Are people with diabetes less likely to have chest pain during a myocardial infarction: a systematic review and meta-analysis

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Abstract

Objective

Chest pain (CP) is key in diagnosing myocardial infarction (MI). Patients with diabetes mellitus (DM) are at increased risk of a MI but may experience less CP, leading to delayed treatment and worse outcomes. Therefore, we compared the prevalence of CP in those with & without DM who had a MI.

Methods

The study population was people with a MI presenting to healthcare services. The outcome measure was the absence of CP during a MI, comparing those with and without DM. Medline and Embase databases were searched to 18/10/21, identifying 9272 records. After initial independent screening 87 reports were assessed for eligibility against the inclusion criteria, quality and risk of bias assessment (STROBE and Newcastle-Ottowa criteria), leaving 22 studies. The meta-analysis followed MOOSE criteria and reported according to PRISMA guidelines. Pooled odds ratios (OR), weights and 95% confidence intervals (CI) were calculated using a random effects model.

Results

This meta-analysis included 232,519 participants from 22 studies and showed an increased risk of no CP during a MI for those with DM, compared to those without. This was 43% higher in DM patients in the cohort and cross-sectional studies (OR:1.43; 95%CI: 1.26 to 1.62), and 44% higher in case-control studies (OR:1.44; 95%CI: 1.11 to 1.87).

Conclusion

In patients with a MI, DM patients are less likely to have presentations with CP recorded. Clinicians should consider a MI diagnosis when patients with DM present with atypical symptoms and treatment protocols should reflect this, alongside an increased patient awareness on this issue.

Summary boxes

What is already known on this topic

- Chest pain is the characteristic presenting symptom of a myocardial infarction (MI) or acute coronary syndrome (ACS) in most patients.
- There is conflicting evidence about whether people with diabetes are less likely to present with chest pain during a MI, which can subsequently lead to delayed treatment due to a late or missed diagnosis.

What this study adds

- Our study suggests there is a significantly increased risk of experiencing ‘no chest pain’ during a MI for those with diabetes.
- This is the first meta-analysis addressing this question and can provide justification for clinicians’ decisions when treating possible MI patients.

How this study might affect research, practice or policy

- Clinicians should have a high index of suspicion for a MI when patients with diabetes present with atypical symptoms.
- Future revisions of ACS treatment guidance and protocols should consider this information to reflect the possible atypical presentations seen in DM patients, and patients themselves should be made aware of this issue.

Introduction

Diabetes Mellitus (DM) is a common health problem affecting approximately 7% of the UK population.(1) DM is a prevalent condition worldwide, with the incidence of DM expected to rise from 382 million in 2014 to an estimated 592 million by 2035.(2) The impaired glucose tolerance seen in DM is a key metabolic risk factor for developing cardiovascular disease (CVD), a major life-threatening complication of DM.(3)

Acute coronary syndromes (ACS) include ST elevation myocardial infarction (STEMI), non-ST elevation myocardial infarction (NSTEMI) and unstable angina. They are one of the principal causes of excess morbidity and mortality in people with DM, and these patients have a worse prognosis when they suffer a myocardial infarction (MI) compared with populations without DM.(4, 5) Possible mechanisms for the increased risk of MI in DM populations include lifestyle behaviours, hyperglycaemia, hypertension, dyslipidaemia, poor renal function and other vascular disease such as cerebrovascular or peripheral arterial diseases.(6) Therefore, with an increased cardiovascular risk and worse prognosis, it is important to understand factors that might drive this disparity in outcome.

Chest pain is a key presenting complaint for a MI which triggers further investigation and management. Late or missed presentation of MI can increase mortality or lead to poorer outcomes, especially in the era of percutaneous coronary intervention (PCI) where prompt treatment can reduce heart muscle damage and reduce mortality.(7) A silent MI (a MI with very few or no symptoms) or atypical symptoms of MI can delay presentation due to non-recognition by patients or missed/late diagnosis by clinicians.(8)

Patients with DM are at risk of autonomic neuropathies including cardiac autonomic neuropathy (CAN) leading to altered pain perception in organs such as the heart.(9) There is increased prevalence of CAN in DM populations who therefore may not experience typical chest pain symptoms during a MI.(10) Furthermore, CAN itself can increase the risk of CVD development with an associated higher mortality.(11)

Despite this, there is conflicting evidence around the issue of whether people with DM present with less chest pain during a MI. Previous studies show results either

supporting or contradicting this, so a meta-analysis is needed to determine whether this clinical truism has some basis.(12)

In this meta-analysis of studies, we aim to investigate if patients with DM are less likely to experience chest pain when having a MI, compared to those without DM.

Methods

This meta-analysis was registered with Prospero (CRD42017058223). https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=58223

Eligibility criteria

This review includes observational studies (cohort, case-control and cross-sectional studies). Case reports, guidelines, protocols, randomised control trials and lab-based studies were excluded. The inclusion criteria for relevant studies were as follows:

- **Participants/population -** People with Type 1 or 2 DM who experience an MI/ACS.

- **Exposures -** Patients with pre-existing DM at presentation of a MI. If patients were diagnosed with DM on admission for their MI, then the study was excluded.

- **Control -** People without Type 1 or 2 DM who experience an MI/ACS. If the study was only examining patients with DM, then it was excluded.

- **Context -** Patients seen by health services such as Emergency Room (ER)/Accident and Emergency (A&E) or a Coronary Care Unit (CCU), with a suspected ACS (e.g., STEMI, NSTEMI or unstable angina). On presentation, the service should also record contemporaneously the patients' symptoms for patients both with and without DM.

- **Main outcome -** Chest pain recorded as either present/absent or with typical/atypical symptoms during admission for an MI/ACS.

Studies were only included if the diagnosis of MI/ACS used objective measures that were clearly stated. These included biochemical cardiac enzyme measurements (e.g., Troponin) and electrocardiography (ECG) changes (e.g., ST changes, new left bundle branch block, inverted T waves). The identified studies often used established criteria for diagnosing MI/ACS from a recognised medical or cardiology association. The definition of MI has evolved over the timeframe of our study search, so diagnostic criteria utilised at the time of the study were accepted. As part of the definition of ACS, a minority of the older studies included unstable angina presentations as well. These patients do not have a rise in troponin or ST elevation, but are diagnosed and treated as part of the ACS protocol(13). Since current UK and US guidelines include NSTEMI and unstable angina together under the same risk stratification and treatment pathway, we allowed patients presenting with unstable angina to be included in our data(14, 15). Features indicating an old MI (such as a Q wave on ECG) were excluded.

Studies were only included if the measure of DM in patients was objective e.g., a clinical record of pre-existing DM (including past biochemical diagnosis using HBa1c or World Health Organisation (WHO) criteria for abnormal glucose tolerance tests) or a patient declared diagnosis of DM. DM classified as either type 1 or 2, or as insulin/non-insulin dependent were included. Studies that had new diagnosis of DM on presentation were excluded.

When defining the type of chest pain, we included studies where explicit clinician judgement with reasoning was clearly stated. The broad definition of typical MI symptoms included acute chest pain that may radiate to the left arm or neck. Atypical MI symptoms could include fatigue; shortness of breath; discomfort in the throat, jaw, neck, arms, back and stomach; and presentations like indigestion or heartburn.(16) Only studies that classed chest pain with typical MI, and absence of chest pain with atypical MI, were included.

Information sources

Medline and Embase databases were searched by a medical librarian from their inception to 18th October 2021. Due to the large number of results retrieved and limited

resources to screen them, conference abstracts and non-English language studies were excluded. We did not contact authors, nor do further ‘grey literature’ searches.

Search strategy

Search strategies using both thesaurus and text word searching were developed by a medical librarian and tested against a set of target references and included terms relating to diabetes, ACS, MI, unstable angina, and terms relating to pain, atypical or asymptomatic presentation, or silent pain. The full search terms for the Medline database are in the appendix[1].

Selection process & study risk of bias assessment

Studies not available in English were excluded. Additionally, if an abstract was present with no full-length report available, then these were excluded. After the identification of references from database searches, pairs of independent reviewers used a title and abstract screening tool (which assessed type of study, study participants, context and the main outcome) to determine a study’s relevance. Discrepancies between reviewers were discussed and resolved with a third reviewer. The independent reviewers then assessed the full studies against the inclusion criteria and performed a quality and risk of bias assessment. The STROBE checklist was used when assessing the eligibility of reports.(17) The risk of bias in studies was assessed using the Newcastle-Ottawa criteria, a tool used for quality assessment of non-randomised studies to be used in systematic reviews.(18) Those studies with a high risk of bias (i.e., low quality studies) were excluded. Again, any discrepancy between the two reviewers was resolved by discussion with a third reviewer.

Data items & Data collection process

Data were obtained for people both with and without DM presenting with an ACS. For cohort studies this meant follow-up of patients who presented to healthcare services with a proven ACS. Symptom presentation was recorded as either present/absent chest pain, or typical/atypical MI, depending on how it was presented in the study. Data were extracted by two reviewers independently. Studies needed to report original data as raw numbers or in a format in which raw numbers could be calculated, and if this was not possible then the study was excluded. We examined the methods section

of the included reports to review the study methods and the selection criteria for those recruited to the studies to ascertain if there was clinical heterogeneity between studies. The population and data collection periods for each study were recorded to ensure there were no duplicate datasets/participants included in the meta-analyses.

Effect measures, synthesis methods and certainty assessment

The main outcome measures were sufficiently homogenous for a quantitative synthesis of the included studies. In line with the Cochrane Reviews guidance, the cohort and cross-sectional studies were analysed separately to the case-control studies, producing two sets of results.(19) A meta-analysis according to MOOSE criteria was undertaken.(20) Effect sizes were expressed as odds ratios (OR) and their 95% confidence intervals (CI) calculated for each study, based on the risk of MI patients having atypical/no chest pain symptoms in people with DM versus non-DM. The results from these studies were combined using the metan command in Stata, and pooled ORs, weights and 95% CI were calculated using a random effects model. A fixed effect could not be assumed, so a random effects model that allows for individual effects between studies was used. The size of the boxes on the point estimates in the forest plot indicates the magnitude of the weight applied to that study in the meta-analyses. Studies with more participants are given a higher weighting than smaller studies. No potential confounders were included in the meta-analysis modelling. Heterogeneity of the study outcomes was examined using the I^2 statistic. A sensitivity analysis was performed to assess the robustness of the synthesised results relative to study size. Studies that could heavily influence the meta-analysis due to their large population were removed, to determine their effect on the overall OR. Data were analysed using Stata v17. A PRISMA checklist is available.

Patient and public involvement (PPI) Statement

The initial research idea was presented to the Northeast London Diabetic research network patient and public involvement (PPI) group in 2011 and was welcomed particularly by one member who had lost a spouse to a MI without classical chest pain. A draft version of the study was presented and reviewed by members of the UCL Primary Care & Population Health Expert by Experience (EbE) PPI group in November 2022. Our members identified technical and presentational issues which

we addressed. Importantly a member identified that CVD and DM disproportionately impact members of Black, Asian and minority ethnic (BAME) groups and was an important potential cofounder. Our data did not allow us to address this, but we do mention this as an important study limitation. In terms of public dissemination of our findings, EbE members commented "(users would) welcome this information in advance and well ahead of routine check-ups. This is important because otherwise patients are taken by surprise and will feel undue stress. So, a gentle 'getting ready leaflet' or 'what to expect' approach will be very useful". They also recommend that we should aim "to contextualise this information" and raise awareness of the issue for different ethnic groups. It was also suggested that seminars/webinars from healthcare professionals would be one of the most effective methods of raising awareness. Another EbE member's suggestion was to engage with charities to see if "websites of the charities Diabetes UK, British Heart Foundation, and the NHS website" might help with dissemination in a patient focused format.

Results

Figure 1 about here

The searches of databases identified 9272 references in total (***Figure 1***). After removal of duplicates and conference abstracts without full text, 5011 records were screened using the title and abstract screening tool, producing 87 studies where full text reports were assessed for eligibility. Of these, 22 eligible studies were included in the review (***Table 1***), and the reasons for exclusion of the other 65 reports were recorded (appendix[2]). There were no issues in checking participant data from the 22 included studies.

Study characteristics and risk of bias in studies

STUDY	STUDY TYPE	NUMBER OF PARTICIPANTS	PATIENTS WITH DM	AGE RANGE	STUDY CHARACTERISITICS	RISK OF BIAS ASSESSMENT

Kim et al, 2021.(21)	Cohort Study	13,104 (Male – 9685, Female – 3419)	4458 (34.0%)	No age limit specified	AMI patients from 20 major centres in Korea from November 2011 to December 2015, taken from the registry of Korea Acute Myocardial Infarction Registry-National Institutes of Health (KAMIR-NIH)	Low risk of bias
Pong et al, 2019.(22)	Case-control Study	4667 (Male – 4064, Female – 603)	1782 (38.2%)	No age limit specified	STEMI patients from the Singapore Myocardial Infarction Registry (SMIR) which includes patients presenting to emergency services in Singapore between January 2010 and December 2012	Moderate risk of bias – only STEMI patients and those who underwent primary or selected percutaneous coronary intervention (PCI) were included in the analysis
Song et al, 2019.(23)	Cohort Study	12,060 (Male – 9693, Female – 2367)	2209 (18.3%)	No age limit specified	STEMI patients from the Chinese Acute Myocardial Infarction (CAMI) registry covering 107 Chinese hospitals between 1st January 2013 to 30th September 2014	Moderate risk of bias – only STEMI patients included in the analysis
Ahmed et al, 2018.(24)	Cross-sectional Study	280 (Male – 194, Female – 86)	130 (46.4%)	No age limit specified	AMI patients attending 3 tertiary hospitals in Karachi, Pakistan between 1st November 2015 to 30th April 2016	Low risk of bias
Bjorck et al, 2018.(25)	Cohort Study	172,981 (Male – 115, 067, Female – 57, 914)	38,694 (22.4%)	18-84 years old	AMI patients presenting to healthcare services in Sweden. Patients were from the SWEDEHEART registry who were admitted between 1996 and 2010 from 72 Swedish hospitals	Low risk of bias
Lichtman et al, 2018.(26)	Cohort Study	2985 (Male – 976, Female – 2009)	905 (30.3%)	18-55 years old	AMI patients from the VIRGO study, recruited from 103 hospitals in the United States from 21st August 2008 to 5th January 2012	Low risk of bias
Fujino et al, 2017.(27)	Cohort Study	3085 (Males – 2312, Female – 773)	1121 (36.3%)	No age limit specified	AMI patients from the J-MINUET registry. Patients were recruited from 28 Japanese hospitals between July 2012 and March 2014	Low risk of bias
Li et al, 2017.(28)	Cohort Study	397 (Male – 309, Female – 88)	126 (31.7%)	Over 18 years old	AMI patients from 3 regional hospitals in Hong Kong from June 2012 to August 2013	Low risk of bias
Angerud et al, 2016.(29)	Cross-sectional Study	694 (Male – 525, Female – 169)	96 (13.8%)	No age limit specified	AMI patients presenting to CCU's. Patients are part of a Swedish multicentre survey study (SymTime), taken	Low risk of bias

					between November 2012 and January 2014	
Kreiner et al, 2014.(30)	Cohort Study	326 (Male – 192, Female - 134)	95 (29.1%)	No age limit specified	Consecutive AMI patients presenting to 3 cardiology units in Montevideo, Uruguay.	Low risk of bias
Choi et al, 2012.(31)	Cohort Study	9735 (Male – 6882, Female – 2853)	2689 (27.6%)	No age limit specified	AMI patients in Korea, taken from the registry of Korea Acute Myocardial Infarction Registry-National Institutes of Health (KAMIR-NIH) from November 2005 to August 2008	Low risk of bias
Shehab et al, 2012.(32)	Cohort Study	1538 (Male – 1327, Female – 211)	574 (37.3%)	Over 18 years old	ACS patients from various hospitals in 6 Middle Eastern countries, taken from the Gulf Registry of Acute Coronary Events (Gulf RACE), from 29th January 2007 to 29th June 2007	Low risk of bias
Wu et al, 2012.(33)	Case-control Study	260 (Male – 201, Female – 59)	88 (33.8%)	No age limit specified	STEMI patients presenting to the emergency department of a general hospital in south-central Taiwan from 2006 to 2009	Moderate risk of bias – only STEMI patients included in the analysis
Bakhai et al, 2005.(34)	Cohort Study	1046 (Male – 635, Female – 411)	170 (16.3%)	No age limit specified	Non-ST elevated ACS patients presenting to 56 hospitals in the UK, with patients taken from the Prospective Registry of Acute Ischaemic Syndromes in the United Kingdom (PRAIS-UK) between 23rd May 1998 and 3rd February 1999	Moderate risk of bias – STEMI patients were excluded from the analysis
Coronado et al, 2004.(35)	Cohort Study	2537 (Male – 1454, Female – 1083)	674 (26.6%)	Over 30 years old	ACS patients presenting to the emergency department in 10 sites over the United States. These patients were entered into a prospective multicentre Acute Cardiac Ischemia-Time Insensitive Predictive Instrument (ACI-TIPI) Clinical Trial from May 1993 to November 1993	Low risk of bias
Fergus et al, 2004.(36)	Cohort Study	1951 (Male – 1236, Female – 715)	598 (30.7%)	No age limit specified	ACS patients presenting to the University of Michigan Medical Center, USA from 27 December 1998 to 16 October 2002	Low risk of bias
Kentsch et al, 2003.(37)	Cohort Study	1042 (Male – 712, Female – 330)	201 (19.3%)	No age limit specified	AMI patients presenting to 8 German hospitals, taken from the North German Registry (NGR) between 1996 and 1998	Low risk of bias

Chyun et al, 2002.(38)	Case-control Study	2050 (Male – 1049, Female – 1001)	586 (28.6%)	Over 65 years old	AMI patients presenting to 35 acute-care hospitals in Connecticut, USA from 1st June 1992 to 28th February 1993	Low risk of bias
Funk et al, 2001.(39)	Cohort Study	215 (Male – 126, Female – 89)	66 (30.7%)	30–96 years old	ACS patients presenting to the emergency department of a cardiac referral centre in the north-eastern United States, with data being collected between September 1995 and August 1997	Low risk of bias
Richman et al, 1999.(40)	Cohort Study	1378 (Male – 988, Female – 390)	264 (19.2%)	No age limit specified	AMI patients presenting to the emergency department of a university-based hospital in the US between 1st December 1993 and 31st October 1996	Low risk of bias
Lusiani et al, 1994.(41)	Case-control Study	94 (Male – 60, Female – 34)	16 (17.0%)	No age limit specified	AMI patients admitted to the Clinica Medica I, Universita di Padova in Italy from January 1989 to June, 1991	Low risk of bias
Yoshino et al, 1983.(42)	Cohort Study	94 (Male – 57, Female – 37)	40 (42.6%)	No age limit specified	AMI patients admitted to the CCU of Saiseikai Central Hospital in Tokyo, Japan over a four-year period from 1979 to 1982	Low risk of bias

Table 1*.* Summary study characteristics of the 22 included studies in the review. The number of participants in each study is recorded alongside the risk of bias assessment

Results on individual studies & results of syntheses

Overall, 232,519 participants from 22 studies were included in our meta-analysis. The analysis from the cohort and cross-sectional studies (***Figure 2***), and the case-control studies (***Figure 3***) are separately presented here. The results of both analyses show a significant overall increased risk of ‘atypical’ or ‘no chest pain (no CP)’ symptoms in patients with DM during a MI.

Figure 2 about here

Figure 3 about here

A pooled overall OR of 1.43 (95% CI: 1.26, 1.62) was calculated from the cohort and cross-sectional studies, and a pooled overall OR of 1.44 (95% CI: 1.11, 1.87) was calculated from the case-control studies. Therefore, the overall result was consistent across both sets of analysis. However, the heterogeneity was substantial at 86.2% and 57.6% respectively. Sensitivity analyses was performed by removing Bjorck et al from the cohort and cross-sectional studies analysis (***Figure 4***).(25) This study included 172,981 participants (over 50% of total participants in the review), therefore having the potential to heavily influence the overall OR. Once removed the overall OR was 1.39 (95% CI: 1.22, 1.59), so it had no significant effect on the overall result.

Figure 4 about here

Discussion

Statement of principal findings and implications for clinicians and policymakers

In this meta-analysis, we confirm our hypothesis that amongst patients with a diagnosis of MI, patients with DM are less likely to have presentations with chest pain recorded, compared to those without DM. These findings were consistent across different study designs.

Diagnosing a MI is a complex process involving patients seeking help for their symptoms, clinicians responding to these symptoms and then requesting relevant diagnostic tests. If typical symptoms such as chest pain are not present, then a MI may not be diagnosed. Therefore, our findings have an important clinical impact for both clinicians and people with DM worldwide. There should be an increased awareness for patients and clinicians around atypical presentations of MI with DM, with the increasing prevalence of DM and the increased risk of CVD in DM patients. Prompt treatment is important for improving outcomes in MI management, and previous studies have shown an increased pre-hospital delay in DM patients presenting with a MI.(43) The results from our analysis also align with previous studies

that show lower pain duration and intensity in the DM population, which could contribute to a delayed presentation.(44) Therefore, clinicians need to have a high index of suspicion for MI in patients with DM who do not experience chest pain or present late, and DM patients themselves should be aware of this.

The findings from this meta-analysis could have implications for policy and guidance. UK guidance from the National Institute for Health and Care Excellence (NICE) and US protocols for suspected ACS are triggered by people reporting chest pain.(13, 45) Consideration is therefore needed about how to recognise ACS among people with DM who do not present with chest pain and consider updating the guidance accordingly.

Strengths and limitations

This study contains a large number of individuals suffering an acute event with symptoms recorded contemporaneously. A range of geographical locations and health systems are represented in our results. To the best of our knowledge, this is the first meta-analysis that addresses the global incidence of absent chest pain in DM populations when having a MI.

The heterogeneity in our results were substantial. This was likely due to our studies including a wide range of populations that varied in type of DM, categories of MI, age, ethnicity etc. The non-randomised studies used in our analyses are expected to be more heterogenous, given the methodological and population diversity compared to randomised trials.(19) Whilst a subgroup analysis would be desirable to address this, the studies did not consistently present these variables.

The number of ‘no chest pain’ presentations could have been underestimated as a patient without chest pain may not present to healthcare services, leading to a reporting bias. There is also an issue around survivor bias. Only those who live long enough during a MI (a disease with high mortality) will be able to present to healthcare services and report their symptoms. Additionally, people with atypical symptoms (with or without DM) have a worse prognosis.(46) Therefore, if people have fewer chest pain symptoms and die earlier, this could be an important confounder in these studies.

Whilst there is an issue around underrepresentation of atypical presentations, our analysis is based on a population who have had their MI diagnosed. This means there

was sufficient evidence for diagnostic testing from their initial presentation. Clinicians may have a higher suspicion of CVD in DM patients. Patients with DM come into clinical care more often and get admitted to hospital more easily, consequently being investigated more frequently.(47) Similarly patients with DM may have a stronger suspicion of MI than non-DM patients, which can increase their health seeking behaviour. This can increase the chance a DM patient having a MI receives their diagnosis.

All these considerations could potentially bias results in either direction (more suspicion among DM patients leading to more recognition, or conversely less chest pain experienced, so less chance of receiving a diagnosis). However, we do see a largely consistent pattern across time, across a wide variety of countries/populations and using a variety of study methodologies, which suggests validity to the findings.

Future research

The impact of potential confounders such as age, duration of DM, gender or ethnicity may have an important role, and future research should specifically assess their influence on symptom presentation. The risk of developing type 2 DM (the most prevalent form of DM) and MI increases with age, and DM is more prevalent in older populations.(48) DM duration was rarely recorded in studies, but longstanding DM may increase the likelihood of a painless MI due to an increase in the likelihood that the patient has developed CAN.(10) Gender is also thought to have an effect on the type of MI symptoms reported and differences should be assessed within DM populations.(49) Ethnicity has an impact on the prevalence of DM and the health care people receive but was not routinely reported in studies and should be addressed in future work.

Other atypical symptoms that might suggest cardiovascular compromise such as sweating or increased breathlessness could be more prevalent in the DM groups.(50) Whilst chest pain may be less likely, if these other atypical symptoms are increased in DM patients with a MI, then this can influence patient education on recognising cardiac events developing. However, it is important to consider that the methods to raise awareness of this phenomena among those with DM should not produce needless anxiety. A method to gain a more complete picture of symptom presentation in DM patients would be to enrol both DM and non-DM populations prospectively into studies

before a MI occurs. If a suspected MI occurs, standardised interview techniques can be used to record their presenting symptoms and subsequently compare the prevalence of different symptoms between the groups.

Conclusion

In patients with a diagnosed MI, people with DM were less likely to have a presentation with chest pain recorded, compared to those without DM. Therefore, healthcare professionals in primary and secondary care should always consider a possible MI diagnosis when patients with DM present with atypical symptoms. ACS guideline committees should consider this information in future guideline or protocol revisions. Finally, DM patients should be vigilant for these atypical symptoms and seek medical attention promptly to ensure better outcomes.

Acknowledgements

We would like to thank the UCL Primary Care & Population Health Expert by Experience (EbE) PPI group for their contribution, and in particular Madiha Sajid and Marie McDevitt for their comments.

Funding sources

Nothing to disclose

Competing interests

Nothing to disclose

Contributorship

All authors have been involved in this study and agreed to the final manuscript. MJ led the study, the analysis and write up and is corresponding author. AK was involved in data collection, analysis and write up and is lead author. SP led the information search

strategy, LM led the statistical analysis. All other authors were involved in data collection and write up.

Ethics Approval

Not applicable – secondary data analysis only

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