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Prevalence of heart failure and left ventricular dysfunction in the general population

The Rotterdam Study

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Aims To determine the prevalence of heart failure and symptomatic as well as asymptomatic left ventricular systolic dysfunction in the general population.

Methods and Results In 5540 participants of the Rotterdam Study (age 68·9 ± 8·7 years, 2251 men) aged 55–95 years, the presence of heart failure was determined by assessment of symptoms and signs (shortness of breath, ankle oedema and pulmonary crepitations) and use of heart failure medication. In 2267 subjects (age 65·7 ± 7·4 years, 1028 men) fractional shortening was measured. The overall prevalence of heart failure was 3·9% (95% CI 3·0 ± 4·7) and did not differ between men and women. The prevalence increased with age, with the exception of the highest age group in men. Fractional shortening was higher in women and did not decrease appreciably with age. The prevalence of left ventricular systolic dysfunction (fractional shortening <=25%) was approximately 2·5 times higher in men (5·5%, 95% CI 4·1–7·0) than in women (2·2%, 95% CI 1·4–3·2). Sixty percent of persons with left ventricular systolic dysfunction had no symptoms or signs of heart failure at all.

Conclusions The prevalence of heart failure is appreciable and does not differ between men and women. The majority of persons with left ventricular systolic dysfunction can be regarded as having asymptomatic left ventricular systolic dysfunction.
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Key Words: Heart failure, epidemiology, prevalence, echocardiography, left ventricular dysfunction, asymptomatic.

Introduction

Heart failure, a syndrome which develops as a consequence of cardiac disease, recognised clinically by a constellation of signs and symptoms produced by complex circulatory and neurohormonal responses to cardiac dysfunction[1], is rapidly becoming one of the most common cardiovascular disorders. The incidence of heart failure is expected to continue to increase[2]. Despite the poor prognosis[3,4], and considerable economic impact on health services because of long-term pharmacological treatment and frequent hospitalizations associated with the syndrome[5], epidemiological data on heart failure are relatively scarce[6]. This may be attributed to the atypical symptoms of the early stages of heart failure, the ongoing debate on the definition of heart failure and the lack of a gold standard to assess the presence of heart failure[7]. According to the guidelines of the European Society of Cardiology, objective evidence of cardiac dysfunction has to be present in addition to symptoms (e.g. shortness of breath or fatigue, at rest or during exercise, ankle swelling) to establish the presence of heart failure[8].

Benefits of ACE inhibition have been documented in persons with impaired left ventricular systolic function either with or without overt symptoms and signs of heart failure[9,10]. Heart failure in persons with intact left ventricular systolic function, often referred to as diastolic heart failure, is less well characterized in terms of epidemiology and optimal treatment[11].

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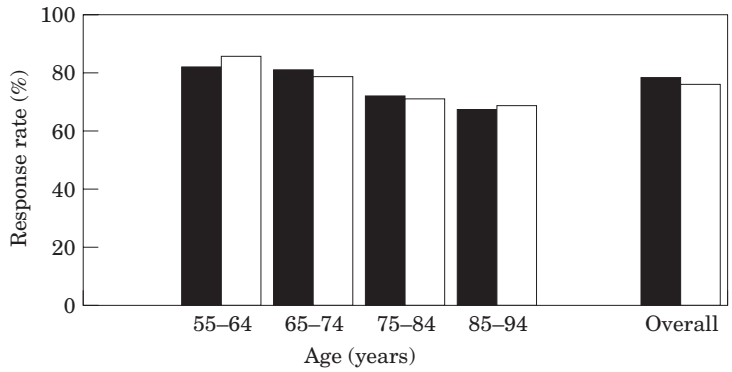

Figure 1 **Gender and age specific response rates in the Rotterdam Study[16]. ■=men; □=women.**

The translation of benefits of recent clinical trials in heart failure to larger groups of heart failure patients will, to a large extent, be determined by the feasibility of methods to detect left ventricular dysfunction in unselected and non-hospitalized subjects. Echocardiography has been recommended as an essential tool in the evaluation of persons suspected of heart failure[8,12] in particular in the assessment of left ventricular systolic function. However, routine application of echocardiography in population-based studies is costly, time consuming and requires considerable expertise[13]. Appreciation of the usefulness of natriuretic peptides in the detection of left ventricular systolic dysfunction is growing[14]. Apart from recent data from Scotland in persons aged 25–74 years[15], estimates of the prevalence of left ventricular systolic dysfunction in the population at large are not available. We set out to estimate the prevalence of heart failure in participants aged 55–94 years of the population-based Rotterdam Study and to relate echocardiographic findings in a sample of participants to symptoms and signs associated with heart failure. Thus, we were able to estimate the prevalence of symptomatic and asymptomatic left ventricular systolic dysfunction in the general population.

Methods

Study population

This study forms part of the Rotterdam Study, a population-based cohort study on prevalence, incidence, and determinants of chronic disabling diseases in the elderly[16]. The first cross-sectional survey started in 1990 and was completed in June 1993. All inhabitants of Ommoord, a suburb of Rotterdam, the Netherlands, who were 55 years or older were invited to participate in the study by mail and contacted by telephone 2 weeks later. Names and addresses were drawn from the municipal register, which is reliable, complete, and updated weekly. Of the 10 275 eligible subjects, 7983 (78%) agreed to participate and signed informed consent. Response rates were slightly lower in older age groups (Fig. 1). Participants were interviewed at home and subsequently examined at the research centre. The Rotterdam Study was approved by the Medical Ethics Committee of Erasmus University Medical School. All participants provided informed consent.

History

A trained non-medical interviewer administered a standardized questionnaire to obtain information on medical history (e.g. myocardial infarction, coronary artery bypass surgery, percutaneous transluminal angioplasty) and current medication use. The presence of angina pectoris and shortness of breath was assessed by means of the WHO questionnaires[17]. Shortness of breath was defined as WHO grade I or higher dyspnoea, reflecting shortness of breath at rest or on moderate exertion. Drug use was coded according to the Anatomical Therapeutic Chemical (ATC) classification index[18].

Height and weight were measured with participants wearing light clothes and without shoes. Body mass index was calculated as weight(kg)/height(m)^2. Standardized physical examination was carried out by a study physician to verify the presence of ankle oedema and pulmonary crepitations or rhonchi. The research physicians were trained to reduce interobserver variability.

A standard 12-lead electrocardiogram (ECG) was recorded using an ESAOTE laptop electrocardiograph (ESAOTE Biomedica, Florence, Italy). All electrocardiograms were digitally stored and analysed using the MEANS program, a standardized and validated ECG software program[19]. Myocardial infarction was defined as myocardial infarction on the electrocardiogram. In addition, if participants reported a history of myocardial infarction without electrocardiographic evidence at the time of examination, myocardial infarction was deemed present, provided that evidence of myocardial infarction was found in specialists' records. The electrocardiogram was used to assess the presence of atrial fibrillation and left ventricular hypertrophy. The MEANS program uses three parameters (voltage and

shape of the QRS complex in addition to repolarization features) to grade the presence of left ventricular hypertrophy as 'absent', 'consider', 'possible', 'probable', 'definite', 'marked' or 'very marked'. In this study left ventricular hypertrophy was deemed present only if graded as 'definite', 'marked' or 'very marked'.

Echocardiography was performed with the participant in the partial left decubitus position (Toshiba SSH-60A). Two-dimensional imaging using parasternal long-axis views was performed to aid M-mode studies. Measurements were made according to the recommendations of the American Society of Echocardiography using a leading edge to leading edge convention. Left ventricular internal dimension (LVIDed) was measured at end diastole, as defined by the onset of the QRS complex and at end systole (LVIDes), as determined at the nadir of septal motion. The percentage fractional shortening was calculated as 100[(LVIDed − LVIDes)/LVIDed] and used as an index of systolic function. Impaired left ventricular function was deemed to be present if fractional shortening was less than or equal to 25%, corresponding to a left ventricular ejection fraction of 42·5%[20].

Classification of heart failure

A two-step approach was used to assess the prevalence of heart failure. Firstly, the presence of shortness of breath at rest or on exertion[17], ankle oedema and pulmonary crepitations was determined. If at least two of these were present in combination with evidence of cardiac disease (angina pectoris, myocardial infarction, documented coronary artery bypass surgery, documented percutaneous transluminal angioplasty, atrial fibrillation or electrocardiographic left ventricular hypertrophy), while shortness of breath could *not* be attributed to chronic obstructive pulmonary disease (as indicated by use of chronic obstructive pulmonary disease medication — ATC code r03 —), heart failure was considered present. This combination had a sensitivity of 80% to detect and a specificity of 98% to exclude the presence of definite heart failure as determined by a cardiologist on clinical grounds in a previous pilot validation study in a sample of 54 carefully selected Rotterdam Study participants[21].

Secondly, the examining physician used standardized questions to verify the indication of cardiovascular medication with the participant. In case diuretics, glycosides or angiotensin converting enzyme inhibitors were used, a possible indication of heart failure (as opposed to hypertension, arrhythmias etc.) was verified. Only participants with a definite indication for heart failure, in whom objective evidence of cardiac disease was found, were included.

Statistical methods

Data were analysed using the STATA statistical package. We calculated age- and sex-specific prevalence figures of heart failure and left ventricular systolic dysfunction. As information on indication for cardiovascular medication use and shortness of breath was not obtained in the beginning of the Rotterdam Study, prevalence estimates are based on 5540 participants (age 68·9 ± 8·7 years, 2251 men), in 1677 of whom (age 66·2 ± 8·2 years, 779 men) auscultation was performed. The prevalence figures are presented in 10 year age groups, separately for men and women, and according to whether or not auscultation was used in the assessment of heart failure. Binomial confidence intervals (95%) were calculated for prevalence estimates. Analysis of covariance was performed to calculate age-adjusted prevalences of heart failure according to whether or not auscultation had been performed. To determine whether the difference in age-adjusted prevalence of men and women was statistically significant, we used logistic regression analyses with age and gender as independent and the presence of heart failure as dependent variables.

Results

Characteristics of participants

Table 1 provides characteristics of all 7939 Rotterdam Study participants aged 55–94 years as well characteristics of those 5540 participants in whom the presence of heart failure was assessed. Apart from a lower prevalence of hypertension, the latter group is highly representative of the complete Rotterdam Study cohort aged 55–94 years. In the subgroup of 1677 participants in whom auscultation of the lungs was performed to determine the presence of heart failure mean age was lower, the percentage men was higher, and the prevalence of cardiac disease and hypertension was lower compared to the complete Rotterdam Study cohort.

Prevalence of heart failure

Table 2 shows the age- and sex-specific percentages of subjects who were classified as having heart failure. The overall prevalence of heart failure in persons aged 55 years or over was 3·9% (95% CI 3·0–4·7) based on persons for whom complete data were available. The prevalence increased with age, with the exception of the highest age group in men. No relevant differences in overall age-adjusted prevalences of heart failure in men and women, either for those who underwent auscultation ($P=0·26$) or for those who did not ($P=0·83$), were observed.

Systolic function

In 2823 persons, M-mode recordings were made to measure left ventricular systolic function (Table 3). In 556 participants (19·7%) M-mode registrations were

Table 1 Characteristics of participants

	Rotterdam Study cohort aged 55–94 years	Assessment of heart failure	Auscultation performed*
n	7939	5540	1677
Age (years)	70·5 ± 9·6	68·9 ± 8·7	66·2 ± 8·2
Women (%)	4839 (61)	3289 (59)	898 (54)
Height (cm)	167 ± 10	166 ± 9	169 ± 10
Weight (kg)	73 ± 12	73 ± 12	74 ± 12
Heart rate (beats . min^{-1})	71 ± 13	71 ± 13	70 ± 13
Systolic blood pressure (mmHg)	139 ± 22	139 ± 22	140 ± 23
Diastolic blood pressure (mmHg)	74 ± 12	74 ± 12	75 ± 12
Myocardial infarction (%)†	747 (11)	611 (11)	125 (7)
Angina pectoris (%)‡	525 (7)	392 (7)	98 (6)
Hypertension (%)§	2893 (36)	1678 (30)	497 (30)
Diabetes mellitus (%)	781 (10)	562 (10)	141 (9)
On cardiovascular medication (%)‖	2931 (38)	1948 (36)	491 (30)
On pulmonary medication (%)¶	434 (6)	285 (5)	58 (3)

Values are mean values ± SD unless otherwise indicated.
*Auscultation performed for the assessment of heart failure (see text).
†Myocardial infarction by ECG or history.
‡Angina pectoris assessed by means of the WHO questionnaire[17].
§On antihypertensive medication or systolic BP >=160 mmHg or diastolic BP >=90 mmHg.
‖Category c (cardiac medication) and/or b04 (lipid lowering agents), Anatomical Therapeutic Chemical (ATC) classification index[18].
¶Code r03, ATC classification index.

deemed inadequate to reliably measure left ventricular dimensions. Persons in whom M-mode registrations were unsuccessful were more likely to be older, to have a higher body mass index and to use medication for chronic obstructive pulmonary disease. Cardiovascular disease and diabetes were also more common in participants with an inadequate echocardiographic window.

The gender-specific distribution of fractional shortening in 2267 participants (mean age 65·7 ± 7·4 years, 1028 men) is shown in Fig. 2. The percentage with impaired left ventricular systolic function — defined as fractional shortening <=25% — was 5·5 (95% CI 4·1–7·0) in men and 2·2 (95% CI 1·4–3·2) in women (Table 4). The age-adjusted prevalence of left ventricular systolic dysfunction was approximately 2·5 times higher in men (OR 2·7, 95% CI 1·7–4·3). Fractional shortening did not change appreciably with age, but was on average somewhat higher in women than in men (Fig. 3). Persons with impaired left ventricular systolic function had more frequently sustained a myocardial infarction, undergone coronary bypass surgery or PTCA, and were more likely to have angina pectoris (Table 5).

The relationship between left ventricular function and symptoms and signs of heart failure was explored in 1698 participants (age 65·4 ± 7·3 years, 771 men) in whom information on presence of heart failure and M-mode data was available. Of the 35 persons deemed to have heart failure by symptoms and signs, only 10 (29%, 95% CI 15–46%) had M-mode echocardiographic evidence of left ventricular systolic dysfunction (Table 6). More importantly, of 60 persons with left ventricular systolic dysfunction only 24 (40%, 95% CI 28–53%) were found to have at least one of the cardinal signs or symptoms of heart failure (shortness of breath, ankle edema or pulmonary crepitations).

Discussion

The overall prevalence of heart failure in our population-based study was estimated at 3·9% and the age-adjusted prevalence of heart failure did not differ between men and women. A consistent and rapid increase in the prevalence of heart failure with age was observed. Left ventricular systolic function, measured by fractional shortening, did not decrease appreciably with age. The prevalence of impaired left ventricular systolic function was 3·7%, and about 2·5 times higher (5·5%) in men than in women (2·2%). Sixty percent of persons with left ventricular systolic dysfunction had no shortness of breath, ankle oedema or pulmonary crepitations.

The diagnosis of heart failure is fraught with difficulties. Most population-based studies employ a combination of medical history, physical examination, electrocardiography and chest X-ray to detect heart failure, although some have relied solely on drug prescription data[6,21]. We used a previously validated combination of signs and symptoms, that bears resemblance to the definition of heart failure proposed by the Task Force on Heart Failure of the European Society of Cardiology[6,8]. In addition, use of medication for heart failure was verified as symptoms and signs may be less prominent in stable patients on heart failure medication. Ideally, each person should undergo a complete comprehensive cardiovascular examination, including echocardiography, and the presence of heart failure should be

Table 2 Prevalence (%) of heart failure in the Rotterdam Study (95% confidence intervals in parentheses)

Age (years)	Men				Women				Total			
	Complete score		No auscultation*		Complete score		No auscultation		Complete score		No auscultation	
	n	Heart failure	n	Heart failure	n	Heart failure	n	Heart failure	n	Heart failure	n	Heart failure
55–64	420	0·7 (0·1–2·1)	481	0·8 (0·2–2·1)	484	0·6 (0·1–1·8)	741	0·3 (0·0–0·9)	904	0·7 (0·2–1·4)	1222	0·5 (0·2–1·1)
65–74	273	3·7 (1·8–6·6)	615	3·7 (2·4–5·6)	255	1·6 (0·4–3·9)	905	2·8 (1·8–4·1)	528	2·7 (1·5–4·4)	1520	3·2 (2·3–4·2)
75–84	69	14·4 (7·2–25·1)	326	5·5 (3·3–8·6)	116	12·1 (6·7–19·4)	592	6·8 (4·9–9·1)	185	13·0 (8·5–18·7)	918	6·3 (4·8–8·1)
85–94	17	5·9 (0·1–28·7)	50	8·0 (2·2–19·2)	43	14·0 (5·3–27·9)	153	15·7 (10·3–22·4)	60	11·7 (4·8–22·6)	203	13·8 (9·4–19·3)
Total	779	3·1 (2·0–4·5)	1472	3·3 (2·5–4·4)	898	3·0 (2·0–4·3)	2391	3·8 (3·1–4·7)	1677	3·0 (2·3–4·0)	3863	3·6 (3·0–4·2)
Adjusted		3·7 (2·5–4·9)†		3·1 (2·2–4·0)†		4·0 (2·9–5·1)‡		3·5 (2·8–4·3)‡		3·9 (3·0–4·7)¶		3·4 (2·8–4·0)¶
Mean age (SE)		65·7 ± 0·3		69·4 ± 0·2		66·6 ± 0·3		70·5 ± 0·2		66·2 ± 0·2		70·1 ± 0·1

*No auscultation performed.
†Age-adjusted to age distribution of all male participants (68·1 ± 8·0 years).
‡Age-adjusted to age distribution of all female participants (69·6 ± 8·7 years).
¶Age-adjusted to age distribution of all participants (68·9 ± 8·7 years).

Table 3 Characteristics of participants who underwent echocardiography

	Quality of M-mode echocardiography to determine fractional shortening		*P**
	Adequate	Inadequate	
n	2267	556	
Age (years)	65·7 ± 7·4	70·1 ± 8·3	<0·001
Women (%)	1239 (55)	288 (52)	ns
Body mass index (kg . m^{-2})	26·0 ± 4·1	26·9 ± 4	<0·001
Heart rate (beats . min^{-1})	69 ± 12	73 ± 13	<0·001
Systolic blood pressure (mmHg)	138 ± 22	144 ± 22	<0·001
Diastolic blood pressure (mmHg)	74 ± 12	75 ± 11	0·007
Myocardial infarction (%)†	173 (8)	70 (13)	<0·001
Angina pectoris (%)‡	133 (6)	37 (7)	ns
Hypertension (%)§	560 (25)	184 (33)	<0·001
Diabetes mellitus (%)	157 (7)	65 (12)	<0·001
On cardiovascular medication (%)‖	684 (31)	200 (36)	0·011
On pulmonary medication (%)¶	76 (3)	34 (6)	0·003

Values are mean ± SD unless otherwise indicated.
*Student's t-test or chi-squared test.
†Myocardial infarction by ECG or history.
‡Angina pectoris assessed by means of the WHO questionnaire[17].
§On antihypertensive medication or systolic BP >=160 mmHg or diastolic BP >=90 mmHg.
‖Category c (cardiac medication) and/or b04 (lipid lowering agents), Anatomical Therapeutic Chemical (ATC) classification index[18].
¶Code r03, ATC classification index.

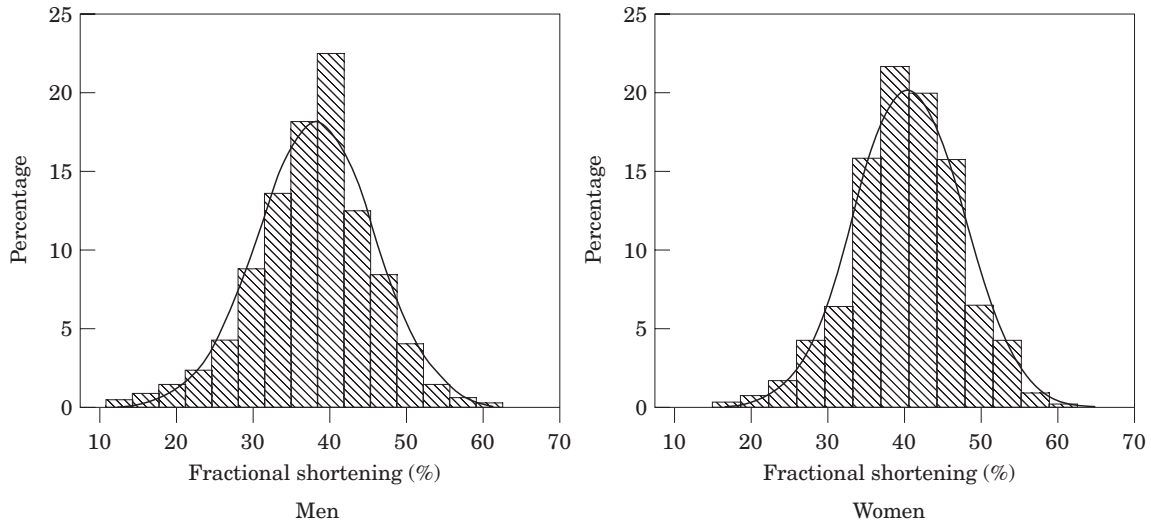

Figure 2 **Gender-specific distribution of fractional shortening, a measure of left ventricular systolic function, in 2267 participants of the Rotterdam Study. 1028 men, mean age ± 1 SD: 65·5 ± 7 years, mean fractional shortening ± 1 SD: 38 ± 8%. 1239 women, mean age ± 1 SD: 65·8 ± 8 years, mean fractional shortening ± 1 SD: 40 ± 7%.**

established by consensus evaluation of available information by a panel of experts. This approach has not been used to date in population-based studies of the prevalence of heart failure. In a study of incident heart failure that is currently carried out in the framework of the Rotterdam Study, however, this strategy is used, as is the case in the Hillingdon Heart failure study[22].

Initially, auscultation of the lungs was not part of the routine Rotterdam Study examination and was thus performed only in 1677 of 5540 participants for whom otherwise complete information was available. However, given the relatively low proportion of subjects found to have crepitations, it is not surprising that age-adjusted prevalence estimates in those who underwent auscultation did not differ appreciably from those who did not. The overall response in our study was good, but non-response may have led to an underestimation of the prevalence of heart failure and left ventricular systolic dysfunction, as response rates were lower in higher age groups and as it is conceivable that

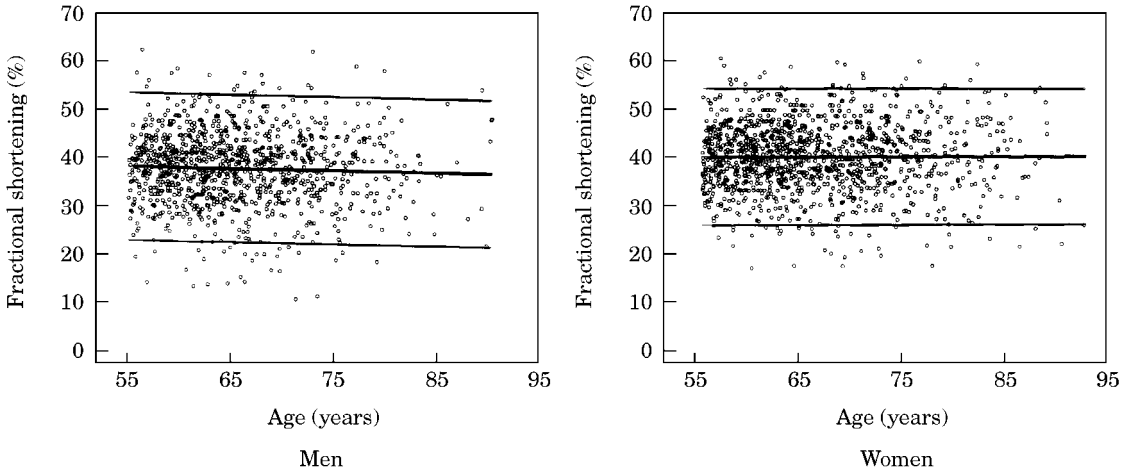

Figure 3 **Gender specific relation of fractional shortening to age in 2267 Rotterdam Study participants. Regression lines with 95% confidence intervals are indicated (solid lines).**

Table 4 Prevalence of left ventricular systolic dysfunction (fractional shortening <=25%) in 2267 Rotterdam Study participants (95% confidence intervals in parentheses)

Age (years)	Men		Women		Total	
	n	LV systolic dysfunction	n	LV systolic dysfunction	n	LV systolic dysfunction
55–64	548	3·7 (2·2–5·6)	674	1·2 (0·5–2·3)	1230	2·3 (1·5–3·3)
65–74	368	7·6 (5·1–10·8)	388	3·1 (1·6–5·3)	756	5·3 (3·8–7·1)
75–84	102	6·9 (2·8–13·6)	150	3·3 (1·1–7·6)	252	4·8 (2·5–8·2)
85–94	10	10·0 (2·5–44·4)	19	10·5 (1·3–33·1)	29	10·3 (2·0–27·3)
Total	1028	5·5 (4·1–7·0)	1239	2·2 (1·4–3·2)	2267	3·7 (2·9–4·5)

diseased persons were less likely to participate. In addition, had all 5540 participants undergone auscultation of the lungs to assess the presence of heart failure, prevalence estimates would have slightly increased as well.

Due to the size of our study population, left ventricular systolic function was estimated by fractional shortening, rather than by 2D echocardiographic determination of ejection fraction. In the absence of major wall motion abnormalities, fractional shortening can be assumed to reliably reflect left ventricular systolic function[20]. Indeed, objective evidence of cardiac disease was more frequently observed in participants with impaired left ventricular function (Table 5).

Several studies on the prevalence of heart failure in the United States and Europe have been reported[3,6]. Most studies were carried out a in general practice and only a few can be regarded as truly population-based. An increase of heart failure with age is a consistent finding, although the Cardiovascular Health Study found that prevalence of heart failure did not increase further in persons over 85 years[23]. Some studies reported a higher overall prevalence in men[3,4,23] whereas others found a higher overall prevalence in women[24–27]. Although differences in case finding procedures and diagnostic criteria may hamper comparison between studies, our prevalence estimates are similar to estimates from recent studies in general practice in the Netherlands and U.K. (Table 7)[25,26,28]. Higher prevalence estimates were reported by a recent population-based study in the U.S.A.[24].

Our findings in persons aged 55–94 years confirm and expand the notion from the Glasgow MONICA risk factor survey that left ventricular systolic dysfunction is common, more frequently observed in men and very often asymptomatic[15]. The overall prevalence of left ventricular systolic dysfunction in a group of 1467 persons aged 25–74 years was 2·9% in Glasgow. Left ventricular dysfunction was asymptomatic in approximately half of the cases. The lower prevalence of left ventricular systolic dysfunction in Glasgow compared to Rotterdam probably reflects the younger age of participants and the stricter definition of left ventricular dysfunction — ejection fraction <30%, estimated by 2D echocardiography — in Glasgow.

Due to a limited availability of echotechnicians echocardiographic information is only available for 2823 participants. Although no prior rules were set for the performance of echocardiography in certain subgroups, our findings may represent a conservative estimate of

Table 5 Characteristics of participants according to left ventricular systolic function

	Left ventricular systolic function		*P**
	Normal Fractional shortening >25%	Impaired Fractional shortening <=25%	
n	2184	83	
Age (years)	65·6 ± 7·4	68·3 ± 7·7	0·001
Women (%)	1212 (55)	27 (33)	<0·001
Body mass index (kg . m^{-2})	26·0 ± 4·1	26·1 ± 3	ns
Heart rate (beats . min^{-1})	69 ± 12	73 ± 16	0·007
Systolic blood pressure (mmHg)	138 ± 22	139 ± 24	ns
Diastolic blood pressure (mmHg)	74 ± 12	75 ± 11	ns
Myocardial infarction (%)†	153 (7)	20 (24)	<0·001
Angina pectoris (%)‡	119 (5)	14 (17)	<0·001
PTCA (%)§	18 (1)	3 (4)	0·01
Coronary artery bypass surgery (%)	37 (2)	9 (11)	<0·001
On cardiovascular medication (%)‖	638 (30)	46 (57)	<0·001
On pulmonary medication (%)¶	69 (3)	7 (9)	0·008

Values are mean values ± SD unless otherwise indicated.
*Student's t-text or chi-squared test.
†Myocardial infarction by ECG or history.
‡Angina pectoris assessed by means of the WHO questionnaire[17].
§Percutaneous transluminal coronary angioplasty.
‖Category c (cardiac medication) and/or b04 (lipid lowering agents), Anatomical Therapeutic Chemical (ATC) classification index[18].
¶Code r03, ATC classification index.

Table 6 Relationship of heart failure to left ventricular systolic dysfunction in 1698 Rotterdam Study participants

Heart failure	Left ventricular systolic function		Total
	Normal Fractional shortening >25%	Impaired Fractional shortening <=25%	
Heart failure absent	1613	50	1663 (98%)
Heart failure present	25	10	35 (2%)
Total	1638 (96%)	60 (4%)	1698

Table 7 Prevalence of heart failure in the Rotterdam Study, compared to other recent studies

Age (years)	Rotterdam Study (The Netherlands)			General practice[25] (United Kingdom)	NHANES[24] (U.S.A.)			Transition[28] (The Netherlands)			Nijmegen[26] (The Netherlands)		
	Men	Women	All	All	Men	Women	All	Men	Women	All	Men	Women	All
55–64	0·7	0·6	0·7		4·5	3·0	3·7						
65–74	3·7	1·6	2·7	2·7	4·9	4·3	4·5	3·3	2·9	3·1	4·9	3·2	4·0
75–84	14·4	12·1	13·0	7·4									

left ventricular systolic dysfunction in the population as the participants who underwent echocardiography tended to be younger and were less likely to have cardiac disease as compared to the overall study group (Tables 3 and 5). Moreover, systolic dysfunction may be more frequently observed in participants whose echocardiogram was of inadequate quality and in non-responders. On the other hand, in large population-based studies, one should be aware of the strong influence of regression to the mean[29]. Upon remeasurement, persons with a low fractional shortening will tend to show an upward shift towards the mean fractional shortening, and thus may not be regarded as truly having left ventricular systolic dysfunction.

We did not observe a difference in (age adjusted) prevalence of heart failure between men and women. Selective non-response of elderly men, accounting for the levelling off of prevalence in men older than 85 years, may have led to an underestimation of prevalence in men, whereas selective misclassification of heart failure

in women[30], who are, for example, more likely to have non-cardiac oedema, may have inflated the prevalence in women. Nevertheless, it is quite well possible that the prevalence difference between women and men is minimal. Age-adjusted discharge rates for heart failure in the Netherlands were at times higher in women than in men in the 1980s[5].

Notwithstanding the similar prevalence of heart failure in men and women, systolic dysfunction was more frequently observed in men. Although overdiagnosing heart failure may more readily occur in women[30], heart failure in the presence of normal left ventricular systolic function, termed 'diastolic' heart failure by some authors, appears to be more frequently observed in women according to a recent report from the Framingham Heart Study[31].

In conclusion, heart failure has an appreciable prevalence in the general population, that increases with age and does not differ markedly between men and women. Left ventricular systolic dysfunction is a common condition (prevalence 3·7%), that is more frequently observed in men than in women. The majority of persons with left ventricular systolic dysfunction show none of the cardinal symptoms or signs of heart failure and can be regarded as having asymptomatic left ventricular systolic dysfunction.

We would like to thank the participants of our study for their co-operation. We highly appreciate the contribution of the staff at the Rotterdam Study research centre.

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