Variables associated with disability in male and female long-term survivors from acute myocardial infarction. Results from the MONICA/KORA Myocardial Infarction Registry

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Abstract

Increasing attention is paid on functional limitations and disability among the elderly population with chronic diseases. However, only few studies have explored disability in persons with acute myocardial infarction (AMI). The objective of this study was to provide a description of disability and to identify determinants of disability in a population-based sample of long-term AMI survivors.

The sample consisted of 1,943 persons (35-85 years) with AMI from the German population-based MONICA/KORA Myocardial Infarction Registry, who responded to a postal follow-up survey in 2011. Disability was assessed with the 12-item version of the World Health Organization Disability Schedule (WHODAS). Multivariate linear regression models were established in order to identify socioeconomic and clinical factors, risk factors and comorbidities which are associated with disability.

The mean WHODAS score for the total sample was 7.86±9.38.The regression model includes 15 variables that explained 36.8% of the WHODAS variance. Most of the explained variance could be attributed to the presence of depression, joint disorders, stroke, and kidney disorders. Depression was the most important determinant of disability in both sexes. Replacement of single comorbidities by the total number of comorbidities resulted in a model with 5 variables explaining 31.6% of the WHODAS variance. Most of the variance was explained by the number of comorbidities. Further significant determinants of disability were female sex, low education level, angina pectoris, and no revascularization therapy.

In AMI patients, the number of comorbidities and particularly the presence of depression are important determinants of disability and should be considered in post-AMI health care.

Keywords

disability evaluation; myocardial infarction; comorbidity

Introduction

Population aging in industrialized countries is expected to increase the number of persons with functional impairments and disabilities. This prognosis is of utmost importance for national health care systems, since disability is associated with loss in quality of life, as well as increased health care needs and expenditures (Fried et al. 2001, Darba et al. 2015, Shaik et al. 2015). One of the leading contributors to disease burden in older people are cardiovascular diseases (CVD) contributing to 33.3% of the total burden in people aged 60 years and older (Prince et al. 2015). A study from the Netherlands found that of 3.01 years with disability in men, 0.85 were contributed by CVD (Klijs et al. 2011).

Knowledge of factors which are related with disability is crucial for the planning of health care provided to people who are at risk of developing disability. However, single chronic diseases and age are not the sole factors associated with disability. A number of other risk factors for disability have been identified in elderly individuals, e.g. age, female sex, low income, unmarried status, cognitive impairment, depression, multimorbidity, frailty, malnutrition, smoking, alcohol intake, obesity and physical inactivity (Strobl et al. 2013, Stuck et al. 1999, Balzi et al. 2010, Tas et al. 2007, Vermeulen et al. 2011).

Only a few studies have examined determinants of disability in persons with acute myocardial infarction (AMI) so far (Ades et al. 2002, Dodson et al. 2012, Quinones et al. 2014). They identified the following independent determinants of disability: older age (Quinones et al. 2014), female sex (Dodson et al. 2012, Quinones et al. 2014), nonwhite race (Dodson et al. 2012), unmarried status (Dodson et al. 2012), uninsured status (Dodson et al. 2012), malnutrition (Quinones et al. 2014), peak aerobic capacity (Ades et al. 2002), depression (Ades et al. 2002, Dodson et al. 2012), end-stage renal disease (Dodson et al. 2012), diabetes (Quinones et al. 2014), heart failure (Quinones et al. 2014), hearing loss in both ears (Quinones et al. 2014), and type of coronary intervention (percutaneous coronary intervention, coronary artery bypass graft) (Quinones et al. 2014). The available studies are hardly comparable, since they had different study designs, included different age groups and considered different potential confounders. The main limitation of these studies is their restricted conceptualization and measurement of disability. They used either the Stanford Health Assessment Questionnaire Disability Index (HAQ-DI) (Quinones et al. 2014), the EuroQol-5D (mobility, self-care, usual activities) (Dodson et al. 2012), or the physical function subscale from the Short Form-36 Health survey (Ades et al. 2002). This approach does not comply with the comprehensive disability concept suggested by the World Health Organization

(WHO) and its International Classification of Functioning, Disability and Health (ICF), which offers a biopsychosocial perspective of functioning and disability (WHO 2001). The ICF considers impairments of body structures and body functions, limitations in activities and restrictions in participation, as well as influencing contextual factors such as personal and environmental factors. The WHO also provides a questionnaire in order to facilitate a standardized assessment of the impact of any kind of disease on individuals' functioning and disability: the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) (Üstün et al. 2010; Federici & Meloni 2013). The WHODAS 2.0 covers six domains of disability: understanding and communication, getting around, self-care, getting along with people, life activities, and participation in society.

The objective of this study was to provide a comprehensive description of disability according to the WHO disability framework and to identify potential determinants of disability in a population-based sample of male and female, long-term AMI survivors.

Methods

Our study has used data from the population-based Augsburg Myocardial Infarction Registry. The registry was implemented in 1984 as part of the WHO-MONICA (**Moni**toring Trends and Determinants in **Ca**rdiovascular Disease) project (Meisinger et al. 2006). After the termination of MONICA in 1995, the registry became part of the framework of KORA (Cooperative Health Research in the Region of Augsburg, Germany). Since 1984, all cases of coronary deaths and non-fatal AMI of the 25-74 year old study population in the city of Augsburg and the two adjacent counties (about 600,000 inhabitants) have been continuously registered. Data sources for hospitalized patients include eight hospitals within the study region and two hospitals in the adjacent areas. Approximately 80% of all AMI cases of the study region are treated in the study region's major hospital, Klinikum Augsburg, a tertiary care centre offering invasive and interventional cardiovascular procedures, as well as heart surgery facilities (Meisinger et al. 2006; Kuch et al. 2008). Methods of case finding, diagnostic classification of events, and data quality control have been described elsewhere (Meisinger et al. 2006; Kuch et al. 2008). Routinely, patients are interviewed during their hospital stay by trained study nurses after transfer from the intensive care unit using a standardized questionnaire. The interviews include demographic data, risk factors, and comorbidities. Further data on clinical variables, comorbidities, treatment, and in-hospital course are determined by chart review.

The study was approved by the Ethics committee of the Bavarian Medical Association and performed in accordance with the Declaration of Helsinki. Participants gave written informed consent prior to study inclusion.

Sample

The target sample consisted of all 3,740 patients with AMI included in the MONICA/KORA Myocardial Infarction Registry, Augsburg, Germany, in the years 2000 to 2008 who were alive on 1 July 2011. Of these, 1,266 persons have previously declined further participation. A postal questionnaire was sent to the remaining 2,474 persons, including questions on the current health status, comorbidities, medication, and health care, as well as the German version of the 12-item WHODAS 2.0 (revised version). Reminders were sent to 1,194 persons who have not responded by September 2011. Persons who still failed to respond were reminded by telephone. Thirty persons could not be reached because they had died, 63 declined their participation, 38 were not available, three were not known at the available address, and 243 could not be reached by telephone for other reasons (e.g., no telephone connection, not reachable). From the 2,077 persons who returned the questionnaire, we excluded 117 patients who had completed less than 11 items from the WHODAS 2.0 and 17 cases without response to the questions on comorbidity , leaving 1,943 men and women aged 35-85 years with first or recurrent AMI for the analysis. Compared with the persons who did not participate for any reason, this sample had a comparable distribution of sexes (21.7% versus 23.0% women), but a slightly higher mean age (66.6±9.6 years versus 64.0±11.9 years).

Data collection

The following data and measures were used:

(1) Data obtained from patient interview and/or chart review during the hospital stay, namely sex, age at AMI, marital status (married vs. not married), history of hypertension, angina pectoris, hyperlipidemia, smoking (current smoker, ex-smoker, never smoker), AMI type (ST-segment elevation MI, non-ST-segment elevation MI, bundle branch block), and revascularization therapy (thrombolysis, bypass surgery, percutaneous coronary intervention). Body mass index (BMI) was determined by assessment of height and weight during the hospital stay. Obesity (yes/no) was defined as BMI ≥30 kg/m^2. A summary variable was built indicating the presence of any of the following in-hospital complications: pulmonary oedema, cardiac arrest, cardiogenic shock, ventricular tachycardia and bradycardia. Educational level was assessed by combining information on school education and vocational training. 'Low

education' was defined as the lowest school education according to the German educational system without completed formal vocational training.

(2) Data from a postal follow-up survey requesting information on current age, living alone, reinfarction and diabetes. Information on reinfarction was validated by hospital admission data and diabetes status was confirmed by the patients' general practitioner. Comorbidities were assessed using a modified version of the Self-administered Comorbidity Questionnaire (SCQ) (Sangha et al. 2003), which requests information on the presence of 11 health conditions, namely diseases of the lung, digestive system, kidney, liver, blood, joints, and vision, mood disorder/depression and neurological diseases, stroke, cancer. In addition, patients were asked to name any other diseases they had. If patients named health conditions which could be assigned to the existing categories, the data was modified accordingly. Finally, a variable reflecting the sum of the 11 SCQ comorbidities plus diabetes was built.

Disability was assessed using the revised self-administration 12-item version of the WHODAS 2.0 (http://www.who.int/classifications/icf/whodasii/en/index3.html). The WHODAS 2.0 12-item form has been successfully tested for its feasibility and psychometric properties in several studies (Andrews et al. 2009; Sousa et al. 2010; Luciano et al. 2010a,b,c), including the present study sample (Kirchberger et al. 2014). For each item, respondents had to indicate the level of difficulty experienced during the previous 30 days using a five-point scale (none, mild, moderate, severe, extreme/cannot do). According to the standard scoring algorithm, a total score was calculated for persons who completed at least 11 of the 12 questions by summing up all items, while one missing item was replaced by the mean score of the remaining items (Üstün et al. 2010b). WHODAS 2.0 scores range from 0 (no disability) to 48 (severe disability).

Data analysis

WHODAS 2.0 scores were expressed as mean values with standard deviation, and 5%, 25%, 50%, 75% and 95% percentiles. Categorical variables were presented as percentages. Mean WHODAS 2.0 scores were tested for differences in all potential covariates (including age group, sex, risk-factors, comorbidities, clinical and treatment characteristics) using Student's t-test. Variables with $p<0.20$ were subjected to multivariate linear regression analysis with log-transformed WHODAS 2.0 scores as dependent variable. Age at AMI and age at follow-up were also log-transformed. Interaction effects of age at AMI, age at follow-up and sex were examined in the full regression model, but failed to be significant. However, because sex was significantly related with disability and it is so far unclear whether the same factors determine disability in men and women with AMI, separate models for men and women were calculated.

The final models were derived using the stepwise variable selection procedure. The significance level for entering variables into the model and keeping them was set to $p<0.05$. Multicollinearity among the independent variables was examined by assessing Variance Inflation Factors (VIF) in the full models (Allison 2015).

Results

The sample consisted of 1,943 patients (76.2% men) with a mean age of 59.6 years at AMI and 66.6 years at follow-up, respectively. Average time between AMI and follow-up was 6.5 years. Further sample characteristics are shown in Table 1.
The percentage of patients who had at least one additional health condition was 74.4%. The median number of comorbidities was 1 (interquartile range 2). The three most common comorbidities were vision disorders (35.5%), joint disorders (31.3%), and depression (16.1%) (see Table 2).

The mean WHODAS 2.0 score for the total sample was 7.86±9.38. Means and distribution of WHODAS 2.0 scores by age group at follow-up and sex indicate higher scores for women compared with men (see Table 3). No linear increase of WHODAS 2.0 scores with increasing age was found. Only patients in the oldest age group (>75 years) had higher scores than patients in younger age groups. On the level of the 12 single items, the highest impairment was reported in terms of "being emotionally affected by the health condition" (see Figure 1). Problems with walking a long distance or standing for long periods were the second and third most common impairments.

Patients with stroke had the highest level of disability (mean WHODAS 2.0 score 19.6), followed by patients with neurological diseases (18.7) and patients with depression (16.1) (see Table 2). WHODAS 2.0 scores significantly increased with the number of comorbidities (see Table 2)

In the bivariate analyses, all variables except smoking, hospital complications and time between AMI and follow-up were associated ($p<0.20$) with the WHODAS 2.0 score (see Table 1 and 2) and therefore included in the regression analyses in the next steps.

Multivariate linear regression modeling resulted in a final model including 15 variables that explained 36.8% of the total WHODAS 2.0 variance (see Table 4). Forty-four percent of the explained variance could be attributed to presence of depression; 80% were explained altogether by joint, kidney and neurological diseases, depression and stroke. Female sex and low education were the only sociodemographic variables which significantly contributed to a higher level of disability. From the risk factors prior AMI, angina pectoris, obesity and hypertension were independently related with disability. In addition, patients having received any revascularization therapy for their AMI, had lower levels a disability at the follow-up.

Table 1: Sample characteristics and WHODAS 2.0 scores

	n	%	WHODAS scores Mean	SD	p
Sociodemographic characteristics					
Sex					
Male	1520	78.23	7.04	8.86	<.0001
Female	423	21.77	10.81	10.55	
Age at AMI					
≤61 years	1044	53.73	7.03	8.52	<.0001
>61 years	899	46.27	8.83	10.21	
Age at follow-up					
≤68.1 years	971	49.97	7.13	8.59	0.0006
>68.1 years	972	50.03	8.59	10.06	
Years between AMI and follow-up					
≤6.2	966	49.72	7.84	9.41	0.9071
>6.2	977	50.28	7.89	9.36	
Education level					
high	1688	89.22	7.39	9.08	<.0001
low	204	10.78	11.24	10.84	
Married					
yes	1517	78.52	7.69	9.24	0.0987
no	415	21.48	8.54	9.86	
Living alone					
yes	371	19.16	9.07	10.11	0.0040
no	1565	80.84	7.53	9.07	
AMI characteristics					
Reinfarction					
yes	300	15.44	9.80	10.33	<.0001
no	1643	84.56	7.51	9.16	
Any revascularization therapy					
yes	1721	88.57	7.45	9.05	<.0001
no	222	11.43	11.05	11.14	
Any in-hospital complication					
yes	261	13.45	8.16	9.55	0.5891
no	1680	86.55	7.82	9.36	
AMI type					
STEMI	751	39.34	7.05	8.86	0.0280
NSTEMI	1061	55.58	8.3.0	9.65	
BBB	97	5.08	8.97	10.37	
Risk factors prior AMI					
Angina pectoris					
yes	319	16.42	10.66	10.37	<.0001

no	1624	83.58	7.31	9.08	
Hyperlipidemia					
yes	1415	72.83	8.05	9.58	0.1462
no	528	27.17	7.36	8.80	
Hypertension					
yes	1482	76.27	8.41	9.76	<.0001
no	461	23.73	6.11	7.80	
Obesity					
yes	482	25.03	9.77	10.53	<.0001
no	1444	74.97	7.25	8.91	
Smoking					
Current smoker	679	35.57	8.44	9.33	0.9337
Ex-smoker	627	32.84	7.14	9.10	
Never smoker	603	31.58	7.88	9.54	

SD: Standard deviation; AMI: acute myocardial infarction; STEMI: ST-segment elevation myocardial infarction; NSTEMI: Non-ST-segment elevation myocardial infarction;

Table 2: WHODAS 2.0 scores stratified by comorbidities and multimorbidity

	n	%	WHODAS scores Mean	SD	p
Comorbidities					
Lung disorders					
yes	144	7.69	13.78	12.14	<.0001
no	1729	92.31	7.08	8.74	
Digestive disorders					
yes	154	8.29	13.09	10.64	<.0001
no	1703	91.71	7.13	8.96	
Kidney disorders					
yes	140	7.48	15.65	12.33	<.0001
no	1731	92.52	6.96	8.62	
Liver disorders					
yes	41	2.22	13.98	11.50	<.0001
no	1803	97.78	7.37	9.06	
Blood disorders					
yes	76	4.11	14.13	10.78	<.0001
no	1773	95.89	7.26	9.01	
Cancer					
yes	106	5.71	12.19	11.49	<.0001
no	1749	94.29	7.27	8.98	
Depression					
yes	300	16.05	16.13	11.32	<.0001
no	1569	83.95	6.01	7.85	
Joint disorders					
yes	579	31.29	11.54	10.13	<.0001
no	1277	68.80	5.93	8.28	
Vision disorders					
yes	661	35.52	10.79	10.91	<.0001
no	1200	64.48	5.90	7.71	
Stroke					
yes	95	5.10	19.59	13.82	<.0001
no	1766	94.90	6.96	8.50	
Neurological disorders					
yes	72	3.92	18.70	13.53	<.0001
no	1767	96.08	7.04	8.62	
Diabetes					
yes	622	32.01	10.04	10.69	<.0001
no	1321	67.99	6.84	8.51	
Multimorbidity*					
0 diseases	497	25.58	3.02	4.90	<.0001
1 disease	634	32.63	5.72	7.23	
2-3 diseases	625	32.17	10.24	9.16	
≥4 diseases	187	9.62	20.04	12.20	

*Number of above mentioned comorbidities in addition to AMI
SD: Standard deviation

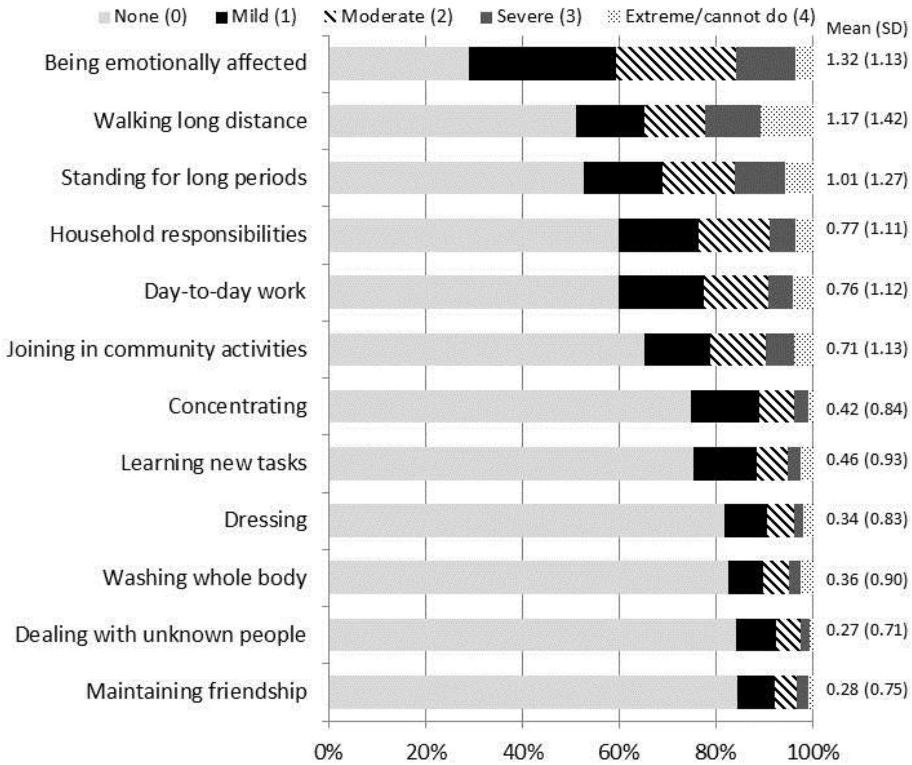

Figure 1: Frequencies and means (standard deviation=SD) for the 12 single items of the WHODAS 2.0

Table 3: WHODAS 2.0 scores stratified by sex and age at follow-up

	WHODAS scores							
				Percentile				
	n	Mean	SD	5th	25th	50th	75th	95th
Men								
35-54 years	199	7.00	8.50	0.00	1.00	3.00	10.00	26.00
55-64 years	407	6.84	8.34	0.00	1.00	4.00	10.00	24.00
65-74 years	577	5.73	7.88	0.00	0.00	2.18	8.00	21.00
75-85 years	337	9.55	10.61	0.00	2.00	6.00	13.00	32.00
Total	1520	7.04	8.86	0.00	1.00	3.00	10.00	26.00
Women								
35-54 years	37	10.71	11.34	0.00	1.00	6.00	21.00	36.00
55-64 years	80	10.15	9.17	0.00	2.00	9.00	14.09	29.73
65-74 years	161	9.30	10.12	0.00	2.00	6.55	13.00	32.00
75-85 years	145	12.89	11.27	0.00	4.00	9.00	21.00	35.00
Total	423	10.81	10.55	0.00	2.18	7.64	16.00	33.00
Men+Women								
35-54 years	236	7.58	9.08	0.00	1.00	3.00	11.50	29.00
55-64 years	487	7.38	8.56	0.00	1.00	4.00	12.00	25.00
65-74 years	738	6.51	8.54	0.00	1.00	3.00	9.00	24.00
75-85 years	482	10.55	10.91	0.00	2.00	7.00	16.00	32.00
Total	1943	7.86	9.38	0.00	1.00	4.00	12.00	28.00

SD: Standard deviation

Replacement of single comorbidities by the total number of comorbidities resulted in a regression model with 5 variables explaining 31.6% of the WHODAS 2.0 variance (see Table 4). Of the explained variance, 92.6% could be attributed to the number of comorbidities. Further significant determinants of disability were female sex, low education level, angina pectoris prior AMI, and no recanalization therapy.

In the subgroup of male individuals, 13 predictor variables explained 35.2% of the WHODAS 2.0 variance (see Table 5). Similar to the total sample, depression explained the highest amount of variance, followed by stroke and joint disorders. In women, 8 variables explained 34.2% of the WHODAS 2.0 variance. Again, depression showed the strongest independent association with disability. Contrary to the analysis among men, diseases of vision, blood, digestive system, cancer, as well as education level and hypertension prior AMI did not significantly contribute to the WHODAS 2.0 variance, but obesity was related with disability.

Table 4: Multivariate linear regression model for disability (log-transformed WHODAS 2.0 scores) with all single comorbidities (Model A: total R^2=0.3683) and the number of comorbidities (Model B: total R^2=0.3155).

Independent variables	Step No.	Partial R^2	ß	Standard error	p
Model A					
Depression	1	0.1639	0.3044	0.0231	<.0001
Joint disorders	2	0.0579	0.1530	0.0177	<.0001
Stroke	3	0.0424	0.2947	0.0394	<.0001
Kidney disorders	4	0.0180	0.1246	0.0328	0.0002
Sex (male)	5	0.0162	-0.0885	0.0196	<.0001
Neurological disorders	6	0.0157	0.2306	0.0423	<.0001
Vision disorders	7	0.0110	0.0660	0.0171	0.0001
Lung disorders	8	0.0088	0.1362	0.0325	<.0001
Cancer	9	0.0065	0.1212	0.0365	0.0009
Digestive disorders	10	0.0061	0.1233	0.0311	<.0001
Angina pectoris	11	0.0054	0.0739	0.0215	0.0006
Low education	12	0.0050	0.0900	0.0262	0.0006
Blood disorders	13	0.0047	0.1453	0.0425	0.0002
Obesity	14	0.0044	0.0527	0.0183	0.0041
Diabetes	15	0.0023	0.0414	0.0172	0.0161
Model B					
Number of comorbidities	1	0.2921	0.1411	0.0055	<.0001
Sex (male)	2	0.0132	-0.0906	0.0194	<.0001
Angina pectoris	3	0.0056	0.0759	0.0209	0.0003
Any evascularization therapy	4	0.0024	-0.0658	0.0247	0.0078
Low education	5	0.0022	0.0628	0.0258	0.0151

Table 5: Multivariate linear regression model for disability (log-transformed WHODAS 2.0 scores) for men (total R^2=0.3522) and women (total R^2=0.3417).

Independent variables	Men					Women				
	Step No.	Partial R^2	ß	Standard error	p	Step No.	Partial R^2	ß	Standard error	p
Depression	1	0.1662	0.3249	0.0267	<.0001	1	0.1358	0.2786	0.0476	<.0001
Stroke	2	0.0540	0.3122	0.0430	<.0001	8	0.0090	0.2036	0.0935	0.0301
Joint disorders	3	0.0465	0.1483	0.0199	<.0001	2	0.0715	0.1726	0.0385	<.0001
Neurological disorders	4	0.0174	0.2200	0.0467	<.0001	6	0.0143	0.2384	0.0985	0.0160
Vision disorders	5	0.0153	0.0802	0.0189	<.0001	-	-	-	-	-
Blood disorders	6	0.0131	0.2174	0.0522	<.0001	-	-	-	-	-
Digestive disorders	7	0.0113	0.1387	0.0341	<.0001	-	-	-	-	-
Low education	8	0.0080	0.1193	0.0354	0.0008	-	-	-	-	-
Cancer	9	0.0064	0.1265	0.0408	0.0020	-	-	-	-	-
Lung disorders	10	0.0052	0.1174	0.0362	0.0012	7	0.0137	0.1995	0.0724	0.0062
Kidney disorders	11	0.0038	0.0928	0.0380	0.0146	3	0.0423	0.2411	0.0646	0.0002
Hypertension	12	0.0028	0.0413	0.0195	0.0345	-	-			-
Angina pectoris	13	0.0021	0.0484	0.0240	0.0438	4	0.0287	0.1639	0.0482	0.0008
Obesity	-	-	-	-	-	5	0.0263	0.1296	0.0399	0.0013

Discussion

The present study has investigated disability in long-term survivors from AMI. We found that among a large number of potential variables associated with disability, the number of comorbidities and particularly comorbid depression emerged as the main determinants of disability in men and women. In addition, socioeconomic disparities were detected with women and persons with low educational status being more disabled compared with their counterparts, despite adjustment for several confounders.

Although no agreed-upon cut-point for identifying persons with significant disabilities exists for the WHODAS 2.0 short-form and population norms for the WHODAS 2.0 in Germany are lacking so far, based on the population norms from Australia, our data indicate that about 25% of the AMI survivors have relevant disabilities (Andrews 2009). Mean WHODAS 2.0 scores derived from our study were at least twice as high as in the respective age groups of the Australian population. Moreover, WHODAS 2.0 scores were slightly higher than in Australian people with more than one physical condition and comparable with people with one mental disorder (Andrews 2009). Considering the high amount of persons with at least one comorbidity and depression among our study sample, the level of disability in long-term AMI survivors detected in our study seems reasonable.

Our results showed that 74% of the AMI patients had at least one additional comorbidity, 42% had two or more comorbidities. Compared with the elderly population in the same study region, where 60.6% of the sample had ≥2 health conditions (Kirchberger et al. 2012), the proportion of people with multimorbidity was higher in the AMI sample although these persons were considerably younger (mean age 66.6 vs. 73.4 years). The number of comorbid conditions also emerged as the most important determinant of disability in the present study. Overall, this finding is in accordance with a systematic review on risk factors of functional decline in elderly people (Stuck 1999) and a large study in U.S. adults aged 50-65 years (Zhao et al. 2009) which also found a linear relationship between number of chronic conditions and disability. In contrast, in patients with coronary heart disease Ades et al. (2002) did not find a significant independent relation between the number of 5 comorbid conditions (diabetes, peripheral vascular disease, cerebrovascular disease, chronic obstructive lung disease, arthritis) and physical function measured by the SF-36. Differences regarding study sample, assessment of comorbidities and disability measures may have contributed to the conflicting results.

Our study results highlight the relevance of affective disorders, such as depression, in AMI patients. Depression was the third most common comorbidity and the strongest contributor to disability in male and female individuals with AMI. The high prevalence of mental diseases in AMI patients is a consistent finding in previous studies (Thombs et al. 2006, Roest et al. 2010) and depression has also been reported to be a predictor of disability in the few studies on AMI patients (Ades et al. 2002, Dodson et al. 2012). Besides depression, joint diseases were shown to be relevant sources of disability in AMI patients, since they were very common (31.3%) and have explained up to 7% of the total disability variance in the regression models. This finding is consistent with the study from Strobl et al. (2013) who reported that joint diseases were the strongest contributor to disability in the elderly population.

It is essential to mention the social disparities found in the present study. The finding that women are more likely to be disabled than men has been described consistently in the available studies on the elderly population (Murtagh 2004, Virues-Ortega 2011, Whitson 2010, Strobl 2013, Melzer 2004) and in patients with heart diseases (Ades 2002, Dodson 2012, Quinones 2014). However, the determinants of disability are roughly the same with depression and joint diseases explaining an important proportion of disability variance in men and women. Interestingly, low education was significantly associated with higher disability scores in men, but not in women, whereas obesity was a determinant of disability only in women but not in men. The latter finding is in line with the finding that obesity has a higher prevalence in women and therefore explained 12.9% of the sex-based difference in disability rates in elderly people (Whitson 2010)

Moreover, our study found significant differences in disability scores between persons with low versus higher education level. Socioeconomic inequality in elderly people with disability is a well-known phenomenon (Strobl 2013, Schoeni 2005, Coppin 2006, Minkler 2006, Melzer 2004). Several studies that have used education as socioeconomic indicator reported that disability is more common in less educated people (Minkler 2006, Schoeni 2005, Melzer 2004). In contrast, Strobl et al. (2013) found differences in disability scores according to income, but not according to educational status in a population-based study of elderly persons in the same study region where our AMI sample came from. The fact that Strobl et al. (2013) have used years of education as continuous variable instead of dichotomizing into groups of patients with very low versus higher education, may partly explain the inconsistency with our results.

In the present study, where the median age of participants was 68 years, no independent significant relation between age and disability was found. This finding indicates that in this specific age group of people who already have one chronic disease, namely coronary artery disease, age per se is not that relevant in contrast to other factors such as additional comorbidities.

To our knowledge, this is the first study that examined the frequency and determinants of disability in long-term AMI survivors using the 12-item WHODAS 2.0. A strength of our population-based study is the inclusion of a large sample of patients in a defined area and according to defined criteria, with validated AMI, and standardized assessment of demographic and clinical variables. A limitation is the cross-sectional design of this study which does not allow conclusions on a causal relationship between the identified determinants and the level of disability. Information on the presence of most comorbid conditions was gathered by patient self-reports which may be biased.

Conclusions

Our study demonstrated that AMI survivors are characterized by a large proportion of persons with multimorbidity, which is strongly related with disability. In order to reduce disability and to improve the post-AMI quality of life of the affected persons, it may be useful to consider comorbidities in all actions related to the health care of these patients: prescription of medication, risk factor management, long-term treatment and rehabilitation. In particular, cardiologists and health care professionals should be aware of the considerable amount of patients with depressive disorders and should make professional support available to these patients. Overall, the gender and socioeconomic disparities in terms of disability which were confirmed in our study are alarming and require attention.

Conflict of interest statement

The authors declare that there are no conflicts of interests.

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