcare services may, in the long-term, have serious undesirable consequences for patients with NDD. These findings support the importance of addressing social determinants in vulnerable populations to promote health.[25] Further research is needed to understand why a diabetes diagnosis was missed in those with NDD, and why risk factor modification before the events was not carried out effectively.

Last, we demonstrated that NDD is associated with significantly less frequent angina, fewer physical limitations due to angina and better quality of life than established diabetes during a 12-month follow-up. Although somewhat unexpected, these differences may relate to their milder and less symptomatic disease state. It is possible that young adults seeking healthcare leading to an initial diabetes diagnosis tend to do so because they are experiencing symptoms. These findings are supported by evidence suggesting the long asymptomatic period and chronic progression of diabetes.[26] Additionally, our finding may be partly because we did not adjust for baseline HbA1c since our dataset has a high percentage of missing data on that variable, and we chose not to impute as a reflection of reality. Although research has produced conflicting results on the prognostic importance of HbA1c levels in AMI, some studies have demonstrated that elevated HbA1c was associated with larger infarct size, worse cardiac functioning and long-term mortality.[27] Our NDD subgroup analysis revealed a trend towards a higher risk of poor health status as HbA1c levels increased. Additional research is needed to confirm the observed trend and understand the impact of baseline HbA1c on post-AMI health status outcomes.

Our findings regarding patients with NDD not having discernably different clinical outcomes than those of patients without diabetes were comparable to research in Korea and China,[28 29] but contradict conclusions from the VALsartan in Acute myocardial iNfarcTion (VALIANT) and Harmonizing Outcomes with RevasculariZatiON and Stents in Acute Myocardial Infarction (HORIZONS-AMI) trials. VALIANT and HORIZONS-AMI trials showed patients with NDD and established diabetes had similarly increased risks of mortality and cardiac events compared with non-diabetics.[7 9] Possible reasons for these differences include:

Table 4 Parameter estimates and P values from the mixed effects models describing the relationship between newly diagnosed diabetes and health status outcomes

Health status outcomes	Reference group	Estimate (Unadjusted models)	95% CI	P value	Estimate (Adjusted models*)	95% CI	P value
SAQ-Angina Frequency							
Newly diagnosed diabetes	Established diabetes	3.79	2.29 to 5.31	**<0.0001**	5.05	2.50 to 7.59	**0.0001**
Newly diagnosed diabetes*time2 interaction							**0.0009**
Newly diagnosed diabetes*time3 interaction							**0.0235**
Newly diagnosed diabetes	Without diabetes	0.07	−1.17 to 1.30	0.9158	0.24	−0.95 to 1.43	0.6928
Newly diagnosed diabetes*time2 interaction							0.8398
Newly diagnosed diabetes*time3 interaction							0.5656
SAQ-Physical Limitations							
Newly diagnosed diabetes	Established diabetes	4.11	2.38 to 5.84	**<0.0001**	6.71	3.67 to 9.74	**<0.0001**
Newly diagnosed diabetes*time2 interaction							**<0.0001**
Newly diagnosed diabetes*time3 interaction							**0.0011**
Newly diagnosed diabetes	Without diabetes	0.57	−0.89 to 2.04	0.4450	−1.55	−3.7 to 0.60	0.1575
Newly diagnosed diabetes*time2 interaction							**0.0311**
Newly diagnosed diabetes*time3 interaction							**0.0183**
SAQ-Quality of Life							
Newly diagnosed diabetes	Established diabetes	6.19	4.08 to 8.29	**<0.0001**	4.35	1.37 to 7.34	**0.0041**
Newly diagnosed diabetes*time2 interaction							0.1143
Newly diagnosed diabetes*time3 interaction							0.2473
Newly diagnosed diabetes	Without diabetes	3.08	1.28 to 4.88	**0.001**	2.58	0.97 to 4.20	**0.0018**
Newly diagnosed diabetes*time2 interaction							0.5455
Newly diagnosed diabetes*time3 interaction							0.5489
SF-12 Mental Functioning							
Newly diagnosed diabetes	Established diabetes	2.82	1.83 to 3.81	**<0.0001**	0.33	−0.88 to 1.56	0.5913
Newly diagnosed diabetes*time2 interaction							0.6385
Newly diagnosed diabetes*time3 interaction							0.9505
Newly diagnosed diabetes	Without diabetes	0.96	0.07 to 1.85	**0.0354**	−0.36	−1.35 to 0.62	0.4646
Newly diagnosed diabetes*time2 interaction							**0.0005**
Newly diagnosed diabetes*time3 interaction							0.1049
SF-12 Physical Functioning							
Newly diagnosed diabetes	Established diabetes	4.31	3.19 to 5.43	**<0.0001**	0.77	−0.40 to 1.94	0.1959
Newly diagnosed diabetes*time2 interaction							0.2478
Newly diagnosed diabetes*time3 interaction							0.7762
Newly diagnosed diabetes	Without diabetes	−1.43	−2.38 to −0.48	**0.0034**	−0.60	−1.43 to 0.22	0.1535
Newly diagnosed diabetes*time2 interaction							0.8236
Newly diagnosed diabetes*time3 interaction							0.6423
EQ-5D Visual Analogue Scale							
Newly diagnosed diabetes	Established diabetes	6.93	5.06 to 8.80	**<0.0001**	4.26	1.70 to 6.82	**0.005**
Newly diagnosed diabetes*time2 interaction							**0.0036**
Newly diagnosed diabetes*time3 interaction							0.3973
Newly diagnosed diabetes	Without diabetes	0.92	−0.64 to 2.49	0.2481	1.19	−0.25 to 2.63	0.106
Newly diagnosed diabetes*time2 interaction							0.7887
Newly diagnosed diabetes*time3 interaction							0.2543

P value numbers in bold denote statistical significance at the p<0.05 level.

*Models adjusted for cardiometabolic characteristics, gender, sociodemographics, CVD risk factors, other comorbidities, AMI treatment, clinical characteristics of AMI, non-pharmacological interventions, psychosocial and behavioural factors, self-reported socioeconomic status and time.

CVD, cardiovascular disease; EQ-5D-VAS, Euro-Quality of Visual Analogue Scale; NS, not significant; SAQ, Seattle Angina Questionnaire; SF-12, 12 Item Short Form Survey; Time2, indicator of the 1-month follow-up time point; Time3, indicator of the 12-month follow-up time point.

(1) adoption of a healthier lifestyle in NDD group leading to CVD risk optimisation, such as weight loss; (2) VALIANT and HORIZONS-AMI trials did not use HbA1c as one of the criteria to identify patients with NDD and (3) updates of guideline treatment of optimal glycaemic control following AMI.[30]

Study limitations

Study limitations should be considered in interpreting our findings. First, we did not collect information on diabetes duration and levels of OGTT/ FPG. We also did not use OGTT/ FPG for identifying NDD. Using OGTT/FPG appears to identify different AMI subgroups.[27] Second, HbA1c was accepted as an additional diagnostic tool for diabetes during the VIRGO study period.[11] Before 2010, FPG and OGTT were the 'gold standard' for diabetes diagnosis. Although not assessed as part of the current study, differences in the number of NDD cases identified by clinicians using HbA1c were presumably greater after 2010. Third, we lacked a serial measurement of HbA1c

Table 5 Mortality and in-hospital medical complications after AMI, stratified by diabetes status

Clinical outcomes	Without diabetes (n=2008, 57.4% of 3501 participants) (a)	Newly diagnosed diabetes (n=508, 14.5% of 3501 participants) (b)	Established diabetes (n=985, 28.1% of 3501 participants) (c)	P value* (b) vs (a)	P value† (b) vs (c)
Mortality					
In-hospital mortality	1 (0.1%)	0	3 (0.3%)	0.555	0.999
30-day mortality	12 (0.6%)	0	9 (0.9%)	**0.026**	**0.011**
1-year mortality	32 (1.6%)	5 (0.9%)	35 (3.6%)	**0.0009**	**0.015**
In-hospital medical complications					
Re-infarction	28 (1.4%)	6 (1.2%)	9 (0.9%)	0.403	0.927
Heart failure	109 (5.4%)	36 (7.1%)	97 (9.9%)	0.176	0.214
Cardiac arrhythmias	151 (7.5%)	32 (6.3%)	65 (6.6%)	0.522	0.607
Stroke/Transient ischaemic attack	6 (0.3%)	2 (0.4%)	4 (0.4%)	0.892	0.912
Haemorrhagic complications	153 (7.6%)	38 (7.5%)	80 (8.1%)	0.489	0.921

P value numbers in bold denote statistical significance at the p<0.05 level.
*Unadjusted p values were testing for clinical outcomes differences between patients with newly diagnosed and no diabetes. Fisher's exact for cells<5.
†Unadjusted p values were testing for clinical outcomes differences between patients with newly diagnosed and established diabetes. Fisher's exact test for cells<5.
AMI, acute myocardial infarction.

to confirm a diagnosis of diabetes in all patients. However, our sensitivity analysis supports our assumption that those with missing HbA1c values were less likely to reach the threshold for diagnosis of diabetes. Fourth, a single HbA1c value limits our ability to explore changes in glycaemic control over time. It is conceivable that some patients with NDD may achieve ideal glycaemic control during follow-up, which could improve their outcomes at 1 year. Finally, we did not adjust for covariates for the comparison of mortality among the three groups due to low mortality in the NDD group. We also were unable to study the reasons for differences in mortality across these groups. Thus, our findings regarding group differences in unadjusted mortality must be interpreted with caution. Future studies are needed to verify these findings and identify responsible factors.

Key messages

What is already known on this subject?

- Newly diagnosed diabetes (NDD) is associated with similarly worse prognosis as established diabetes in older adults (>55 years) with acute myocardial infarction (AMI). Little is known about the prevalence and association of NDD with post-AMI outcomes in young adults (≤55 years).

What might this study add?

- Using data from the VIRGO multinational cohort of young adults admitted for AMI, our findings suggest that NDD was frequent among young adults hospitalised with AMI and was prominent in non-White, obese and financially stressed individuals. Nearly 80% of patients with NDD had neither received a discharge diabetes diagnosis nor initiation of diabetes education or pharmacological interventions within 1-month post-AMI. NDD was not associated with worse health status compared with risk noted for established diabetes over a 12-month period after AMI. This study suggests that screening to identify NDD in young patients with AMI and improving their cardiometabolic risk profile by pharmacological or lifestyle interventions may help reduce short-term mortality and lead to better health status.

How might this impact on clinical practice?

- Clinicians should be aware of an increased risk for NDD in young adults hospitalised with AMI, particularly those from disadvantaged backgrounds. The application of a convenient test such as haemoglobin A1c (HbA1c) in acute settings may help identify more individuals at risk for diabetes complications so that they can be treated.

CONCLUSION

In this diverse, multinational cohort of young adults hospitalised for AMI, NDD was relatively common and was more prominent in non-White, obese, and financially stressed individuals. Less than 20% of patients with NDD received a discharge diabetes diagnosis or diabetes education or pharmacological interventions within a month after AMI. Compared with established diabetes, NDD was not associated with an increased risk of worse health status during a 12-month follow-up. These results build on the work of others in support of improved efforts to screen and modify risk factors for diabetes at the time of AMI admission.

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Supplementary material

Online Supplemental Material

Newly diagnosed diabetes and outcomes after acute myocardial infarction in young adults

Ding Q, *et al. Heart* 2020;0:1–10. doi: 10.1136/heartjnl-2020-317101

Supplementary material

eAppendix 1 Patient data collected at baseline

Patient characteristics included: socio-demographics, AMI treatment, clinical, psychosocial and behavioral, and self-reported socioeconomic factors. Use of glucose-lowering medications was assessed through chart review at baseline admission, discharge, and 1-month follow-up. Random blood glucose levels were collected on admission, and peak glucose levels were recorded during hospital stay. HbA1c was extracted from medical records at baseline admission and assessed in all US participants at 1-month with blood samples analyzed at Quest Diagnostics, San Juan Capistrano, CA.

Socio-demographic variables were age, sex, race, Hispanic ethnicity, marital status, education, employment status, and annual household income. Cardiometabolic characteristics were assessed through review of medical records and included body mass index $\geq 30 kg/m^2$, random blood glucose (initial and peak), blood pressure, low-density lipoprotein, and triglycerides, cardiovascular disease (CVD) risk factors; other comorbidities included family history of CVD, hypertension, hypercholesterolemia, smoking 30 days before admission, sleep apnea, renal dysfunction, heart failure, stroke, depression, alcohol abuse, prior AMI, and prior primary percutaneous coronary intervention.

AMI treatments assessed at baseline were coronary revascularization (percutaneous coronary intervention/coronary artery bypass grafting), diagnostic angiography, aspirin at arrival, reperfusion therapies, and discharge medications. Non-pharmacological interventions prescribed at discharge were obtained from medical record and included diet counseling, activity guidelines, out-patient cardiac rehab, diabetes education, weight management counseling, smoking cessation counseling and participated in in-patient cardiac rehab program. Clinical characteristics of AMI included coronary occlusion ≥50% as documented by coronary angiography, AMI symptom

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presentation, ST-elevation MI, initial systolic heart rate, peak troponin, Global Registry of Acute Coronary Events risk score, left ventricular ejection fraction <40%, and whether the patient presented to hospital >6 hours after symptom onset. Other clinical characteristics included peak creatinine levels, type of diabetes, self-report treatment for diabetes, and diabetic complications.

Psychosocial and behavioral characteristics assessed at baseline included social support, stress, and depressive symptoms using the 7-item ENRICHD Social Support Instrument, [1] the 14-item Perceived Stress Scale [2] and the 9-item version of the Patient Health Questionnaire, [3] respectively. Physical activity was assessed with the Behavioral Risk Factor Surveillance Survey Physical Activity Instrument.[4] These questionnaires have well-documented reliability and validity.[2, 3, 4]

Self-reported socioeconomic status collected at baseline included health insurance, self-report of difficulty obtaining medical care when needed, medical costs posing an economic burden over the past year, avoiding health care services because of cost, and frequency of not taking prescribed medication because of cost. The above questions are validated measures of financial barriers to health care in AMI patients and were prognostic of worse outcomes.[5] (socio-demographics, AMI treatment, clinical, psychosocial and behavioral and self-reported socioeconomic factors)

eAppendix 2 Details of LME model fitting to explore the association between NDD and health status 1-year post AMI

We constructed a series of linear mixed effects (LME) regression models, with and without adjustment for baseline covariates (socio-demographics, AMI treatment, clinical, psychosocial and behavioral and self-reported socioeconomic factors) to explore the association between NDD and the repeated measurements of health status during the 12 months after AMI, using patients

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with established diabetes as a reference group. For each health status outcome, a separate LME model was fit. The repeated measurements of health status at baseline, 1 month and 12 months were the response variables for each model. The fixed effects in LME models included a dummy variable of diabetes status (NDD vs. established diabetes), two dummy variables of time since baseline (baseline to 1 month and baseline to 12 months), and terms of interactions between diabetes status and time points. Individual-specific random-effects terms were included for intercept and time (to account for the within-person effect of repeated health status measures and the within-person change over time). A follow-up set of models was fit to compare NDD with those without diabetes.

eAppendix 3 Missing data and additional analyses

To ensure that we evaluated a representative cohort of AMI patients with diabetes by accounting for missing-not-at-random, we performed a sensitivity analysis to examine baseline characteristics of patients with diabetes lost to or unavailable for follow-up at 12-months with those who had follow-up data (Online Table 1). Similar baseline characteristics comparisons were performed between patients with and without HbA1c values because we implicitly assumed that if an HbA1c was missing, then the unmeasured value was below the threshold for diabetes diagnosis (Online Table 2). Subgroup analyses were performed to explore the associations of NDD subgroups (HbA1c <8% and HbA1c ≥8%) with health status and clinical outcomes (Online Tables 3, 4, 5). Additional analyses were conducted to assess differences between diabetes groups in self-reported weight changes and whether adoption of weight control led to weight loss by the end of 12-months follow-up. Missing covariates (<5%, except for HbA1c, type of diabetes, self-report treatment for diabetes, and diabetic complications) were imputed to the most

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common category for categorical variables and the median for continuous variables. The use of LME and mixed-effects logistic regression models were sufficient to account for missing responses that are missing-at-random (assuming that the missing observations depend on observed variables but not unobserved variables).[6] All analyses were performed with SAS 9.4. (SAS Institute Inc, Cary, NC), and statistical significance was defined as $p<0.05$ for 2-sided tests. Because of the exploratory nature of this observational study, we did not apply multiplicity correction on an overall statistical significance level to obtain a significance level per test.

eAppendix 4 Summary of baseline characteristics differences between diabetic patients with and without 12-month health status outcomes data

Baseline characteristics of patients with and without follow-up did not differ significantly in age, gender, CVD risk factors, AMI clinical characteristics, AMI treatment, psychosocial and behavioral factors or self-reported socioeconomic status. The remaining baseline characteristics differed significantly between the 2 groups.

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FIGURE LEGENDS:

Supplementary Figure 1: Prevalence of newly diagnosed diabetes in young adults admitted to hospital with AMI

Supplementary Figure 2: Violin plot of HbA1c level distribution for newly diagnosed diabetes

Supplementary Figure 3: Trends of disease-specific and non-disease-specific health status outcomes recovery after AMI in young adults, stratified by diabetes status

Ding Q, *et al. Heart* 2020;0:1–10. doi: 10.1136/heartjnl-2020-317101

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Supplementary Table 1: Comparison of baseline characteristics between diabetic patients with and without 12-month health status outcomes data

Characteristics	**Missing Health Status Outcomes (N=274, 18.4%)**	**Not Missing Health Status Outcomes (N=1219, 81.6%)**	**P-value**
SOCIO-DEMOGRAPHICS			
Age, year (Median, IQR)	48.0 (9.00)	49.0 (8.00)	0.237
Female (%)	191 (69.9%)	888 (72.8%)	0.347
Race			**0.036**
White	184 (67.4%)	909 (74.5%)	
Black	64 (23.4%)	238 (19.5%)	
Others	25 (9.2%)	73 (5.9%)	
Hispanic (Yes/No)	32 (11.7%)	96 (7.9%)	**0.039**
Marital Status			0.303
With Partner (%)	133 (48.7%)	655 (53.7%)	
Without Partner (%)	138 (50.6%)	554 (45.4%)	
Education Status			**0.003**
Less than high school	15 (5.6%)	39 (3.2%)	
Some high school	134 (50.0%)	499 (41.5%)	
More than high school	119 (44.4%)	665 (55.3%)	
Employment Status			**<0.0001**
Working full time	95 (34.8%)	561(45.9%)	
Working part-time	21 (7.7%)	133 (10.9%)	
Not working	157 (57.5%)	526 (43.1%)	

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Household income			0.269
<$30,000	147 (54.2%)	599 (49.1%)	
$30,000-$69,999	64 (23.6%)	337 (27.6%)	
≥$70,000	60 (22.1%)	284 (23.3%)	
CVD RISK FACTORS			
Family history of CVD	185 (68.3%)	925 (75.8%)	**0.029**
History of hypertension	214 (78.4%)	907 (74.3%)	0.163
History of hypercholesterolemia	253 (92.7%)	1101 (90.3%)	0.212
Smoking within last 30 days	170 (62.3%)	674 (55.3%)	**0.036**
Sleep apnea	26 (9.6%)	86 (7.1%)	0.158
Body mass index >30 kg/m^2	162 (59.8%)	780 (63.9%)	0.199
OTHER COMORBIDITIES			
History of renal dysfunction	56 (20.6%)	163 (13.4%)	**0.003**
History of heart failure	41 (15.0%)	70 (5.7%)	**<0.0001**
History of prior stroke/TIA	25 (9.2%)	67 (5.5%)	**0.023**
History of depression	127 (46.5%)	540 (44.3%)	0.498
History of alcohol abuse	18 (6.6%)	61 (5.0%)	0.292
Prior MI	72 (26.4%)	229 (18.8%)	**0.005**
AMI TREATMENT DURING HOSPITALIZATION			
Diagnostic angiography	253 (92.7%)	1159 (95.0%)	0.125
Aspirin at arrival	263 (98.9%)	1155 (97.1%)	0.094
Reperfusion			0.913
Fibrinolytic therapy	14 (5.7%)	58 (5.1%)	

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Primary angioplasty	124 (50.4%)	569 (50.0%)	
Discharge medications			
Aspirin at discharge	260 (97.0%)	1156 (97.7%)	0.485
Statin prescribed	255 (95.9%)	1130 (94.9%)	0.502
Beta-blocker prescribed	246 (95.4%)	1118 (97.1%)	0.141
ACEI or ARB prescribed	183 (74.7%)	855 (82.1%)	0.585
CLINICAL CHARCTERISTICS OF AMI			
AMI symptom presentation			
Typical chest pain	194 (71.1%)	938 (76.9%)	**0.042**
Atypical chest pain	55 (20.2%)	234 (19.2%)	0.715
AMI severity			
ST-segment elevation	130 (47.6%)	604 (49.5%)	0.573
Initial systolic blood pressure (mmHg), median (IQR)	143.5 (42.0)	144.0 (40.0)	0.805
Initial diastolic blood pressure (mmHg), median (IQR)	88.0 (28.5)	86.0 (27.0)	0.169
Initial heart rate, median (IQR)	87.0 (26.0)	85.0 (26.0)	0.086
Peak troponin, median (IQR)	5.5 (19.1)	5.97 (23.6)	0.638
Ejection fraction <40%	49 (18.3%)	130 (11.1%)	**0.001**
Time to presentation >6 hours	128 (47.2%)	571 (47.0%)	0.953
GRACE scores			**0.012**
GRACE 0-99	217 (82.8%)	1073 (89.2%)	
GRACE 100-127	37 (14.1%)	112 (9.3%)	

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GRACE 128-263	8 (3.1%)	18 (1.5%)	
OTHER CLINICAL CHARACTERISTICS			
Baseline HbA1c (%), median (IQR)	8.30 (4.1)	7.70 (4.0)	**0.012**
1-month HbA1c (%), median (IQR)	7.4 (1.7)	7.0 (1.5)	**0.017**
Peak glucose, median (IQR)	241.5 (170.0)	192.0 (162.0)	**<0.0001**
Peak creatinine, median (IQR)	1.0 (0.5)	0.9 (0.3)	**0.022**
Types of Diabetes			**0.002**
Type I	25 (9.2%)	79 (6.5%)	
Type II	158 (57.9%)	584 (47.9%)	
Self-report treatment			
None	23 (8.4%)	82 (6.7%)	0.319
Diet	60 (21.9%)	185 (15.2%)	**0.006**
Insulin	82 (30.0%)	285 (23.4%)	**0.021**
Oral hypoglycemic drugs	86 (31.5%)	359 (29.4%)	0.498
Diabetic Complications			
Kidney disease	29 (10.6%)	51 (4.2%)	**<0.0001**
Retinopathy	13 (4.8%)	56 (4.6%)	0.903
Neuropathy	24 (8.8%)	96 (7.9%)	0.612
Amputation	17 (6.2%)	9 (0.7%)	<0.0001
Other complications	8 (2.9%)	23 (1.9%)	0.274
PSYCHOSOCIAL AND BEHAVIORAL FACTORS			
Social support via ESSI	24.8 (6.16)	25.5 (5.5)	0.096
Stress via PSS	27.1 (9.3)	26.6 (9.9)	0.488

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Depressive symptom via PHQ-9	9.2 (6.9)	8.7 (6.6)	0.326
SELF-REPORTED SOCIOECONOMIC STATUS			
Health insurance			**0.004**
Insured	196 (71.8%)	972 (79.7 %)	
How difficult is it for you to get medical care when needed?			0.139
Extremely difficult	32 (11.8%)	134 (10.9%)	
Some difficult	56 (20.7%)	195 (15.9%)	
Little/not difficult	183 (67.5%)	891 (73.0%)	
Have your medical costs been an economic burden to you over the past year?			0.371
Severe burden	55 (20.3%)	204 (16.7%)	
Some burden	58 (21.4%)	269 (22.1%)	
Little/no burden	158 (58.3%)	747 (61.2%)	
Avoided health-care services due to cost (Yes/No)	100 (36.9%)	439 (35.9%)	0.776
How often have you not taken a medication that your doctor prescribed because of the cost?			0.305
Always	19 (7.0%)	63 (5.2%)	
Sometimes	61 (22.5%)	248 (20.3%)	
Rarely to never	191 (69.7%)	909 (74.5%)	

Abbreviations: ACEIs = angiotensin converting enzyme inhibitors; ARBs = angiotensin receptor blockers; BMI = body mass index; CVD = cardiovascular disease; ESSI = ENRICHD social support instrument; GRACE = Global registry of acute coronary events; IQR = interquartile range; MI = myocardial infarction; PCI = percutaneous coronary intervention; PHQ-9 = patient health questionnaire-9; PSS = perceived stress scale; SD = standard deviation; TIA = transient ischemic attack

P-values numbers in bold denote statistical significance at the $p < 0.05$ level.

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Supplementary Table 2: Comparison of baseline characteristics between AMI patients with and without missing values of HbA1c (baseline and/or 1-month)

Characteristics	**HbA1c Missing AMI Patients (N=745, 21.28%)**	**No Missing HbA1c AMI Patients (N=2756, 78.72%)**	**P-value**
SOCIO-DEMOGRAPHICS			
Age, year (Median, IQR)	45.9 (9.00)	47.3 (8.00)	**0.0049**
Female (%)	251 (33.7%)	901 (32.7%)	0.6066
Race			0.1866
White	601 (80.7%)	2141 (77.7%)	
Black	107 (14.4%)	443 (16.1%)	
Others	37 (4.9%)	172 (6.2%)	
Hispanic (Yes/No)	53 (7.1%)	216 (7.8%)	0.5107
Marital Status			0.1123
With partner (%)	446 (59.9%)	1583 (57.4%)	
Without partner (%)	287 (38.5%)	1147 (41.6%)	
Unknown	12 (1.6%)	26 (0.9%)	
Education Status			**<0.0001**
Less than high school	90 (12.6%)	95 (3.5%)	
Some high school	336 (47.1%)	1081 (39.7%)	
More than high school	287 (40.3%)	1545 (56.8%)	
Employment Status			0.4052
Working full time	364 (48.9%)	1423 (51.6%)	
Working part-time	82 (11.0%)	288 (10.5%)	

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Not working	299 (40.1%)	1045 (37.92%)	
Household income			**0.0014**
<$30,000	345 (46.4%)	1163 (42.2%)	
$30,000-$69,999	232 (31.2%)	788 (28.6%)	
≥$70,000	167 (22.5%)	803 (29.2%)	
CVD RISK FACTORS			
Family history of CVD	487 (65.5%)	2018 (73.3%)	**<0.0001**
History of hypertension	420 (56.4%)	1797 (65.2%)	**<0.0001**
History of hypercholesterolemia	620 (83.2%)	2382 (86.4%)	**0.0263**
Smoking within last 30 days	518 (69.6%)	1567 (56.9%)	**<0.0001**
Sleep apnea	18 (2.4%)	143 (5.2%)	**0.0013**
Body mass index >30 kg/m^{2x}	282 (38.1%)	1427 (51.8%)	**<0.0001**
OTHER COMORBIDITIES			
History of renal dysfunction	66 (8.9%)	296 (10.8%)	0.1409
History of heart failure	24 (3.2%)	117 (4.3%)	0.2067
History of prior stroke/TIA	24 (3.2%)	123 (4.5%)	0.1334
History of depression	272 (36.5%)	1126 (40.8%)	**0.0311**
History of alcohol abuse	63 (8.5%)	168 (6.1%)	**0.0221**
Prior MI	98 (13.2%)	445 (16.2%)	**0.0453**
Prior PCI	78 (10.5%)	430 (15.6%)	**0.0004**
AMI TREATMENT DURING HOSPITALIZATION			
Coronary revascularization (PCI/CABG)	591 (79.3%)	2260 (82.0%)	0.0958

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Diagnostic angiography	703 (94.4%)	2609 (94.7%)	0.7448
Aspirin at arrival	715 (97.15%)	2642 (97.7%)	0.3797
Reperfusion			**0.0165**
Fibrinolytic therapy	59 (8.4%)	140 (5.5%)	
Primary angioplasty	355 (50.6%)	1334 (52.3%)	
Not received	287 (40.9%)	1077 (42.2%)	
Discharge medications			
Aspirin at discharge	716 (97.9%)	2658 (98.1%)	0.8672
Statin prescribed	686 (94.1%)	2526 (94.1%)	0.9905
Beta-blocker prescribed	643 (92.5%)	2500 (96.7%)	**<0.0001**
ACEI or ARB prescribed	468 (68.0%)	1763 (70.8%)	0.1539
CLINICAL CHARCTERISTICS OF AMI			
Coronary occlusion ≥50% (documented by coronary angiography)			0.6619
Yes	621 (83.4%)	2306 (83.7%)	
No	76 (10.2%)	274 (9.9%)	
Unknown	48 (6.4%)	176 (6.4%)	
AMI symptom presentation			
Typical chest pain	632 (84.8%)	2141 (77.7%)	**<0.0001**
Atypical chest pain	98 (13.2%)	526 (19.1%)	**0.0002**
AMI severity			
ST-segment elevation	421 (56.5%)	1390 (50.4%)	**0.0032**

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Initial systolic blood pressure, median (IQR)	139.0 (41.0)	142.0 (37.0)	**0.0037**
Initial diastolic blood pressure, median (IQR)	85.0 (26.0)	87.0 (25.0)	0.3664
Initial heart rate, median (IQR)	80.0 (23.0)	81.0 (25.0)	0.1356
Peak troponin, median (IQR)	9.8 (38.1)	6.6 (24.8)	**0.0002**
Ejection fraction <40%	75 (10.4%)	293 (10.9%)	0.6569
Time to presentation >6 hours	277 (37.3%)	1189 (43.3%)	**0.0035**
GRACE scores			**0.0316**
GRACE 0-99	680 (93.8%)	2456 (90.7%)	
GRACE 100-127	39 (5.4%)	222 (8.2%)	
GRACE 128-263	6 (0.8%)	29 (1.1%)	
OTHER CLINICAL CHARACTERISTICS			
Baseline HbA1c (%), median (IQR)	NA	7.70 (4.0)	
1-month HbA1c (%), median (IQR)	NA	7.0 (1.5)	
Initial glucose, median (IQR)	119.0 (44.0)	132.0 (73.0)	**<0.0001**
Peak glucose, median (IQR)	130.0 (49.0)	145.0 (92.0)	**<0.0001**
Peak creatinine, median (IQR)	0.9 (0.3)	0.9 (0.3)	0.8610
Types of Diabetes			**<0.0001**
Type I	19 (2.6%)	85 (3.1%)	
Type II	70 (9.4%)	672 (24.4%)	
Unknown	656 (88.1%)	1999 (72.5%)	
Self-report treatment			

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None	12 (1.6%)	93 (3.4%)	**0.012**
Diet	25 (3.3%)	220 (7.9%)	**0.0001**
Insulin	37 (4.9%)	330 (11.9%)	**0.0001**
Oral hypoglycemic drugs	48 (6.4%)	397 (14.4%)	**<0.0001**
Unknown	623 (83.6%)	1716 (62.3%)	
Diabetic Complications			
Kidney disease	10 (1.3%)	70 (2.5%)	0.0523
Retinopathy	5 (0.7%)	64 (2.3%)	**0.004**
Neuropathy	11 (1.5%)	109 (3.9%)	**0.001**
Amputation	5 (0.7%)	21 (0.8%)	0.798
Other complications	2 (0.2%)	29 (1.1%)	0.0428
Unknown	712 (95.6%)	2463 (89.4%)	
PSYCHOSOCIAL AND BEHAVIORAL FACTORS			
Social support via ESSI	24.8 (6.16)	25.5 (5.5)	0.096
Stress via PSS	27.1 (9.3)	26.6 (9.9)	0.488
Depressive symptom via PHQ-9	9.2 (6.9)	8.7 (6.6)	0.326
Physical activity			**<0.0001**
Physically active	244 (33.2%)	1002 (36.7%)	
Insufficient activity	169 (23.0%)	774 (28.4%)	
Inactivity	321 (43.7%)	954 (34.9%)	
SELF-REPORTED SOCIOECONOMIC STATUS			
Health insurance			**0.0001**
Insured	633 (84.9%)	2166 (78.6 %)	

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How difficult is it for you to get medical care when needed?			0.1114
Extremely difficult	57 (7.7%)	281 (10.2%)	
Some difficult	124 (16.7%)	437 (15.9%)	
Little/not difficult	563 (75.7%)	2036 (73.9%)	
Have your medical costs been an economic burden to you over the past year?			**<0.0001**
Severe burden	74 (9.9%)	392 (14.2%)	
Some burden	113 (15.2%)	566 (20.6%)	
Little/no burden	557 (74.9%)	1796 (65.2%)	
Avoided health-care services due to cost (Yes/No)	152 (20.4%)	904 (32.8%)	**<0.0001**
How often have you not taken a medication that your doctor prescribed because of the cost?			**0.0064**
Always	24 (3.2%)	125 (4.5%)	
Sometimes	96 (12.9%)	464 (16.9%)	
Rarely to never	624 (83.9%)	2165 (78.6%)	

Abbreviations: ACEIs = angiotensin converting enzyme inhibitors; ARBs = angiotensin receptor blockers; BMI = body mass index; CABG = coronary artery bypass grafting; CVD = cardiovascular disease; ESSI = ENRICHD social support instrument; GRACE = Global registry of acute coronary events; IQR = interquartile range; MI = myocardial infarction; PCI = percutaneous coronary intervention; PHQ-9 = patient health questionnaire-9; PSS = perceived stress scale; SD = standard deviation; TIA = transient ischemic attack.

P-value numbers in bold denote statistical significance at $p<0.05$ level.

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Supplementary Table 3: Health Status Outcomes Stratified by NDD Subgroups

Health Status Outcomes	**NDD (HbA1c ≥8) (N=47) Mean (SD) (a)**	**NDD (6.5≤ HbA1c <8) (N=435) Mean (SD) (b)**	**Without Diabetes (N=2008) Mean (SD) (c)**	**Established Diabetes (N=985) Mean (SD) (d)**	**P-Value*** **(a) vs. (c)**	**P-Value†** **(a) vs. (d)**	**P-Value‡** **(b) vs. (c)**	**P-Value§** **(b) vs. (d)**
Baseline								
SAQ-Angina Frequency	87.87 (15.73)	85.30 (18.22)	85.84 (18.94)	79.33 (23.73)	0.465	**0.008**	0.059	**<0.0001**
SAQ-Physical Limitations	83.18 (26.85)	82.41 (24.63)	84.56 (22.93)	73.77 (28.72)	0.688	**0.029**	0.084	**<0.0001**
SAQ-Quality of Life	61.35 (22.21)	60.52 (25.73)	57.48 (22.84)	52.94 (25.25)	0.251	**0.025**	**0.024**	**<0.0001**
SF-12 Mental Functioning	46.72 (12.11)	45.41 (12.18)	46.36 (12.37)	43.21 (12.81)	0.849	0.069	0.155	**0.003**
SF-12 Physical Functioning	46.03 (11.63)	44.24 (11.87)	45.84 (11.65)	39.71 (12.06)	0.914	**0.001**	**0.012**	**<0.0001**
EQ-5D-VAS	62.55 (21.75)	67.55 (21.07)	66.34 (20.62)	58.49 (22.27)	0.228	0.237	0.282	**<0.0001**
1-Month Follow-Up								

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SAQ-Angina Frequency	94.32 (12.83)	88.95 (18.20)	89.51 (17.27)	87.39 (18.53)	**0.019**	**0.014**	0.058	0.151
SAQ-Physical Limitations	88.13 (20.04)	91.48 (18.04)	89.90 (19.09)	88.91 (20.94)	0.544	0.081	0.124	**0.024**
SAQ-Quality of Life	71.97 (21.87)	71.51 (24.50)	67.94 (24.57)	66.39 (26.40)	0.284	0.162	**0.008**	**0.001**
SF-12 Mental Functioning	51.91 (10.07)	51.68 (9.41)	49.61 (10.85)	48.61 (11.21)	0.174	0.062	**0.001**	**<0.0001**
SF-12 Physical Functioning	41.39 (11.94)	42.43 (11.60)	43.51 (11.28)	38.10 (11.75)	0.229	0.078	0.089	**<0.0001**
EQ-5D-VAS	64.39 (20.63)	72.99 (19.42)	71.75 (20.09)	67.37 (22.40)	**0.016**	0.386	0.254	**<0.0001**
12-Month Follow-Up								
SAQ-Angina Frequency	93.82 (11.29)	92.28 (14.74)	92.06 (16.03)	89.21 (19.12)	0.378	**0.030**	0.793	**0.003**
SAQ-Physical Limitations	89.22 (18.79)	93.74 (15.72)	91.87 (17.98)	89.79 (20.94)	0.395	0.863	**0.041**	**0.001**
SAQ-Quality of Life	71.57 (23.22)	76.39 (21.87)	72.23 (22.51)	70.32 (24.88)	0.866	0.775	**0.001**	**<0.0001**

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SF-12 Mental Functioning	52.80 (10.74)	51.28 (9.62)	50.61 (10.80)	48.81 (11.79)	0.243	0.054	0.237	**0.001**
SF-12 Physical Functioning	44.43 (12.91)	45.28 (12.08)	46.14 (11.55)	40.61 (12.83)	0.395	0.089	0.203	**<0.0001**
EQ-5D-VAS	68.62 (20.54)	76.60 (18.07)	73.61 (20.22)	68.55 (22.87)	0.169	0.987	**0.001**	**<0.0001**

*=P-values were testing for health status outcomes differences between NDD patients with HbA1c ≥8 and those without diabetes.
†=P-values were testing for health status outcomes differences between NDD patients with HbA1c ≥8 and those with established diabetes.
‡=P-values were testing for health status outcomes differences between NDD patients with HbA1c <8 and those without diabetes.
§=P-values were testing for health status outcomes differences between NDD patients with HbA1c <8 and those with established diabetes.

Abbreviations: EQ-5D-VAS = Euro-Quality of Life Visual Analog Scale; NDD = newly diagnosed diabetes; SAQ = Seattle Angina Questionnaire; SF-12 = 12-Item Short Form Health Survey

P-values numbers in bold denote statistical significance at the p<0.05 level.

Supplementary material

Supplementary Table 4: Mortality and in-hospital medical complications after AMI stratified by NDD subgroups

Clinical Outcomes	**NDD (HbA1c ≥8) (N=47) (a)**	**NDD (6.5≤ HbA1c <8) (N=435) (b)**	**Without Diabetes (N=2008) (c)**	**Established Diabetes (N=985) (d)**	**P-Value*** **(a) vs. (c)**	**P-Value †** **(a) vs. (d)**	**P-Value ‡** **(b) vs. (c)**	**P-Value §** **(b) vs. (d)**
Mortality								
In-hospital mortality	0	0	1 (0.1%)	3 (0.3%)	0.999	0.999	0.999	0.557
30-day mortality	0	0	12 (0.6%)	9 (0.9%)	0.999	0.999	0.126	0.102
1-year mortality	0	5 (1.2%)	32 (1.6%)	35 (3.6%)	0.822	0.519	**0.029**	**0.003**
In-Hospital Medical Complications								
Re-infarction	2 (4.3%)	4 (0.9%)	28 (1.4%)	9 (0.9%)	0.131	**0.033**	0.868	0.815
Heart failure	3 (6.4%)	30 (6.9%)	109 (5.4%)	97 (9.9%)	0.829	0.759	0.269	0.154
Cardiac arrhythmias	2 (4.3%)	26 (5.9%)	151 (7.5%)	65 (6.6%)	0.664	0.845	0.526	0.680
Stroke/Transient ischemic attack	0	1 (0.2%)	6 (0.3%)	4 (0.4%)	0.999	0.569	0.889	0.999
Hemorrhagic	6 (12.8%)	26 (5.9%)	153 (7.6%)	80 (8.1%)	0.281	0.078	0.455	0.281

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complications				

*=P-values were testing for clinical outcomes differences between NDD patients with HbA1c ≥8 and those without diabetes. Fisher exact for cells <5.
†=P-values were testing for clinical outcomes differences between NDD patients with HbA1c ≥8 and those with established diabetes. Fisher exact for cells <5.
‡=P-values were testing for clinical outcomes differences between NDD patients with HbA1c <8 and those without diabetes. Fisher exact for cells <5.
§=P-values were testing for clinical outcomes differences between NDD patients with HbA1c <8 and those with established diabetes. Fisher exact for cells <5.

Abbreviations: NDD = newly diagnosed diabetes
P-values numbers in bold denote statistical significance at the p<0.05 level.

Ding Q, *et al. Heart* 2020;0:1–10. doi: 10.1136/heartjnl-2020-317101

Supplementary material

Supplementary Table 5: Parameter estimates and P-values from the mixed effects models describing the relationship between newly diagnosed diabetes subgroups and health status outcomes

Health Status Outcomes	Reference Group	Estimate (Unadjusted models)	95% Confidence Intervals	P-Value	Estimate (Adjusted models*)	95% Confidence Intervals	P-Value
SAQ-Angina Frequency							
Newly diagnosed diabetes HbA1c ≥8	Without diabetes	2.81	-1.00 to 6.63	0.149	1.75	-2.12 to 5.62	0.376
Newly diagnosed diabetes HbA1c ≥8	Established diabetes	6.67	2.22 to 11.11	**0.003**	1.25	-3.01 to 5.52	0.564
Newly diagnosed diabetes HbA1c <8	Without diabetes	-0.20	-1.52 to 1.11	0.7616	0.29	-0.96 to 1.53	0.653
Newly diagnosed diabetes HbA1c <8	Established diabetes	3.49	1.89 to 5.10	**<0.0001**	1.30	-0.47 to 3.08	0.149
SAQ-Physical Limitations							
Newly diagnosed diabetes HbA1c ≥8	Without diabetes	-1.45	-6.01 to 3.12	0.535	-1.31	-5.74 to 3.13	0.5635
Newly diagnosed diabetes HbA1c ≥8	Established diabetes	1.75	-3.39 to 6.89	0.504	4.86	-3.07 to 12.79	0.2291

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Newly diagnosed diabetes HbA1c <8	Without diabetes	0.99	-0.55 to 2.53	0.209	-1.24	-3.49 to 1.01	0.2800
Newly diagnosed diabetes HbA1c <8	Established diabetes	4.52	2.71 to 6.33	**<0.0001**	5.47	2.40 to 8.54	**0.0005**
SAQ-Quality of Life							
Newly diagnosed diabetes HbA1c ≥8	Without diabetes	3.16	-2.26 to 8.59	0.253	2.19	-2.98 to 7.37	0.4065
Newly diagnosed diabetes HbA1c ≥8	Established diabetes	6.21	0.25 to 12.2	**0.041**	1.20	-4.27 to 6.68	0.667
Newly diagnosed diabetes HbA1c <8	Without diabetes	3.47	1.56 to 5.39	**0.0004**	3.46	1.77 to 5.17	**<0.0001**
Newly diagnosed diabetes HbA1c <8	Established diabetes	6.64	4.41 to 8.86	**<0.0001**	2.78	0.45 to 5.11	**0.019**
SF-12 Mental Functioning							
Newly diagnosed diabetes HbA1c ≥8	Without diabetes	1.92	-0.82 to 4.66	0.169	0.84	-1.36 to 3.04	0.455

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Newly diagnosed diabetes HbA1c ≥8	Established diabetes	3.79	0.92 to 6.66	**0.009**	0.75	-1.38 to 2.88	0.488
Newly diagnosed diabetes HbA1c <8	Without diabetes	0.89	-0.05 to 1.85	0.063	-0.76	-1.80 to 0.28	0.150
Newly diagnosed diabetes HbA1c <8	Established diabetes	2.77	1.72 to 3.81	**<0.0001**	0.31	-0.59 to 1.21	0.508
SF-12 Physical Functioning							
Newly diagnosed diabetes HbA1c ≥8	Without diabetes	-1.20	-4.04 to 1.64	0.407	-0.67	-3.25 to 1.92	0.612
Newly diagnosed diabetes HbA1c ≥8	Established diabetes	4.56	1.45 to 7.67	**0.004**	-0.03	-2.67 to 2.62	0.984
Newly diagnosed diabetes HbA1c <8	Without diabetes	-1.21	-2.22 to -0.19	**0.019**	-0.25	-1.11 to 0.61	0.569
Newly diagnosed diabetes HbA1c <8	Established diabetes	4.53	3.35 to 5.71	**<0.0001**	0.59	-0.57 to 1.75	0.319
EQ-5D Visual Analogue Scale							

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Newly diagnosed diabetes HbA1c ≥8	Without diabetes	-5.25	-10.0 to 0.48	**0.031**	-4.87	-9.44 to -0.29	**0.037**
Newly diagnosed diabetes HbA1c ≥8	Established diabetes	0.78	-4.64 to 6.21	0.777	-4.10	-9.17 to 0.96	0.112
Newly diagnosed diabetes HbA1c <8	Without diabetes	1.71	0.05 to 3.37	**0.044**	1.99	0.49 to 3.48	**0.009**
Newly diagnosed diabetes HbA1c <8	Established diabetes	7.69	5.73 to 9.66	**<0.0001**	3.21	1.09 to 5.33	**0.003**

Abbreviations: EQ-5D-VAS = Euro-Quality of Life Visual Analogue Scale; SAQ = Seattle Angina Questionnaire; SF-12 = 12-Item Short Form Health Survey
P-values marked in bold denote statistical significance at the p<0.05 level.

Supplementary material

Supplementary Table 6: P-values for interactions between newly diagnosed diabetes subgroups and time in the fully adjusted linear mixed effects models

Post-AMI health outcomes (baseline, 1-month & 12-months)	**P-value**
Newly Diagnosed Diabetes HbA1c ≥8% vs. No Diabetes	
SAQ-Angina Frequency Scores	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.4365
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.8564
SAQ-Physical Limitations	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.8196
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.8367
SAQ-Quality of Life	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.8487
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.2614
SF-12 Mental Functioning	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.3982
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.4809
SF-12 Physical Functioning	

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Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.2143
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.4112
EQ-5D Visual Analogue Scale	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.2847
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.7516
Newly Diagnosed Diabetes HbA1c ≥8% vs. Established Diabetes	
SAQ-Angina Frequency Scores	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.5699
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.3091
SAQ-Physical Limitations	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	**0.0219**
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.0648
SAQ-Quality of Life	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.3472
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.1107
SF-12 Mental Functioning	

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Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.8504
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.8983
SF-12 Physical Functioning	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	0.0771
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.2923
EQ-5D Visual Analogue Scale	
Newly diagnosed diabetes HbA1c ≥8%*time2 interaction	**0.0465**
Newly diagnosed diabetes HbA1c ≥8%*time3 interaction	0.3579
Newly Diagnosed Diabetes HbA1c <8% vs. No diabetes	
SAQ-Angina Frequency Scores	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	0.9969
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.6595
SAQ-Physical Limitations	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	**0.0126**
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	**0.0092**
SAQ-Quality of Life	

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Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	0.6480
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.5222
SF-12 Mental Functioning	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	**<0.0001**
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	**0.0350**
SF-12 Physical Functioning	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	0.4923
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.5369
EQ-5D Visual Analogue Scale	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	0.9700
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.2111
Newly Diagnosed Diabetes HbA1c <8% vs. Established Diabetes	
SAQ-Angina Frequency Scores	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	**0.0009**
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	**0.0251**
SAQ-Physical Limitations	

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Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	**0.0004**
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	**0.0065**
SAQ-Quality of Life	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	0.1085
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.3087
SF-12 Mental Functioning	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	0.2410
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.6515
SF-12 Physical Functioning	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	0.4914
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.9131
EQ-5D Visual Analogue Scale	
Newly Diagnosed Diabetes HbA1c <8%*time2 interaction	**0.0114**
Newly Diagnosed Diabetes HbA1c <8%*time3 interaction	0.5387

Abbreviations: EQ-5D = Euro-Quality of Visual Analogue Scale; SAQ = Seattle Angina Questionnaire; SF-12 = 12-Item Short Form Survey; Time2=indicator of the 1-month follow-up time point; Time3=indicator of the 12-months follow-up time point. P-values marked in bold denote statistical significance at the $p<0.05$ level.

Supplementary material

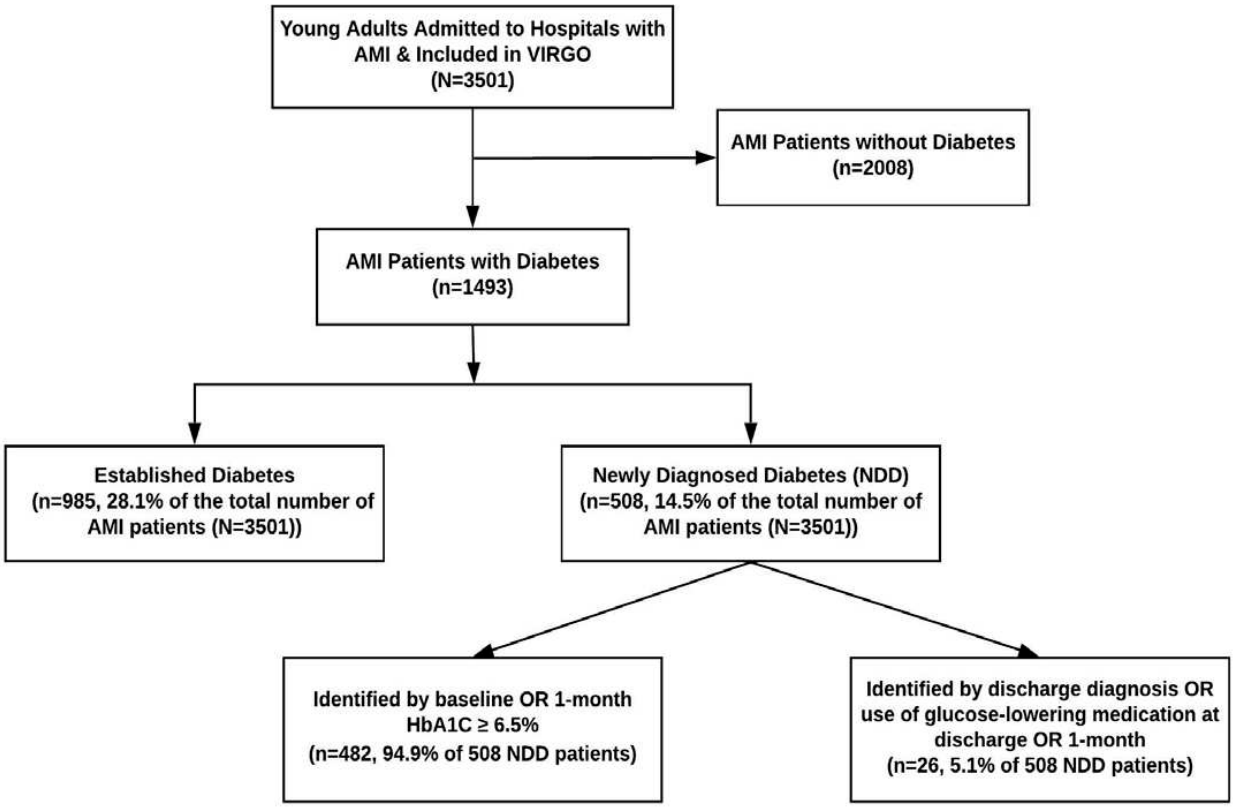
Supplementary Table 7: Self-reported weight changes during 12-month follow-up, stratified by diabetes status

Self-reported weight changes during 12-month follow-up	**Without Diabetes (N=2008, 57.36%) (a)**	**Newly Diagnosed Diabetes (N=508, 14.51%) (b)**	**Established Diabetes (N=985, 28.13%) (c)**	**P-value (b) vs. (a)**	**P-value (b) vs. (c)**
Gain weight	620 (30.9%)	150 (29.5%)	265 (26.9%)	0.556	0.2836
Lost weight	508 (25.3%)	157 (30.9%)	282 (28.6%)	**0.0105**	0.3604
No change	416 (20.7%)	117 (23.0%)	166 (16.9%)	0.2541	**0.0039**
Unknown	31 (1.5%)	8 (1.6%)	20 (2.0%)	0.959	0.5386
Among AMI patients who had received weight management counseling at discharge					
Self-reported weight changes during 12-month follow-up	**Without Diabetes (n=753, 37.5% out of 2008) (a)**	**Newly Diagnosed Diabetes (n=195, 38.4% out of 508) (b)**	**Established Diabetes (n=427, 43.4% out of 985) (c)**	**P-value (b) vs. (a)**	**P-value (b) vs. (c)**
Gain weight	219 (29.1%)	58 (29.7%)	118 (27.6%)	0.8567	0.588
Lost weight	196 (26.0%)	63 (32.3%)	129 (30.2%)	0.0795	0.599
No change	158 (20.9%)	44 (22.6%)	63 (14.8%)	0.6308	**0.016**
Unknown	9 (1.2%)	4 (2.1%)	4 (0.9%)	0.3596	0.2525

*P-values in bold denote statistical significance at the $p<0.05$ level

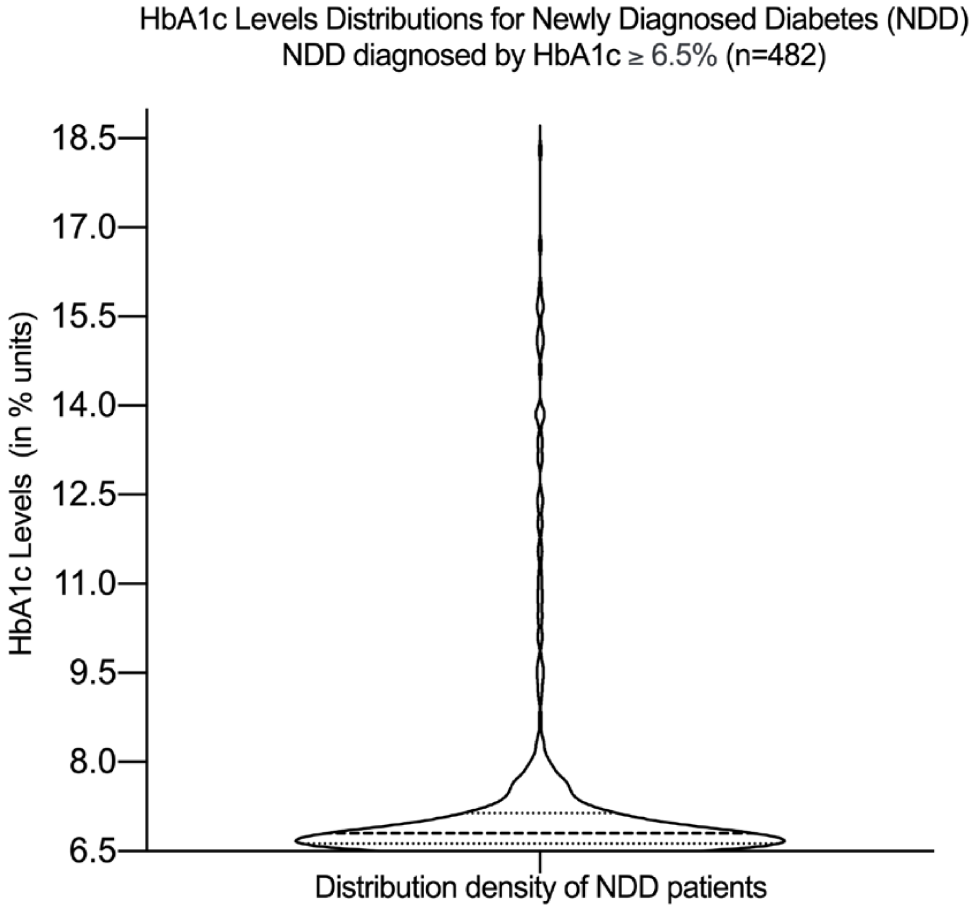
Supplementary material

Supplementary Figure 1:



Supplementary material

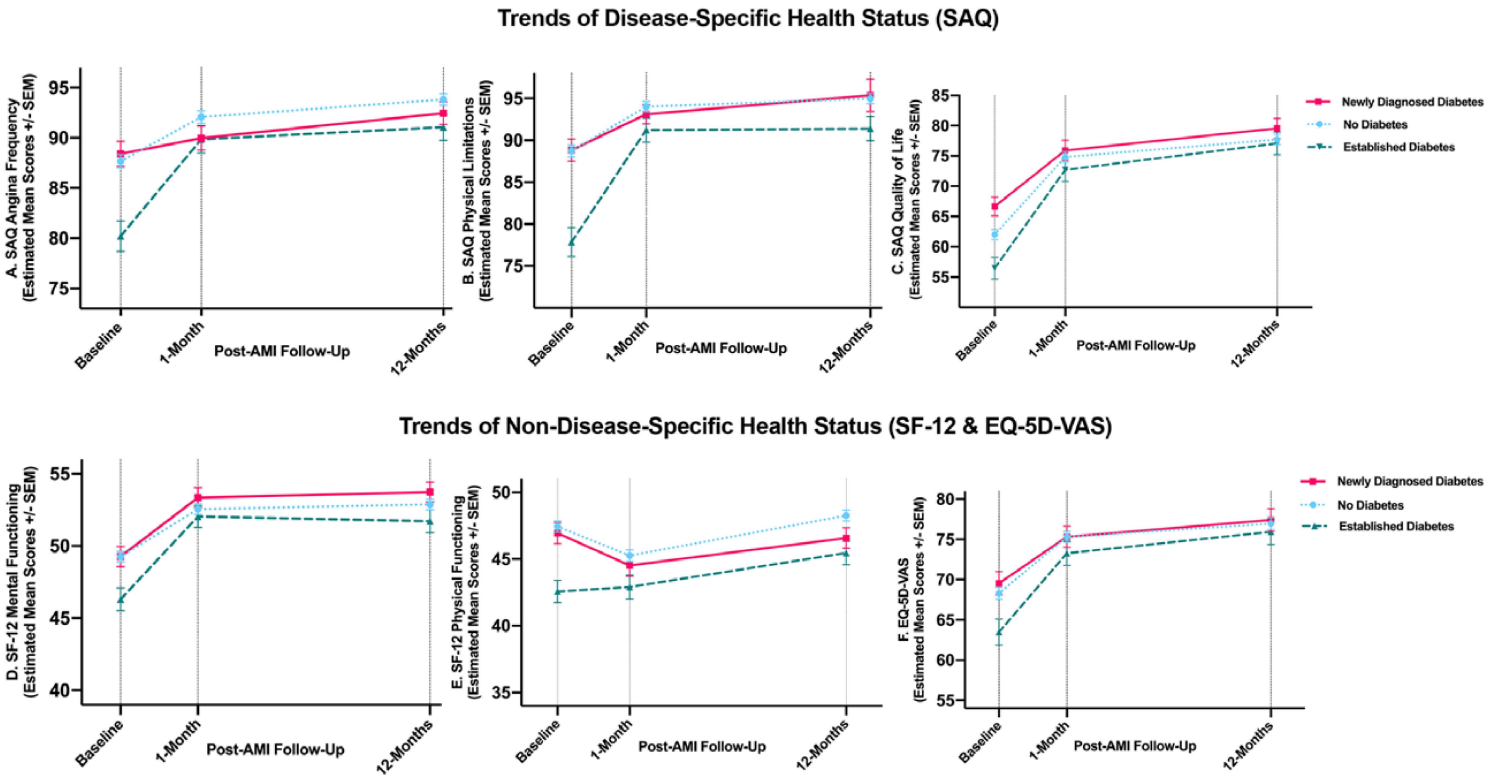
Supplementary Figure 2:



Note: median is shown with a dashed line, first and third quantiles are shown dotted lines. The first quantile is below the dashed line and the third quantile is above the dashed line.

Supplementary material

Supplementary Figure 3:



Supplementary material

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