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Association between engagement in exercise training and peak cardiac biomarker concentrations following ST-elevation myocardial infarction

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ABSTRACT

Background Regular exercise training is an important factor in prevention of myocardial infarction (MI). However, little is known whether exercise engagement prior to MI is related to the magnitude of post-MI cardiac biomarker concentrations and clinical outcomes.

Objectives We tested the hypothesis that exercise engagement in the week prior MI is related to lower cardiac biomarker concentrations following ST-elevated MI (STEMI).

Methods We recruited hospitalised STEMI patients and assessed the amount of exercise engagement in the 7 days preceding MI onset using a validated questionnaire. Patients were classified as 'exercise' if they performed any vigorous exercise in the week prior MI, or as 'control' if they did not. Post-MI peak concentrations of high-sensitive cardiac troponin T (peak-hs-cTnT) and creatine kinase (peak-CK) were examined. We also explored whether exercise engagement prior MI is related to the clinical course (duration of hospitalisation and incidence of in-hospital, 30-day and 6-month major adverse cardiac events (reinfarction, target vessel revascularisation, cardiogenic shock or death)).

Results In total, 98 STEMI patients were included, of which 16% (n=16) was classified as 'exercise', and 84% (n=82) as 'control'. Post-MI peak-hs-cTnT and peak-CK concentrations were lower in the exercise group (941 (645–2925) ng/mL; 477 (346–1402) U/L, respectively) compared with controls (3136 (1553–4969) ng/mL, p=0.010; 1055 (596–2019) U/L, p=0.016, respectively). During follow-up, no significant differences were found between both groups.

Conclusion Engagement in exercise is associated with lower cardiac biomarker peak concentrations following STEMI. These data could provide further support for the cardiovascular health benefits of exercise training.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Engagement in exercise training is associated with a reduced risk of myocardial infarction (MI). In addition, engagement in exercise training following MI reduces the risk for recurrent events and all-cause mortality. However, the potential relation between engagement in exercise training preceding MI and peak concentrations of cardiac biomarkers as a result of MI is unknown.

WHAT THIS STUDY ADDS

⇒ Only a small proportion of patients who experienced an MI engaged in exercise training in the week prior MI.

⇒ Engagement in exercise in the week prior MI is associated with lower peak concentrations of cardiac biomarkers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our data suggest that exercise training might be associated with a lower MI severity. These data potentially provide further support for the cardiovascular health benefits of exercise training.

INTRODUCTION

Myocardial infarction (MI) is induced by prolonged ischaemia, which in ST-segment elevation MI (STEMI) is usually precipitated by atherosclerotic plaque disruption and ultimately results in myocyte necrosis.[1]

Prevalence of MI is increasing worldwide, and as a result, MI is a major cause of mortality and morbidity.[1–3] Studies have provided solid evidence that regular exercise training is associated with a reduced risk of MI.[4–6] In addition, the benefits of exercise-based cardiac rehabilitation following MI are well known, including reduced risk for recurrent events and all-cause mortality and improvement in quality of life.[7 8] These lines of evidence have resulted in a class I recommendation for the prescription of exercise-based cardiac rehabilitation for patients with STEMI.[9] While much is known about exercise-induced risk reduction after STEMI, less studies have focused on the potential relation between engagement in

exercise training preceding an MI and peak cardiac biomarker concentrations following STEMI.

Previous preclinical studies have demonstrated that (regular) exercise training is associated with a cardioprotective effect during MI.[10–12] These effects may translate to clinically relevant benefits. The prospective Copenhagen General Population Study included 14 223 individuals and showed that individuals who have engaged in light or moderate to high leisure time physical activity before MI were more likely to survive than their sedentary peers.[13] In addition, this cohort study also revealed that protection against post-MI mortality through physical activity follows a dose–response association: higher levels of physical activity result in a decreased risk of fatal MI.[14] However, important limitations of this study were that physical activity was questioned over the past year, that the questionnaire was unspecific, and that there was no information on markers for infarct size, such as cardiac biomarker concentrations. As a result, not yet clear was the impact of regular exercise training on post-MI peak cardiac biomarker concentrations, potentially reflecting infarct sizes[15] and eventually leading to higher risk of major adverse cardiovascular events (MACE).[16]

Therefore, the aim of this study was to explore the relation between exercise engagement prior to MI and peak cardiac biomarker concentrations following STEMI. To evaluate infarct size, we assessed post-MI peak high-sensitive cardiac Troponin-T (hs-cTnT) and creatine kinase (CK) concentrations, which represent commonly used cardiac biomarkers as surrogate measures of infarct size in STEMI patients.[16] Second, we explored potential differences in duration of hospitalisation and assessed in-hospital, 30-day and 6-month event rate between STEMI patients who have engaged in regular exercise training versus their non-exercise controls. We hypothesised that exercise engagement is associated with lower post-MI peak concentrations of cardiac biomarkers compared with their non-exercising peers following STEMI, which may contribute to a more beneficial clinical course, with shorter length of hospital stay and/or better clinical outcomes.

METHODS

Study design and study population

In this cohort study, we recruited hospitalised Dutch-speaking patients who suffered an MI according to current guidelines[1] from January 2019 to September 2021. Patients aged 18 years and over and not wheelchair-bound were approached to participate. Patients were recruited during their hospitalisation on the cardiology ward of the Radboud university medical centre, within 7 days after the event. All patients gave written informed consent, followed by a bedside interview. This is a substudy of the SIT LESS project, registered in the Dutch trial register (NTR 7646). Patients who were diagnosed with a type 2 infarction were excluded from the present study. Subsequently, patients were divided into STEMI and non-STEMI (NSTEMI), with our analysis being focused on those with STEMI as previous studies have demonstrated that the magnitude of cardiac biomarker concentrations represents a surrogate marker for infarct size in STEMI, but not NSTEMI.[15 16] The study was conducted in accordance with the principles of the 'Declaration of the Helsinki' and received approval from the ethics committee of the Radboud university medical centre, Nijmegen (2018–4537).

Data collection

Patient characteristics

Baseline characteristics, medical history and clinical outcomes were collected from the electronic patient file and from the bedside interview. All data were stored in an electronic case report form using Castor EDC v2021.5.6 (Ciwit B.V., Amsterdam, Netherlands).

Exercise engagement

To retrospectively assess the amount of exercise engagement in the 7 days preceding MI onset, the Short Questionnaire to Assess Health-enhancing physical activity (SQUASH) was used, a validated questionnaire to assess physical activity.[17] Using the SQUASH, it was possible to question physical activity in different domains in the week prior MI. The different domains consisted of walking and cycling to work and/or during leisure time, gardening, odd jobs, household activities, activities at work and sports. For each activity, time and intensity (light, moderate or vigorous) were indicated. Subsequently, physical activity was indicated as exercise when the patient cycled or walked at vigorous intensity or when the patient performed sports at moderate to vigorous intensity. When the patient had performed any activity in the week prior MI that was indicated as exercise, the patient was assigned to the exercise group, otherwise the patients were assigned to the control group.

Cardiac biomarker release

Data collection of concentrations of hs-cTnT in ng/mL (Roche Diagnostics GmbH, Mannheim, Germany), and CK in U/L (Roche Diagnostics GmbH, Mannheim, Germany), during hospital stay was based on available clinically measured biomarker concentrations. According to the Acute Coronary Syndrome protocol of the hospital, cardiac biomarker concentrations were measured every 6 hours, until the peak concentrations were established. To measure hs-cTnT concentrations, high-sensitive immunoassays were used, with an analytical limit of detection of 3 ng/L and a 99th percentile upper reference limit of 14 ng/L. For CK concentrations, enzymatic assays were used, with an analytical limit of detection of 7 U/L. Normal ranges of CK concentrations are 20–200 U/L for men and 20–180 U/L for women. Peak concentrations of hs-cTnT (peak-hs-cTnT) and CK (peak-CK) were used for the analyses.

Clinical outcomes

To assess clinical outcomes during and following hospitalisation as a result of the MI, clinical outcomes were

extracted from the electronic patient file, including information about duration of hospitalisation, details of hospital stay (eg, Global Registry of Acute Coronary Events (GRACE)-risk score, treatment, time from symptoms hospital admission (hours), time from hospital admission to coronary angiogram (CAG) (hours), left ventricular ejection fraction (LVEF), creatinine levels (µmol/L)) and prevalence of MACE during hospitalisation, 30 days and 6 months. MACE was defined as reinfarction, target vessel revascularisation, cardiogenic shock or death.

Statistical analysis

All statistical analyses were carried out using SPSS software V.25.0 (IBM, Armonk, USA). The Kolmogorov-Smirnov test was used to check for normal distribution, with $p<0.05$ as cut-off value to reject the assumption of normal distribution. Continuous data were reported as mean±SD, or median (Q1–Q3) unless indicated otherwise and categorical data were shown as number and percentages. For comparison between the control and exercise group, Student's t-test was used for continuous normally distributed variables, Mann-Whitney U test for continuous skewed variables, χ^2 tests for categorical variables with expected frequencies of 5 or greater, and Fisher's exact tests for categorical variables with a number of cases below 5. Statistical significance was set at $p<0.05$.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting or dissemination plans of our research.

RESULTS

Study population

Two hundred and fifty-two patients diagnosed with an MI were approached for participation in the study and 200 patients gave informed consent. Nine patients with a type 2 MI and 93 patients with NSTEMI were excluded from our analyses, resulting in an analytical cohort of 98 (49%) patients hospitalised with STEMI (figure 1). The majority of patients did not engage in any exercise the week prior MI and were, therefore, allocated to the control group ('controls') (N=82). The remaining patients performed 2 (1–3) hour of exercise in the week preceding the MI and were allocated to the exercise group ('exercise') (N=16). The exercise group consisted of patients who performed sports in the week prior to MI (N=14, minimal 45 to maximal 270 min), and patients who cycled at vigorous intensity in the week prior to MI (N=2, both 90 min). Baseline characteristics were not different between the exercise and control groups (table 1).

Cardiac biomarker release

Cardiac biomarker peak concentrations were based on 4 (3–5) measurements, in which peak concentrations of hs-cTnT were measured in the first three measurements within 78.1% of the patients, and peak concentrations of CK were measured in the first three measurements in 73.5% of the patients. In both the exercise group and control group, hs-cTnT and CK measurements were in 6.3% of the patients performed prior to angiography and in the remaining patients following angiography. Post-MI peak-hs-cTnT concentrations were significantly lower in the exercise group (941 (645–2925) ng/mL) compared with controls (3136 (1553–4969) ng/mL, p=0.010) (figure 2A). Similarly, we found significant lower peak-CK concentrations following MI in exercise (477 (346–1402) U/L) compared with controls (1055 (596–2019) U/L, p=0.016) (figure 2B).

Clinical outcomes

We found no significant differences between groups for the time from symptom onset to hospital admission, time from hospital admission to CAG, TIMI flow at baseline and post-treatment, LVEF, creatinine levels at admission, GRACE risk score, reperfusion treatment or duration of hospitalisation (table 2). There was a significant difference in coronary artery disease severity between the exercise and control group, with more one-vessel disease and fewer two-vessel disease patients in the control group. We found 12 MACE across 6-month follow-up, with the majority taking place in-hospital (n=9). We found no significant differences between groups in occurrence of in-hospital, 30-day or 6 month MACE (table 2).

DISCUSSION

The purpose of the current study was to determine whether exercise engagement prior to STEMI is related to lower post-MI peak cardiac biomarker concentrations following STEMI. We found that only 16% of the study population had engaged in any form or type of exercise in the week prior to STEMI onset. Second, those who engaged in exercise in the week prior to STEMI demonstrated significantly lower peak concentrations of cardiac biomarkers following STEMI compared with their physically inactive peers. Although explorative and being underpowered, these effects did not translate to differences in clinical outcomes between STEMI patients engaged in exercise versus their physically inactive peers at 30 days or 6 months. Taken together, these data provide further support for the beneficial effects of regular exercise training, potentially leading to lower post-MI cardiac biomarker peak concentrations.

In our population of STEMI patients, only 16% performed exercise in the week prior MI. Although the number of patients who performed exercise prior MI is small, a low level of physical activity is typical for this population.[4 14] However, it is remarkable that those individuals who performed exercise in the week preceding STEMI demonstrated significantly lower STEMI-induced cardiac biomarker peak concentrations of both hs-cTnT and CK. Previous studies demonstrated that hs-cTnT is a cardiac-specific protein, which has shown to increase rapidly following MI, whereas CK is a non-cardiac-specific enzyme but increases following MI as well.[15] Research has

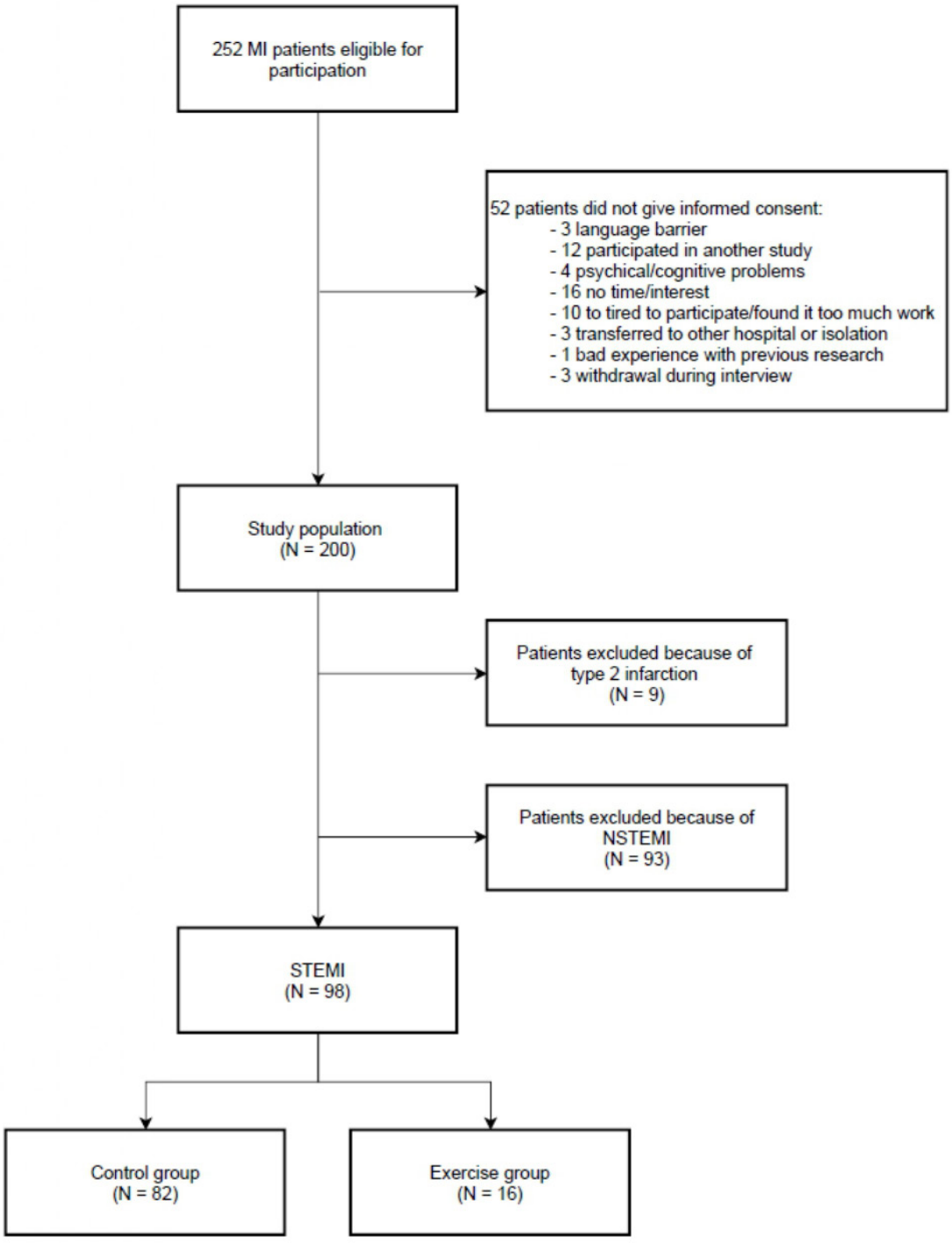

Figure 1 Flowchart of study inclusion. Flow of patients that were eligible for study inclusion (n=252) to the amount of patients that were included in the analysis (n=98) and the distribution of patients between the control and exercise group. MI, myocardial infarction; NSTEMI, non-ST elevation myocardial infarction; STEMI, ST elevation myocardial infarction.

shown that concentrations of hs-cTnT and CK reasonably relate to infarct size, with smaller infarct sizes being related to lower peak concentrations.[15 16 18] Even though the use of cardiac MRI is the golden standard to appropriately determine infarct size, it is not widely available, expensive and contraindicated in a substantial proportion of patients. In addition, the benefits of exercise on STEMI-induced cardiac biomarker concentrations are possibly in line with clinical outcomes from other studies. For example, the Copenhagen study showed that exercise, even in small amounts, is associated with lower risk for mortality following MI,[13] and a previous study revealed that lifelong athletes show a better left ventricular systolic function following MI compared with sedentary controls.[19] Therefore, our data could provide a first insight into the suggestion that regular exercise is associated with a smaller infarct size. Altogether, the proportion of STEMI patients who engage in exercise is

Table 1 Patient characteristics

Baseline characteristics	Control group (N=82)	Exercise group (N=16)	P-value
Male sex, n (%)	53 (64.6)	11 (68.8)	0.75
Age (years)	64.8±10.5	64.6±10.6	0.96
Height (cm)	174.3±10.5	176.4±8.8	0.45
Weight (kg)	82.4±15.3	82.8±14.2	0.92
BMI (kg/m^2)	27.0±3.8	26.6±4.3	0.71
Smoking, n (%)			0.58
Yes	25 (30.5)	3 (18.8)	
Packyears	30.0 [13.1–35.6)	37.5 (12.5--)	
No, stopped	31 (37.8)	6 (37.5)	
Packyears	11.2 [7.5–35.0)	10.2 [1.2–40.5)	
No, never	26 (31.7)	7 (43.8)	
Alcohol, n (%)	47 (57.3)	10 (62.5)	0.7
Amount (units/week)	3.0 [1.0–6.0)	4.0 [1.8–6.3)	0.7
Medical history	**Control group (N=82)**	**Exercise group (N=16)**	**P-value**
Hypertension, n (%)	33 (40.2)	7 (43.8)	0.75
Dyslipidaemia, n (%)	21 (25.9)	3 (18.8)	0.75
Diabetes mellitus, n (%)			N/A
Type I	0 (0)	0 (0)	
Type II	10 (12.2)	0 (0)	
Rheumatoid arthritis, n (%)	4 (4.9)	1 (6.3)	1
Prior MI, n (%)	13 (15.9)	3 (18.8)	0.72
Prior resuscitation, n (%)	1 (1.2)	0 (0)	1
Heart valve disease, n (%)	3 (3.7)	1 (6.3)	0.52
LVEF*, n (%)			N/A
Normal—good (LVEF>50%)	2/2 (100)	0/0 (0)	
Mildly reduced (LVEF 40–50%)	0/2 (0)	0/0 (0)	
Moderately reduced (LVEF 30–40%)	0/2 (0)	0/0 (0)	
Severely reduced (LVEF<30%)	0/2 (0)	0/0 (0)	
Kidney failure,† n (%)	4 (4.9)	0 (0)	1
G3a	2 (50)		
G3b	2 (50)		
Cancer, n (%)			0.85
Yes, in the past 5 years	6 (7.3)	2 (12.5)	
Yes, not in the past 5 years	7 (8.5)	1 (6.3)	

*Left ventricular ejection fraction (LVEF) provides an estimation of the left ventricular function and is measured with a transthoracic ultrasound. Not all patients receive an ultrasound, therefore the number is shown per the number of measured patients.
†Kidney failure stages: G1, G2: normal or mildly decreased; G3a: mildly to moderately decreased; G3b: moderately tot severely decreased; G4: severely decreased; G5: kidney failure.
BMI, Body Mass Index.

small, but these patients demonstrate lower peak hs-cTnT and CK concentrations than their non-exercising peers.

Comparing both groups, no significant differences between the control group and exercise group were found regarding disease characteristics and patient characteristics. Although statistically not significant, comorbidities were not equally distributed across subgroups, for example, four patients had kidney failure in the control group verus zero patients in the exercise group. Kidney failure relates to higher post-MI cardiac biomarkers, but excluding individuals with kidney failure did not alter the main findings of our study. In addition, even though it was not significant, time from symptom onset to hospital admission was two times higher in

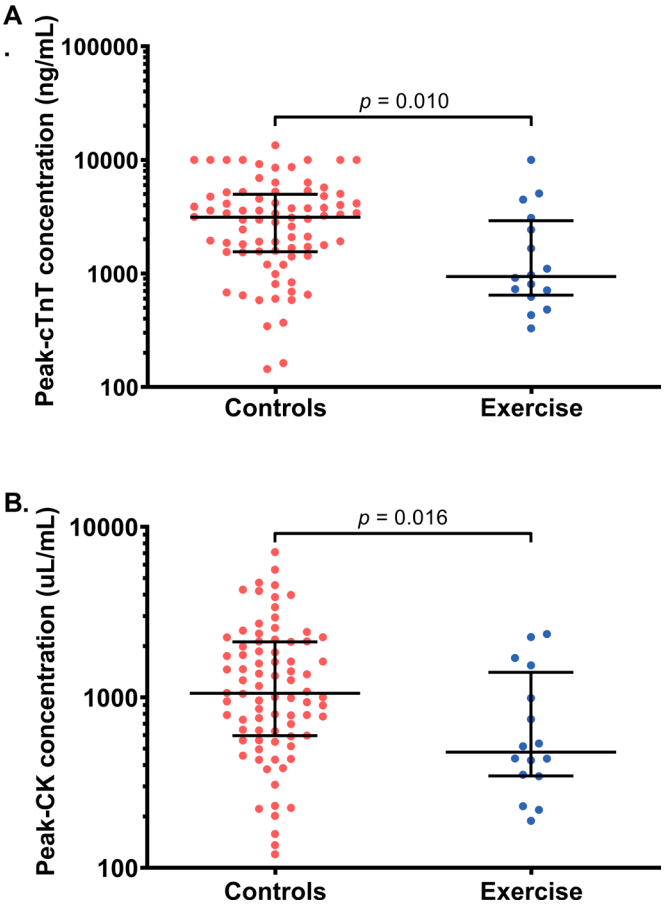

Figure 2 Peak cardiac biomarker concentrations in patients diagnosed with a STEMI, in logarithmic scale. Peak cardiac biomarker concentrations in the control group (light grey) and in the exercise group (dark grey). Each dot represents a case, middle line is the median, upperline is Q3, lower line is Q1. (A) Post-MI peak concentrations of high sensitive cardiac troponin-T (ng/mL). (B) Post-MI peak concentrations of creatine kinase (U/L). MI, myocardial infarction; Peak-CK, peak creatine kinase; Peak-cTnT, peak cardiac troponin-T; STEMI, ST elevation myocardial infarction.

the exercise group compared with the control group. This may underestimate the protective effect of exercise on cardiac biomarker release. Indeed, in patients undergoing an STEMI, ischaemia will occur until revascularisation, and cardiac biomarker concentrations will continue to rise.[20] Despite the longer ischaemic period, the peak cardiac biomarker concentrations remains lower in the exercise group. Considering the points mentioned above, it seems unlikely that any of these patient-related or MI-related characteristics underlie the differences in cardiac biomarker concentrations post-MI between the exercise and control group. This raises questions about other potential explanations for the difference in cardiac biomarker concentrations between both groups. Exercise may have a direct effect to attenuate myocardial infarct severity.[21 22] Studies have demonstrated that exercise can induce a functional or structural change in coronary arteries, potentially via collateral formation. This mechanism is a possible explanation of the protective effect of exercise training on both the occurrence and severity of MI.[21 23 24] In addition, studies have demonstrated that exercise also has short-term protective effects. For example, studies in animals revealed that single bouts of exercise prior to planned cardiac ischaemic-reperfusion injury significantly attenuate cardiac injury. Similarly, also in humans, short-term exercise has demonstrated to reduce injury to vascular and cardiac tissue.[10 25–27]

Although peak concentrations of cardiac biomarkers were significantly lower in the exercise group, we found that these effects did not translate to differences in the clinical course between groups. For example, we found no difference in duration of hospitalisation between the groups. Duration of hospitalisation was typically 3 to 4 days with very little variation, which is mainly depending on the clinical course of the patient. We also found no difference between groups in 6-month MACE, which may relate to the relatively low number of events within this time-frame (n=12), with a majority of these MACE occurring during hospitalisation (n=9). Accordingly, statistical power is too low to provide meaningful insights into the potential impact of exercise engagement prior to STEMI on clinical outcomes. Nonetheless, previous studies show that patients who engage in exercise prior MI show lower long-term MACE incidence compared with inactive peers. Maessen *et al* compared 18 veteran post-MI athletes with 18 sedentary post-MI controls across 3–10 years. While veteran athletes did not report any secondary events, their sedentary peers reported eight events (six elective PCIs, two recurrent MIs).[28] Exercise prior to MI is also associated with lower risk of postinfarct mortality.[13 14] On the contrary, physical activity can also act as a trigger for MI, with patients that exercise infrequently particularly at risk.[29 30] Given the low number of patients with exercise directly prior MI in our study (n=1 <24 hours prior to MI, n=0 during MI), we do not expect that MIs in our exercise cohort were triggered by exercise. However, a previous study showed that if MI was triggered by exercise, in-hospital and 1-year mortality were significantly lower compared with MIs not triggered by exercise.[29 31] At least, our observation of lower cardiac biomarker concentrations, among patients who engaged in exercise prior to STEMI, aligns with observations from other studies, which report that exercise prior to STEMI is associated with lower mortality and morbidity following STEMI.

Limitations

Some limitations must be acknowledged. First, we have used questionnaires to gain insight into the physical activity pattern of the patients. To minimise bias, we used the validated SQUASH questionnaire.[17] To further counteract the subjective nature and recall bias, the questionnaire specifically relates to the physical activity pattern in the week preceding STEMI-onset only rather than asking for the typical engagement in exercise training across the past months. It must be considered that although we found a beneficial effect of physical

Table 2 Clinical outcomes

Clinical outcomes	Control group (N=82)	Exercise group (N=16)	P-value
Out-of-hospital cardiac arrest*, n (%)	4 (4.9)	1 (6.3)	1
GRACE risk score†, n (%)	116.9±23.4	115.7±23.7	0.87
Localisation of STEMI on the ECG, n (%)			0.85
Anterior	32 (39.0)	7 (43.8)	
Lateral	4 (4.9)	1 (6.3)	
Inferior	10 (48.8)	8 (50.0)	
Posterior	6 (7.3)	0 (0)	
Coronary artery disease severity, n (%)			0.03
1-vessel disease	51 (62.2)	5 (31.3)	
2-vessel disease	21 (25.6)	8 (50.0)	
3-vessel disease	10 (12.2)	2 (12.5)	
No significant coronary stenosis	0 (0)	1 (6.3)	
Time onset of symptoms to admission (hour)	2.0 [1.2–5.3)	4.0 [1.3–25.3)	0.25
Time of admission to CAG (hour)	0.3 [0.1–0.8)	0.2 [0.1–0.7)	0.69
TIMI flow baseline‡, n (%)			0.33
TIMI 0	43 (52.4)	8 (50.0)	
TIMI 1	4 (4.9)	3 (18.8)	
TIMI 2	17 (20.7)	2 (12.5)	
TIMI 3	17 (20.7)	2 (12.5)	
Unknown	1 (1.2)	1 (6.3)	
Treatment, n (%)			0.08
PCI	76 (92.7)	12 (75.0)	1
Balloon dilatation	2 (2.6)	0 (0)	
1 x DES	30 (39.5)	5 (41.7)	
>1 x DES	44 (57.9)	7 (58.3)	
CABG	4 (4.9)	3 (18.8)	
Conservative	(2.4)	1 (6.3)	
TIMI flow post treatment‡, n (%)			0.59
TIMI 0–2 (no to reduced perfusion)	6 (7.3)	0 (0)	
TIMI 3 (full perfusion)	69 (84.1)	12 (75.0)	
Unknown	7 (8.5)	4 (25.0)	
LVEF during hospitalisation§, n (%)			0.91
Normal—good (LVEF >50%)	28/54 (51.9)	5/10 (50.0)	0.88
Mildly reduced (LVEF 40%–50%)	17/54 (31.5)	4/10 (40.0)	
Moderately reduced (LVEF 30%–40%)	8/54 (14.8)	1/10 (10.0)	
Severely reduced (LVEF <30%)	1/54 (1.85)	0/10 (0)	
Time of MI to measurement LVEF (day)	2.65±4.90	1.30±1.25	
Creatinine at admission (µmol/L)	80.7±28.2	79.3±14.2	0.85
Hospitalisation duration (days)	4.0 [3.0–8.0)	3.0 [3.0–7.8)	0.83
LVEF during follow-up§, n (%)			1
Normal—good (LVEF >50%)	16/21 (76.2)	4/4 (100)	0.71
Mildly reduced (LVEF 40%–50%)	4/21 (19.0)	0/4 (0)	
Moderately reduced (LVEF 30%–40%)	0/21 (0)	0/4 (0)	
Severely reduced (LVEF <30%)	1/21 (4.8)	0/4 (0)	

Continued

Table 2 Continued

Clinical outcomes	Control group (N=82)	Exercise group (N=16)	P-value
Time of MI to measurement LVEF (day)	63.8±42.9	80.3±79.2	
MACE¶ hospitalisation, n (%)	8 (9.8)	1 (6.3)	1
MACE 30 days, n (%)	8 (9.8)	1 (6.3)	1
MACE 6 months, n (%)	10 (12.2)	2 (12.5)	0.71

*Out-of-hospital cardiac arrest as a result of MI, before hospital admission.
†GRACE risk score provides an estimate of the probability of death within 6 months of hospital discharge in patients with acute coronary syndrome, score <100: Low risk—mortality <4.5%, score 100–127: Intermediate risk—mortality 4.5–11%, score >127: High risk—mortality >11%.
‡ TIMI flow grade is the thrombolysis in myocardial infarction grade, TIMI 0: complete occlusion, TIMI 1: penetration of obstruction by contrast but no distal perfusion, TIMI 2: perfusion of entire artery but delayed flow, TIMI 3: Full perfusion, normal flow.
§Left ventricular ejection fraction (LVEF) provides an estimation of the left ventricular function and is measured with a transthoracic ultrasound. Not all patients receive an ultrasound, therefore the number is shown per the number of measured patients.
¶MACE is defined as reinfarction, target vessel revascularisation, cardiogenic shock or death.
CABG, Coronary Artery Bypass Grafting; CAG, coronary angiogram; DES, Drug Eluting Stent; GRACE, Global Registry of Acute Coronary Events; MACE, major adverse cardiovascular event; PCI, Percutaneous Coronary Intervention; STEMI, ST elevation myocardial infarction; TIMI, Thrombolysis in Myocardial Infarction.

activity on cardiac biomarker concentrations post-MI, it is unclear whether the lower post-MI cardiac biomarker concentrations in the exercise group are causally linked to an acute exercise bout or to higher lifelong exercise levels. Therefore, more longitudinal studies are recommended. Another limitation in this study is that we derived cardiac biomarkers from electronic patient files, leading to a relatively limited number of time points. This minimises the temporal resolution, so we might underestimate the true maximum of hs-cTnT and CK concentrations. Nonetheless, this approach was adopted for both groups and underestimation was probably larger in the control group compared with the exercise group. Additionally, we performed additional analyses exploring mean values and changes from lowest to highest cardiac biomarker levels to see whether taking baseline measurements per individual into account yields the same results (online supplemental appendix 1). These additional analyses confirm our initial observations. Therefore, we believe that this approach cannot explain the difference in effect size between both groups. finally, an important limitation is the relatively small group of patients, with especially a low number of patients in the exercise group. Therefore, we must be careful in drawing conclusions. However, despite the relatively small patient number and the suboptimal measure of infarct size, this study does provide grounds to investigate the effect of exercise on the severity of MI in a larger format with more accurate infarct size assessments (such as MRI) and longer follow-up.

CONCLUSION

In conclusion, we found that a relatively small portion of the study population (ie, 16%) engaged in exercise in the week prior STEMI, and those patients demonstrated lower post-MI cardiac biomarker concentrations compared with physically inactive peers. In addition to the well-established benefits of regular exercise training in reducing risks for STEMI incidence, our data might suggest that exercise could be associated with a lower MI severity. Larger studies with more accurate assessment of MI size and longer follow-up are warranted to confirm these findings and to evaluate the impact of exercise engagement prior to MI on clinical outcomes.

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Contributors IAdK: corresponding author, guarantor, acquisition of data, data analysis, visualisation, data interpretation and writing original draft; BMAvB: conceptualisation, design, methodology, acquisition of data, data curation, data interpretation, and review and editing; HR: acquisition of data, review and editing, RG: review and editing, GEC: review and editing, GAMP: review and editing, TE: conceptualisation, design, methodology, review and editing; DHJT: conceptualisation, design, methodology, review and editing. All authors have read and approved the manuscript.

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Competing interests None declared.

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