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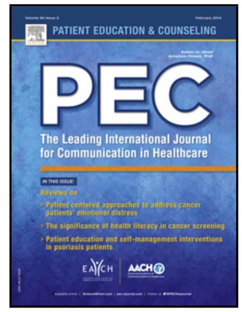

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Highlights

- Knowledge of AMI (in particular knowledge of atypical symptoms) is substandard.
- Vulnerable groups (e.g. Women) are more likely to have inadequate knowledge
- Knowledge of AMI-symptoms had a beneficial impact on delay time.

ABSTRACT

Objective: We aimed to assess whether patients' knowledge about Acute-Myocardial-Infarction (AMI) has an impact on the prehospital delay-time.

Methods: This investigation was based on 486 AMI patients who participated in the cross-sectional Munich-Examination-of-Delay-in-Patients-Experiencing-Acute-Myocardial-Infarction (MEDEA) study. A modified German-version of the ACS-Response-Index Questionnaire was used. Multivariate logistic-regression models were used to identify factors associated with knowledge-level as well as the impact of knowledge-level on delay-time.

Results: High AMI-knowledge shortened median delay-time in men (168[92-509] vs. 276[117-1519] minutes, *p*= .0069), and in women (189[101-601] vs. 262[107-951]minutes, *p*= .34). Almost half-of-patients (n=284,58%) demonstrated high AMI-knowledge. High-knowledge were independently associated with male-gender (*OR=1.47[1.17-1.85]*) and General-Practitioner as a knowledge-source (*OR=1.42[1.14-1.77]*). Old-age (*OR=0.87[0.86-0.89]*) and previous AMI-history/stent-placement (*OR=0.65[0.46-0.93]*) were significantly associated with lower-knowledge. Although the majority (476,98%) correctly recognized at least one AMI-symptom, 69(14.2%) patients correctly identified all AMI-symptoms. Additionally, one-in-three believed that heart-attack is always accompanied with severe chest-pain. Elderly-patients and women were more likely to be less-knowledgeable about atypical-symptoms (*p*=.006), present with atypical AMI-presentation (*p*<.001) and subsequently experience protracted delay-times (*p*<.001).

Conclusions: Knowledge of AMI-symptoms remains to be substandard, especially knowledge of atypical-symptoms. Knowledge is essential to reduce delay-times, but it is not a panacea, since it is not sufficient alone to optimize prehospital delay-times.

Keywords: decision time, cognitive factors, knowledge, atypical symptoms, Myocardial infarction

1. INTRODUCTION

Time is critical in the management of an acute coronary syndrome, as longer delay from the symptoms-onset to reperfusion has been linked to increased mortality and worse clinical outcomes [1, 2]. It is estimated that every additional 30 minutes of reperfusion delay increases 1-year mortality by 8% [3]. Significant improvements have been achieved during the last decades in shortening of the in-hospital and system delay [4]. However, little has been gained in the pre-hospital delay times, with patient decision delay remaining the largest portion of the total delay and thus encompassing a major unresolved public health problem [5, 6]. Potential reasons for the patient decision delay may be a lack of knowledge regarding the typical and atypical presentation of acute myocardial infarction (AMI) as well as the appropriate reaction to these symptoms. Considerable interests and efforts have been invested in strategies to improve prehospital delay times. For instance, many public health campaigns have been undertaken in the hope that providing individuals with knowledge about AMI will improve the timely access to medical services during acute event. However, they often ended up with disappointing results despite an increase of AMI-knowledge in the population through extensive community education programmes [7, 8]. Therefore, it is still questionable whether patients' knowledge has an actual impact on their behaviour and reaction during the acute event.

Indeed, there is a considerable room for improving patients' knowledge about AMI [9-11]. While knowledge on typical symptoms such as chest pain might have improved over years, knowledge of atypical symptoms is less evident [11-14]. Nevertheless and surprisingly, there is no clear evidence that educating patients on AMI-related symptoms actually improves their knowledge, enables them to quickly make decision during acute event and ultimately reduces the prehospital delay time. While some studies reported beneficial impact of knowledge on delay time [15, 16], others failed to find a significant difference with regards to the effects of knowledge [7, 17, 18]. Thus, it is important to determine the patients' characteristics associated with inadequate knowledge, in particular knowledge of atypical symptoms, in order to identify those patients in clinical practice who may need extra attention by clinicians and to facilitate the development of appropriate targeted information and educational interventions as well.

The aim of the present investigation, therefore, was to describe the level of knowledge about AMI in patients with documented STEMI, to identify the patients' characteristics associated with inadequate knowledge and to assess the impact of patients' knowledge about AMI on prehospital delay.

2. METHODS

The multicentre, cross-sectional MEDEA study (Munich Examination of Delay in Patients Experiencing Acute Myocardial Infarction) was conceived with the aim to document the prehospital delay of patients with ST-elevation Myocardial Infarction (STEMI), and the factors which may contribute to prolonged delay.

2.1 Study design

The patients were recruited from eight different university or municipal hospitals with coronary care units, belonging to the Munich emergency system network clinics. The MEDEA study was approved by the Ethic Commission of the Faculty of Medicine of the Technischen Universität München (TUM). The main inclusion criterion was diagnosis of STEMI as evidenced by typical clinical symptoms, ECG changes and myocardial biomarkers levels. Exclusion criteria were: in-hospital STEMI, resuscitation at AMI-onset and language barriers or cognitive impairment impeding patients to answer the questionnaires properly. There were no age restrictions.

Standardized operation procedures (SOPs) were implemented to ensure the consecutive referral of eligible patients into the study. All patients were informed of the aim and procedures of the study and also that taking part in the study would have no effect on their treatment. All patients were required to sign a declaration of consent. Details about study design, sampling method and data collection are reported elsewhere [19].

2.2 Sample

From 12.12.2007 until 31.05.2012, 755 patients had a diagnosis of STEMI, data on 619 patients were collected. Approximately 18% of patients (n=136) were excluded due to not meeting inclusion criteria (4%) and due to absence of consent (14%). There were few dropouts in the study since physicians did not inform MEDEA study personnel of AMI patients who were unable to answer the study questionnaire due to their critical condition (e.g. coma).

For the present analysis, 486 patients were included since 133 patients with missing values on knowledge score were excluded. Drop-out analysis revealed no significant difference in age, sex, sociodemographic, clinical and other relevant covariates. However, included patient were more likely to have a high-education level and being employed.

2.3 Data collection

The data collection process was divided into three sections. Firstly, a bedside structured interview was conducted with trained personnel. Secondly, a self-administered questionnaire was filled by the patient without supervision. Thirdly, data were collected from the hospitals' patient charts.

2.4 Measures

2.4.1 Knowledge Score

Knowledge of AMI symptoms was measured using a modified German version of the ACS Response Index Questionnaire [20], which was reviewed by experienced cardiologists as well as patients' representatives. It is an 18-item instrument reflecting two main components. (1) Knowledge of AMI symptoms subscale: from a list of 13 predefined symptoms (8 were correct and 5 were distractor), patients were asked to correctly identify symptoms that could be a representative of AMI. (2) Knowledge of appropriate behaviour subscale: patients were also asked to respond to additional five statements related to the appropriate behaviour during AMI. This instrument was self-administered. The total knowledge score was 18, and for analysis purposes the score was dichotomized by the median (Low: < 14, High: ≥14). (See **Table S1**)

2.4.2 Pre-hospital Delay (PHD)

Patients were asked to recall at what time acute symptoms began. The time difference between symptom-onset and first ECG in the clinic constitutes "prehospital delay" (PHD), measured in minutes. PHD was thus available as a continuous variable which was heavily left-skewed. PHD did not approximate a normal-distribution after transformations and, therefore, was further dichotomized into 2 groups: <120, and ≥120 minutes.

2.4.3 Baseline, clinical and behavioural measures

The hospital patient charts and bedside patient-interviews provided data on metabolic risk factors and presenting symptoms. Educational level was defined as low (who have not completed 12 years of basic education) and high (completed 12 years or more of basic education). Prodromal symptoms were defined by the presence of any of the symptoms related to CAD. Additionally, patients were asked about the sources of their information about AMI: family doctor (GP), friends, media or public campaigns by the heart foundation. Information about the chosen mode of transportation to hospital and whether the patient called the emergency services (as a first reaction) were also collected.

The structured bedside interview included a documentation of subjective risk perception (1 item, 5-point Likert-scale) and symptom expectation ('how much were the symptoms experienced comparable with the symptoms that you would have expected from a heart attack', 5-point Likert-scale). Dichotomized measures of risk perception (≤3 vs >3) and symptom expectation (≤3 vs >3) were used.

2.5 Data analysis

Differences between dichotomous variables were assessed using the chi-square test. When comparing ordinal variables with more than two outcomes, the Mantel-Haenszel chi-square test was used. Differences in age were assessed using the t-test. The nonparametric Wilcoxon test was used for assessing differences in median prehospital delay times. Stepwise multivariate logistic regression models were used to assess factors independently associated with knowledge level. Variables shown to be significantly associated with knowledge level by bivariate analysis were included as potential confounders in the model. Non-significant terms removed to determine the most parsimonious model for the outcome of interest. All statistical analyses were run in SAS (Version 9.2, SAS-Institute Inc., Cary, NC, USA). The significance level α was set at .05. The analysis and the description in this paper follow the STROBE guidelines for cross-sectional studies [21].

3. RESULTS

A total of 486 patients were included in the present investigation. The majority were men (n=364; 74.9%). The mean age was 61.6±12.1 years; men were on average 6 years younger than women (p< .001). In the total sample, median delay until the first ECG was recorded in the hospital was 210 minutes (100-728, IQR = 628). The median knowledge score of STEMI patients was 14[13-15]; which is equivalent to77.8% [72.2%-83.3%] of total distribution. Just over half of the participants (n= 284; 58.4%) were identified as having higher level of knowledge (≥14).

3.1 Characteristics of patients with adequate AMI-knowledge

Univariate and multivariate logistic regression analyses have been performed to identify factors related to knowledge level of AMI. As can be seen in **Figure 1**, the most significant factor independently associated with adequate level of knowledge was male gender (OR= 1.47, 95% CI: 1.17-1.85; p=.0008) and GP as a source of information (OR= 1.42, 95% CI: 1.14-1.77; p=.002), while age (OR=0.87, 95% CI: 0.86-0.89; p=.001) and previous history of MI/stent (OR= 0.65, 95% CI: 0.46-0.93; p=.0192) were negatively associated with AMI-knowledge. The sex-stratified multivariate logistic model shows that previous history of MI/stent placement was only a significant predictor of a lower knowledge level in men but not in women. There were no significant differences with regards to history of prodromal symptoms and documented cardiac risk factors as summarized in **Table 1**.

3.2 Knowledge of AMI symptoms

Although 476 patients (98%) correctly recognized at least one AMI-symptom, all the AMI symptoms were correctly identified by only 69 (14.2%) patients. Evaluation of the patients' knowledge of individual symptoms revealed that the majority of the patients correctly recognized chest pain (94.8%) as a typical symptom of myocardial infarction, followed by shoulder pain (83.2%). However, approximately two third of the participants failed to recognize low jaw pain as one of the heart attack symptoms. About one in three STEMI patients believed that heart attack is always accompanied with severe crushing chest pain. Additionally about one in five patients incorrectly recognized heartburn, tinnitus, visual disturbance and headache as typical heart attack symptoms. (see **Table S1**).

3.3 Knowledge of AMI appropriate behaviour and attitude

Patients with adequate knowledge of AMI were more likely to report that their symptoms met their previous expectation of STEMI (p=.026) and they perceived their personal AMI risk as high (p=.006). However, there were no significant differences between both groups (high/low knowledge level) in calling emergency services as the first response (p=.235) and using ambulance to get to the hospital (p=.112). The majority of our STEMI patients (93.4%) reported that they should call emergency services directly in response to a heart attack. However, only one third of them had actually called the emergency services in response to their acute symptoms (37%).

3.4 Impact of patients' knowledge about AMI on prehospital delay (PHD)

As reflected in **Figure 2**, the median PHD in male patients who achieved high scores on the knowledge scale was significantly shorter than those achieved low scores (median PHD 168[92-509] vs. 275.5[117-1519] minutes, p= .0016). In women, the median PHD was substantially lower in the adequate knowledge group (189[101-601] minutes) compared to 262[107-951] minutes in inadequate knowledge group, however, this was not significant (p= .34). As shown in **Table 2**, these sex-stratified results remained stable even after adjusting for age, socio-demographic and clinical covariates. We further examined the individual sex-stratified impact of typical and atypical knowledge on delay times. Knowledge of typical symptoms did not have a significant impact neither in men nor in women, while knowledge of atypical AMI-symptoms significantly shortens delay times in men (p= .0006) but not women (p= .767). (see **Table3**)

3.5 Age group sub-analyses of delay time, adequate knowledge and actual experience of atypical symptoms

Given that elderly people are more likely to experience atypical symptoms of MI, and have more protracted prehospital delays in seeking acute medical care than younger patients, we further examined the age differences in prehospital delay, actual experience of atypical symptoms and their knowledge of these atypical symptoms of AMI. As shown in **Figure 3**, elderly patients were significantly more likely to have lower knowledge in atypical symptoms (p=.006). However, they were more likely to present with atypical presentation of AMI (p<.001) and subsequently had protracted delay times (p<.001). These results were more significant and evident in women than in men (**Figure 4**).

4. DISCUSSION AND CONCLUSION

The first main finding of the present investigation is that knowledge about AMI symptoms and treatment requirements have a beneficial impact on delay time: patients experiencing a STEMI with adequate knowledge of AMI symptoms have 50% higher chance of early arrival (< 2hours) at the hospital compared to patients with inadequate knowledge summing up to a median PHD of 168min vs 276min in men and 198min vs 262min in women. Furthermore, patients with adequate knowledge about AMI were more likely to report that their symptoms met their expectation of STEMI and perceived their AMI risk as high.

On the first glance these findings may appears as intuitively expected, however, earlier investigations and randomised education campaigns have consistently demonstrated that increased awareness of AMI-knowledge does not automatically translate into reduced delay time [7, 22, 23].

Interestingly, when exploring the impact of knowledge in typical and atypical symptoms separately, we found that the beneficial timesaving impact of knowledge was mainly attributed to the adequate-level of knowledge on atypical symptoms. This seems reasonable as patients who experienced atypical symptoms may be less likely to recognise their symptoms as a heart attack and thus may delay longer in seeking treatment.

In addition, we found a sex-differential impact of AMI-knowledge on delay time. Men who achieved higher level of knowledge were more likely to have shorter delay time than their counterparts while level of AMI-symptoms knowledge had not a significant impact on delay time in women. Few previous studies reported beneficial effect of knowledge on delay [15, 24], however they did not report any sex-stratified analysis of the effect of knowledge on delay time as well as the individual impact of atypical AMI-knowledge.

4.1 Description of the AMI-knowledge of vulnerable group of STEMI patients

The present investigation revealed that about 40% of STEMI patients involved in our study had inadequate knowledge, as shown in previous studies [5, 11, 24]. It is of particular concern that a close insight into vulnerable subgroups of STEMI patients revealed that patients who are mostly in need for knowledge and information, mostly lack it: women who are at a high risk of atypical symptoms [25], were less knowledgeable about these atypical symptoms. In contrast to many previous studies [12, 13], we found women were significantly less knowledgeable about AMI and its atypical presentation compared to men. This finding is of particular importance because a great attention has been paid in past years towards women to increase their awareness about AMI and to alert them to their risk for heart disease. Similarly, elderly were less knowledgeable about AMI as well as its atypical symptoms. In the light of these findings and the fact that these subgroups of patients, namely elderly and women, were more likely to experience atypical presentation of heart attack [26], it seems reasonable that many of them failed to recognize their atypical symptoms as a heart attack, and subsequently had protracted delay time [6].

Notwithstanding the fact that STEMI patients who had a previous history of MI or stent placement had significantly lower knowledge score compared to those who had not. This is a counterintuitive finding since they should be an expert in AMI-symptoms, thus there are apparently other driving factors beyond that such as denial and psychological-trauma induced by the first attack. In addition, this could be resulted from the inadequate pre-discharge information and counselling received by AMI patients during their hospitalization as well. These findings provide possible explanations for previous observations [27] that documented the insignificant difference in delay time with regards to history of previous myocardial infarction.

4.2 Sources of Information about AMI

In the present investigation, STEMI patients reported that the most significant source for obtaining health information was the general practitioner (GP) compared to other sources (e.g. friends, mass media or public campaigns). This finding is important as previous studies had reported that patients often do not receive adequate amount of information and physicians rarely discuss symptoms of AMI with their patients whom at risk [11, 28, 29]. Even patients who have already suffered from AMI in the past apparently receive minimal education and counselling from physicians and nurses during their hospitalisation [13]. Interestingly, patients who received their information from their physicians were more likely to have higher level of AMI knowledge compared to those receive their information from other sources. This could be attributed to the individualized approach in conveying the message regarding the symptoms of myocardial infarction, in particular atypical presentation of heart attack.

In line with these findings, even among patients with adequate AMI-knowledge, only one third of them actually called an ambulance. This suggests that providing patients with knowledge about AMI symptoms is necessary but not sufficient in its own to improve delay times and needs to be translated into action in the presence of health thread.

4.3 Limitations

Data were collected retrospectively from the patients, and thus there is potential for recall bias. However, all data were collected at bedside within a very narrow time frame after STEMI. The inter-rater reliability between interviewers were not measured, however, all of them were carefully trained following the recommendation made by Moser et al[30] which focuses on the assistance of patients to triangulate the time of AMI onset. We had relatively small numbers of women, so replications of these results in larger datasets are warranted. The psychometrics properties for the German modified version of knowledge test have not been tested. Moreover, our investigation did not made any assumptions on AMI patients not receiving any medical attention.

4.4 Conclusions

Knowledge of AMI has improved in last years but remains substandard and a substantial gap in knowledge level exists among women compared to men; and among elderly compared to younger age groups. Despite, the relatively adequate knowledge of typical symptoms of AMI (i.e. chest pain), we found that elderly patients and women who are at higher risk for atypical symptoms of AMI were also less likely to know about these atypical symptoms which in turn put them at a high risk for retracted delay times.

4.5 Practice Implications

These results suggest that public health campaigns should focus more specifically on vulnerable groups (women and elderly) to raise their level of knowledge and attitude towards AMI. In addition to that, these campaigns should take into account the complexity of translating knowledge into actions and tailor their message according to target groups. Furthermore, clear and explicit counselling information regarding AMI should be considered as an integral part of the clinicians' role to their patients. Clinicians should individualise their approach in educating vulnerable groups (elderly and women) and address relevant issues such as the various presentations of AMI (both typical and atypical 'confusing'), the importance of the timely response to these symptoms as well as their misbeliefs that changing their lifestyle will completely eliminate their future risk of having recurrent heart attack. Importantly, knowledge is essential to reduce delay times but it is not a panacea since it is not sufficient alone to optimize prehospital delay times.

Conflicts of interest: None to declare

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Figures

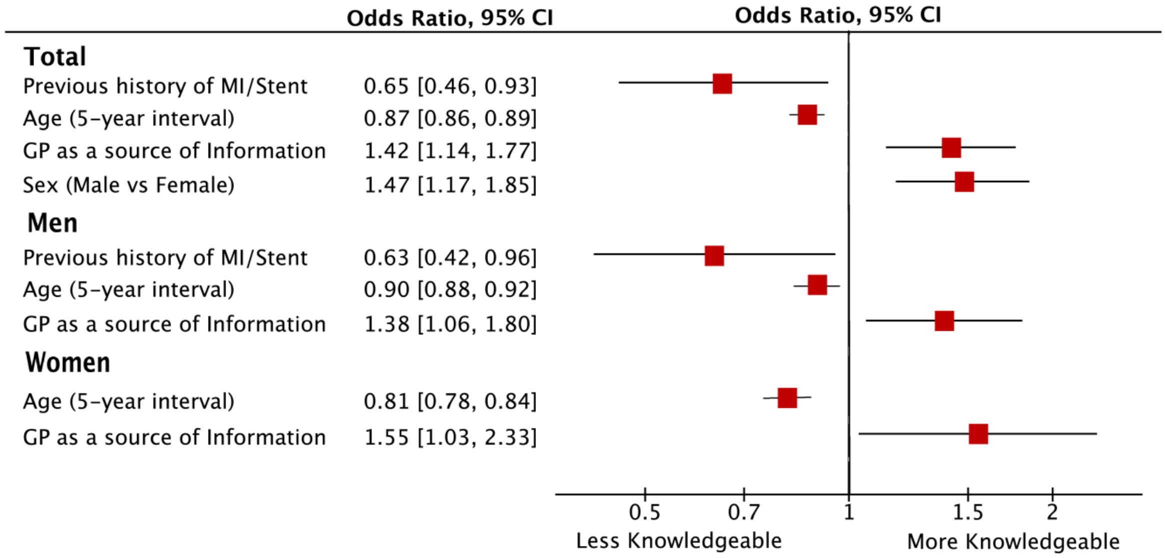

Figure 1: Factors associated with Knowledge Level in STEMI patients: result of the multivariate logistic regression

Variables included in the model: age, sex, employment, education, history of MI, stent placement, prodromal symptoms, information from GP or friends and risk perception.

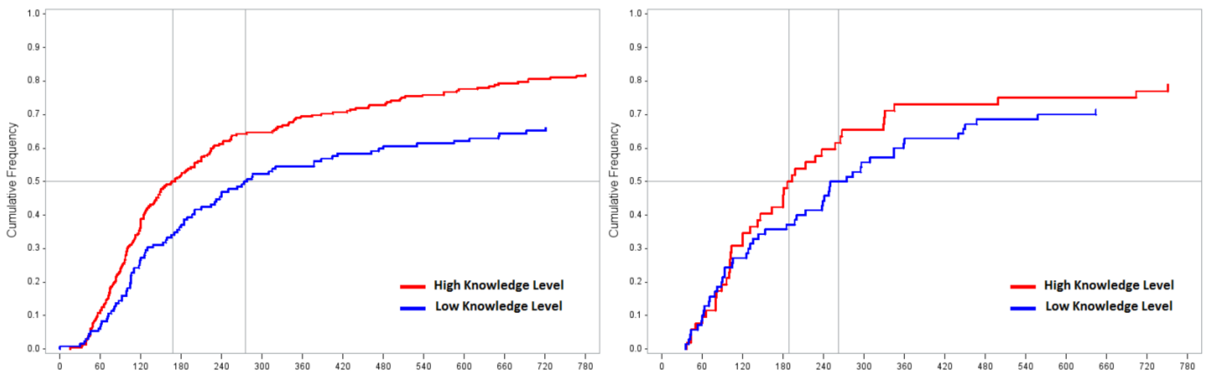

Figure 2: Cumulative frequency distribution curves for delay times among STEMI patients according to level of knowledge.

Left in men (*p* value = .0016, Wilcoxon test), right in women (*p* value = .34, Wilcoxon test)

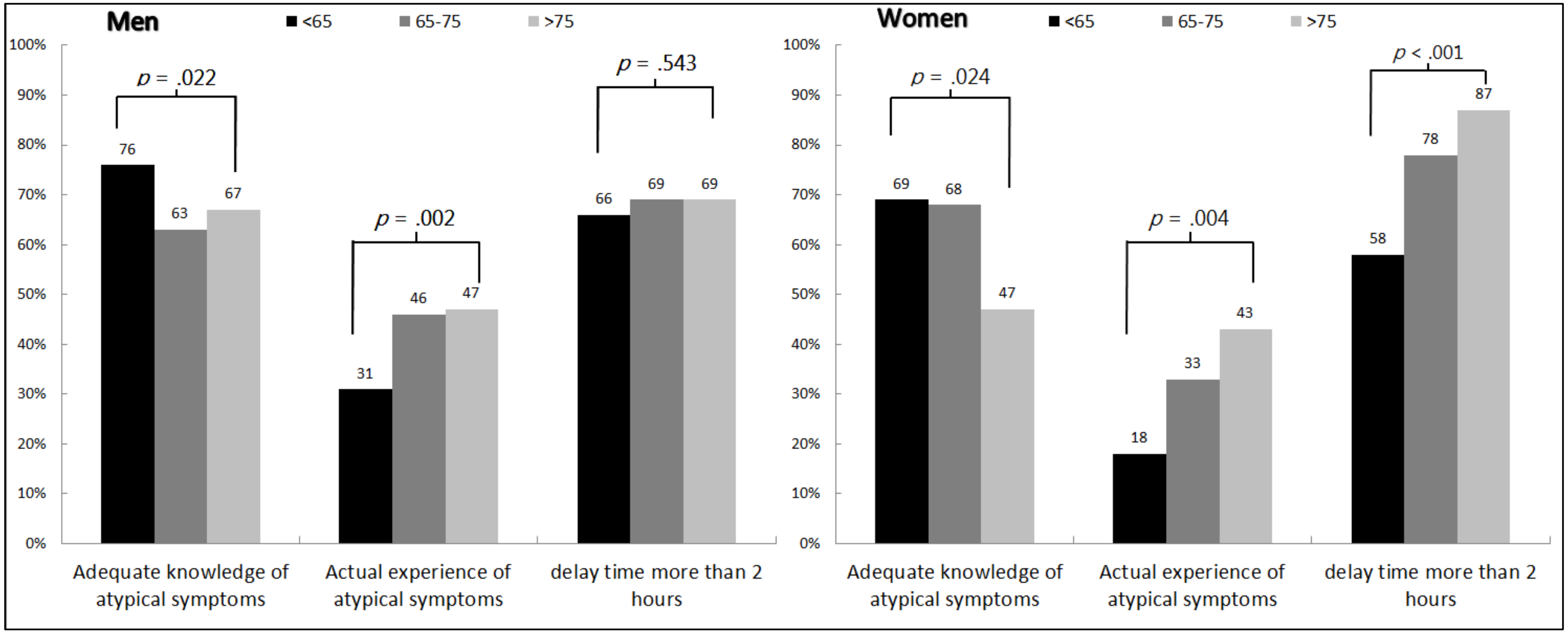

Figure 3: Frequency of adequate knowledge and actual experience of atypical symptoms and delay times stratified by age group for men and women.
P-value derived from Cochran Mantel Haenszel (CMH) test. Left in *Men* and right in *Women*

Tables

Table 1: Patient Characteristics associated with level of knowledge about AMI in STEMI patients (n=486)

	n†	Knowledge Level		
		High	Low	***P*-value**
All Patients		284 (58.4%)	202 (41.6%)	
Age, y*		60.0±11.7	63.9±12.4	**<.001**
<65*		190(65.5%)	100(34.5%)	**<.001**
65-75		61(49.2%)	63(50.8%)	
>75		33(45.8%)	39(54.2%)	
Sex (Male)**		232 (63.7%)	132 (36.3%)	**<.001**
Sex (Female)		52 (42.6%)	70 (57.4%)	
Employed**		162 (57.0%)	91 (45.1%)	**.009**
Low education level*		97 (34.2%)	86 (42.6%)	.059
Medical History (Co-morbidities)				
Hypertension	4	165 (58.7%)	128 (63.7%)	.272
Hypercholesterolemia	4	106 (37.6%)	68 (34.0%)	.419
Diabetes Mellitus	6	53 (18.9%)	45 (22.5%)	.339
Smoking	1	169 (59.7%)	111 (54.7%)	.295
Obesity (BMI >30)	5	101 (35.9%)	61 (30.5%)	.214
Family History MI**	2	141 (49.8%)	97 (48.3%)	.735
History of MI/ stent placement		20 (7.00%)	25 (12.4%)	**.046**
Prodromal symptoms	3	183(64.4%)	137(67.8%)	.439
Source of knowledge about AMI				
Family doctor (GP)**	4	100 (35.6%)	58 (28.9%)	.121
Mass Media	4	186 (66.2%)	130 (64.7%)	.730
Friends	4	156 (55.5%)	95 (47.3%)	.074
Public campaign	4	56 (19.9%)	41 (20.4%)	.899
Evaluation of symptoms				
Risk perception (high vs. low)		153 (53.9%)	83 (41.1%)	**.006**
Symptoms Expectation (high vs. low)**	6	145 (51.8%)	83 (41.5%)	**.026**
Patients behaviours during attack				
Used ambulance to get to hospital	2	104 (36.9%)	89 (44.1%)	.112
Call EMS (as the first response)	1	114 (40.1%)	70 (34.8%)	.235

Abbreviation: MI: Myocardial infarction, EMS: Emergency medical services, GP: General Practitioner ; bold means significant results (<.05); Show results of comparisons between patients with low knowledge vs. high knowledge about atypical symptoms * p<.001 **p<.05; † number of missing values

Table 2: Median delay times saved by adequate knowledge in crude and adjusted models, stratified by sex.

	Total (n = 486)		Men (n = 364)		Women (n = 122)	
	Difference in delay time (95% CI)	**P-value**	**Difference in delay time (95% CI)**	**P-value**	**Difference in delay time (95% CI)**	**P-value**
Crude Model						
Knowledge (high vs. Low)	-95(-163, -27)	**.006**	-107(-194, -21)	**.015**	-77(-207, 52)	.24
Age and Sex Adjusted Model						
Knowledge (high vs. Low)	-91(-156, -27)	**.0058**	-106(-193, -20)	**.0165**	-49(-195, 97)	.507
Full Model						
Knowledge (high vs. Low)	-82(-148, -16)	**.0146**	-110(-190, -31)	**.0069**	-38(-220, 144)	.679

Estimates and p-values were obtained using quantile regression models (50^{th} quantile); Full model: adjusted for age, sex, education level, employment, obesity, history of MI or stent, information from GP or friends. **Bold** font highlights significant p values

Table 3: Impact of patients knowledge on median prehospital delay times

	Prehospital delay					
	Overall		**Male**		**Female**	
	median(IQR)	*P*-value	median(IQR)	*P*-value	median(IQR)	*P*-value
Total Knowledge score						
High	179(96-509)	**.0007**	168(93-509)	**.0016**	189(101-602)	.34
Low	274(110-1406)		276(118-1520)		262(104-951)	
Knowledge of atypical symptoms						
High	182(89-459)	**.0007**	176(87-426)	**.0006**	237(89-886)	.7666
Low	250(110-1095)		259(110-1429)		226(105-558)	
Knowledge of typical symptoms						
High	200(101-692)	.771	196(103-870)	.797	198(103-819)	.923
Low	218(100-840)		201(100-680)		239(100-704)	

Bold font highlights significant p values, IDR: inter-quantile range; P-values acquired by the non-parametric Wilcoxon test to compare the median prehospital delay between patients with low knowledge and high knowledge.