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Gunilla Hollman and Margareta Kristenson

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The prevalence of the metabolic syndrome and its risk factors in a middle-aged Swedish population - mainly a function of overweight?

Gunilla Hollman, PhD

Department of Medicine and Care, Division of Nursing Sciences, Faculty of Health Sciences, Linköping University, 581 85 Linköping, Sweden.

Margareta Kristenson, Ass. professor

Department of Health and Society, Division of Preventive and Social Medicine, Faculty of Health Sciences, Linköping University,

581 85 Linköping, Sweden.

Corresponding author: Gunilla Hollman, Department of Medicine and Care, Division of Nursing Sciences, Faculty of Health Sciences, Linköping University, 851 85 Linköping, Sweden. E-mail: gunho@imv.liu.se, Telephone: +46 13 222115, fax: +46 13 149991.

Abstract

Background: The prevalence of obesity, one risk factor for developing the metabolic syndrome (MS), has increased during the last decades. It has therefore been assumed that the prevalence of MS would also increase.

Aims: The aim was to analyse the prevalence of MS and its risk factors in a middle-aged Swedish population.

Methods: Data were obtained between 2003 and 2004 from a random population based sample of 502 men and 505 women, 45-69 years old. Measures of plasma glucose, serum lipids, blood pressure, weight, height, waist circumference and self-reported data concerning presence of disease, medication and lifestyle were obtained.

Results: The prevalence of MS was 14.8 % among men and 15.3 % among women, with an increase by age among women only, 10 % to 25 % ($p=0.029$). Among individuals with MS the most frequent risk factor was large waist circumference, present in 85 % of men and 99 % of women, followed by high blood pressure, high triglycerides, high glucose and HDL cholesterol (38 % and 47 % respectively).

Conclusion: The prevalence of MS was 15 %, increasing with age only among women. Overweight was a dominant characteristic, and only half of the individuals with MS had glucose/HDL cholesterol levels beyond defined cut points of the syndrome.

Key words: Metabolic syndrome, prevalence, population

Introduction

The metabolic syndrome (MS) is a cluster of cardiovascular risk factors that identifies individuals at increased risk of cardiovascular disease (CVD). While there are several definitions at hand, all of them include the following factors: abdominal obesity, elevated blood pressure, high triglycerides, low high density cholesterol (HDL cholesterol) and signs of insulin resistance, such as high fasting plasma glucose [1]. According to the National Cholesterol Education Programme (NCEP) definition of MS, three of five risk factors should be present to identify MS [2]. A large body of research has focused on this syndrome and several studies have demonstrated an increased risk of CVD related to MS. In addition, the risk of CVD increased with increase in the number of risk factors [3-7], so that individuals with > 4 risk factors have a fivefold higher risk of developing CVD [2].

The prevalence of overweight and obesity has increased in Sweden during the last decades, both among adults and among adolescents and children. Mean body mass index (BMI) has increased over the years between 1985 and 2002 [8], and among adults, the prevalence of obesity has increased twofold between 1980 and 2003. Obesity is reported as the main cause of the rising prevalence of metabolic syndrome (MS) [1], and it could therefore be assumed that the prevalence of MS would also increase [9]. Few studies have, however, explored this question.

Data are also in place concerning the prevalence of other risk factors for developing MS. For Sweden, informative datasets are available from the MONICA studies, with data collected at two study centres; one in northern and one in south-western Sweden, both including data from individuals 25-64 years of age, and recent trends available for 1985-2002 (southwest) and 1986-2004 (north). For blood pressure, no significant changes were found during this period

in the south-western Swedish population, while in the northern part blood pressure levels decreased. Despite no significant changes being found in southwest Sweden for triglyceride levels, serum cholesterol levels showed a downward trend [10]. For HDL- cholesterol, no significant change has been reported for the southwest of Sweden [8] , while an increase was reported in comparison with the northern part [11]. No changes were found in the prevalence of diabetes mellitus [12].

The prevalence of MS varies worldwide. In European countries, the prevalence varies from 4-36 % depending on age and definition of MS [4, 13]. The prevalence of MS is reported to be highly age-dependent, increasing with increasing age [14-17], but seems to decline in the oldest population (> 70 years) [18]. Cultural factors are also important [15] and MS is becoming more prevalent in developing countries in the Middle East [16].

As obesity is an increasing problem in Sweden, the prevalence of MS could be expected to increase [8, 9]. Yet there are few recent studies about the prevalence of MS in the Swedish population. The purpose of this study was to analyse the prevalence of MS and its risk factors in a middle-aged Swedish normal population.

Methods

Subjects

This study is a part of a population-based study from a middle-aged Swedish population in a southeastern Swedish municipality, the LSH-study (Life conditions, Stress and Health) where life conditions are being studied in relation to coronary heart disease. Participants (502 men and 505 women, 45-69 years of age) were randomly drawn from the population, stratified according to the catchment areas of 10 different primary health care centres, gender and age at

5-year intervals. A letter of enquiry about willingness to participate was sent to potential participants. Signing a reply form represented informed consent. At the visit, information about the voluntariness of participating in the study was given verbally. Exclusion criteria were severe physical or mental disease or difficulties in understanding the Swedish language. One reminder was sent and those who did not answer the reminder were contacted by telephone. Response rate was 62 % (n=1007). The ethics committee, Faculty of Health and Science, Linköping University, approved the study.

Data collection

In order to ensure standardization of the data collection, nurses collecting data were trained together. Blood samples were drawn with the subjects fasting and analysed at the same laboratory. Plasma levels of glucose and lipids were analysed directly after sample collection. Analyses of triglycerides, total and HDL cholesterol levels were performed in the same, central, laboratory, using a spectrophotometric method (ADVIA 1650), and commercial reagents from Siemens Medical Solution Diagnostic AB. LDL-cholesterol was calculated using Friedewalds formula [19]. Plasma glucose levels were determined by the photometric method HemoCue. This was done at the local PHC's as these laboratories are accredited according to a quality assurance system demanding high inter-laboratory concordance of results i.e. CV less than 8 %.

Blood pressure was taken in the sitting position and measured with Omron M5-1 digital (mean of the last two of three measures); weight, length and waist circumference were also measured. Questionnaires concerning self-reported data, such as demographics, life style, medication and previous disease were filled in. In order to identify individuals with MS, the National Cholesterol Education Programme (NCEP) definition of MS was used, where three or more of the following risk factors should be present: 1) arterial blood pressure \geq 130/85

mmHg and/or antihypertensive medication, 2) waist circumference > 102 cm for men and > 88 cm for women, 3) triglycerides > 1.7 mmol/L, 4) HDL cholesterol < 1.0 mmol/L for men and < 1.29 mmol/L for women and 5) fasting plasma glucose \geq 6.1 mmol/L [2]. Individuals with diabetes mellitus were excluded.

Statistical analysis

Mean, standard deviation and percentage were used to describe characteristics of participants. Differences between two of the groups were, depending on data, assessed by Students t-test, Mann-Whitney U test, Chi-Square test and Fishers exact test. For descriptive data, age standardization was performed, and age effect was controlled using linear regression model. Anova test was used to compare the prevalence of MS between more than two groups. A p-value <0.05 was considered as significant.

Results

Of the 1007 individuals participating in the LSH-study 15.1 % fulfilled the criteria for MS, 14.8 % among men and 15.3 % among women. The prevalence increased with age, from 10 % among women aged 45-49, to 25 % among women aged 65-69 ($p=0.029$), with a variation from 12-18 %, but with no significant age effect for men ($p=0.826$). Accordingly, women with MS were older (59 ± 7 years) than women without MS, (56.7 ± 7 years) ($p=0.008$), with no difference among men ($p=0.617$). The prevalence of risk factors differed significantly between the participants with and those without MS ($p < 0.001$) (Table1).

In the total study population ($n=1007$), the most prevalent risk factors were high blood pressure, 45 % ($n=453$), high waist circumference, 33 % ($n=327$) and high triglycerides, 25 % ($n=252$). Twenty nine percent ($n=293$) had no risk factor, 29% had one risk factor, while two

risk factors were present in 20 % (n=195) (Figure 1). Of those having one risk factor, high blood pressure was the most frequent, while high blood pressure together with high waist circumference were the most common among those with two risk factors present.

The most prevalent risk factors among individuals with MS were, in descending order, high waist circumference (men 85 %, n=62; women, 99 %, n= 75), high blood pressure (men 85 %, n=62; women 79 %, n=60), high triglyceride levels (men 78 %, n=57; women 54 %, n= 41), high plasma glucose (men 45 %, n=33; women 54 %, n= 41) and low HDL-cholesterol (men 38 %, n=28; women 47 %, n= 36) (Figure 2).

Thirty-one percent (n=46) of the individuals with MS and 15 % (n=123) of those without MS, were on medication for high blood pressure, while 13.4 %, (n=20) and 7 % (n=59), respectively, were on lipid lowering treatment. There was no significant difference between men and women with regard to medication. History of myocardial infarction was more common in men with MS (8 %, n=6), compared with men without MS (2 %, n=10) (p=0.023), with no corresponding difference among women. For angina pectoris and stroke no differences were seen.

Discussion

We found, using the NCEP definition of MS, and data collected 2003-2004 from a middle-aged Swedish population, a prevalence of 15 %, almost the same for men and women (14.8 % men and 15.3 % women). We also found an increase in the prevalence of MS with increasing age among women. The latter is in line with results from a middle-aged Finish population using the WHO definition of MS (i.e. glucose intolerance/insulin resistance, and 2 of the

following: Obesity, dyslipidemia, hypertension, microalbuminuria) where a concordant increase of MS with age among women has been reported [20].

We have found three Swedish datasets with comparable data that applied the NCEP definition (Table 2). Firstly, using data from 1994 to 1999, (611 women and 524 men, range 37-61 years of age), Larsson et al [21] reported a prevalence of 7 % and 11 % among women ≤ 49.9 and ≥ 49.9 years old respectively. The LSH-data for the corresponding age groups were 10 % and 15 %, respectively. For men ≤ 49.9 and ≥ 49.9 years of age, Larsson et al reported a prevalence of 10 % and 18 % respectively, while LSH-data for the corresponding age-groups were 13 % and 17 %. Secondly, using data from 1995-1997, (316 men, 58 years old), Wallenfeldt et al [22] reported a prevalence of 19 %, while LSH-data for men aged 55-59 showed a prevalence of 16 % . In data from 1997-1999, Sjögren et al 2005 [23], using the NCEP definition, report a prevalence of 8 % (n=289) in 62-64 year old men [23], while comparable LSH-data (men 60-64 years) was 8 %. Newly published population based data by Nilsson et al [24], from 1992-1995, (n=5047, 66 % women, range 46-68 years) showed a prevalence of 21 %, while in LSH data adjusted to their definition the prevalence was 25 %. According to the definition of MS provided by Horsten et al [25] and Wamala et al [26], with data from 1993, (300 women, 31-65 years old), the prevalence was 12 % in women, while LSH-data, using the same definition, was 22 % for women 45-69 years old.

Nilsson et al [24] also report prevalence of MS according to the new definition by the International Diabetes Federation (IDF) on 22 %, again data from 1992-1995, (n=5047, 66 % women, range 46-68 years). Corresponding prevalence based on LSH data, adjusted to the IDF definition, was 32 %. This figure may, however, be overestimated as difference with type 1 diabetes could not be differentiated from type II diabetes.

In data on Danish women 38-48 years of age, from 2000-2002, the prevalence of MS was 14.8 % [28] in contrast to our result of 10 % in the age group 45-49 year old women.

Sigurdardottir et al [29] found, using the NCEP definition (including individuals with diabetes mellitus), a prevalence of 29 % (n=513) in men 61 years old. When including individuals with diabetes mellitus in the LSH-study, the prevalence in men in this age group was 21 %. In a finish cohort of 42-60 year-old men, with present CVD excluded and data from 1998, Lakka [30], reported a prevalence of 8 %, in comparable LSH-data, the prevalence was 13.5 % among men.

Thus, compared with earlier Swedish data, using the NCEP – but also the IDF definition and the same inclusion criteria, the prevalence of MS seems to have increased over the last decade in a Swedish middle-aged population. Comparison with other studies is, however, often difficult, due to differences in inclusion criteria, ages and, especially due to different definitions of MS. To allow for more precise estimates on differences over time and between populations´ further studies with strict definitions and inclusion criteria are needed.

Overweight, in terms of high waist circumference, emerged as the most prevalent risk factor, present in 85 % of men and 99 % of women with MS. This dominance of overweight has been reported in several studies; high waist-hip-ratio (WHR) was reported among 97 % and 75 % of 45-64 year old finish men and women with MS, respectively (data from 1992, MS defined by the WHO definition) [20] and all subjects, 62-64 year old men, studied by Sjögren et al [24] had high waist circumference. In parallel, overweight and obesity in Swedish population has increased two-fold in both men and women over the last 20 years [8-10] as has the prevalence of $WHR > 85$ increased from 12 % to 23 % in the age-group of 25-64 years old women [8]. This rise in overweight and obesity is a threat to population health and

cardiovascular winnings can be gained by only a 10 % decrease of weight [8]. While both BMI and waist circumference are well validated methods for identifying individuals who are overweight [8], waist circumference is argued to be a better risk marker for CVD and diabetes mellitus [8]. Blood pressure was the second most prevalent risk factor among both men and women with MS and increased triglyceride levels was the third most common factor; present among 78 % of men and 54 % of women with MS. The latter figures are lower compared to data reported by Larsson et al [21], where 88 % of men and 71 % of women had increased triglyceride levels. The NCEP definition includes medical treatment for hypertension in addition to levels of blood pressure but has no criteria for lipid treatment, which could influence estimates of prevalence of dyslipidemia.

A remarkably small proportion (only 50 %) of individuals with MS had glucose levels above the cut point for inclusion in the syndrome using the NCEP definition of MS. Insulin resistance is regarded as a central factor in the MS. One might question if our finding is an illustration of the NCEP definition of MS being less sensitive in capturing individuals with insulin resistance, or if insulin resistance has not increased among Swedish adults in the same manner as among nondiabetic adults in the US population, shown by Li et al [31].

For practical reasons, in this population-based study of 1007 participants, glucose intolerance/insulin resistance was not investigated and we could not, therefore, compare data with studies using glucose intolerance as a criterion in the definition of MS, as in the World Health Organization (WHO) and European Group of Insulin resistance (EGIR).

As discussed above comparing with other studies is often problematic due to differences in inclusion criteria, ages and, especially due to different definitions of MS. We have mainly

compared our results to studies using the same definition of MS (NCEP), carefully looked at inclusion criteria, and made subgroup analyses to achieve (age) groups comparable to studies we compare our results with. The response rate in this population-based study was 62 % and the sampling procedure was stratified for age and sex. While data are representative of the population as to employment status, occupational status and immigrant status, it is well known that less healthy people tend to be over represented among people not participating in population based studies, and therefore the true prevalence may be even higher. On the other hand, in cross-sectional study where all data are based on single measurements there is also a risk of overestimation. Finally, as discussed above, it is clear that several of risk factors in MS are susceptible to influence of medication. While the NCEP definition exclude individuals with diabetes and include individuals with hypertension and /or medical treatment for hypertension there are no such criteria for lipid lowering or other drugs.

MS as a “syndrome” has recently been challenged as not yet being sufficiently grounded by well-defined criteria [1, 31]. It has also been argued that MS as a syndrome is an uncertain predictor of CVD risk as the separate risk factor for CVD continue to represent stronger predictors than MS does [31]. One example of this is the observation that increasing obesity was associated with increasing mortality even in women below middle age (30-50 years) [32]. Our data may also serve as a reminder of the heterogeneity of this syndrome, where some risk factors were present among most of the individuals’ i.e. high waist circumference and hypertension, while other risk factors were much less frequent.

Conclusion

The prevalence of MS in this middle-aged population in the southeast of Sweden was 15 %, among both men and women. Comparisons with previously published data suggest that the

prevalence of MS has increased among women over recent years. The most prominent risk factor was high waist circumference and only half of the individuals with MS had high glucose/low HDL cholesterol levels.

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Table 1. Characteristics of the study population, mean (m), standard deviation (SD) and percentage (%). P-value for difference between men and women with and without MS.

	Study population men, n=502	Study population women, n=505	Men with MS, n=73	Men without MS, n=420	p-value	Women with MS, n=76	Women without MS, n=420	p-value
Age, years m ±SD	57 ± 7	57 ± 7	57.3±7.0	56.8±7.1	0.617	59.0±7.0	56.7 ± 7.0	0.008
Body Mass Index, kg/m ² , m ± SD	27.1 ± 3.8	26.5 ± 4.8	31.6 ±1.0	26.4 ±3.2	<0.0001	31.4 ± 4.6	25.7 ± 4.4	< 0.0001
Waist circumference, cm, m ± SD	98 ± 10	87 ± 12	110 ± 10	96 ± 9	< 0.0001	100 ± 10	84 ± 11	< 0.0001
Systolic blood pressure, mmHg, m ± SD	136 ± 19	131 ± 21	147 ± 19	134 ± 19	< 0.0001	144 ± 19	129 ± 20	< 0.0001
Diastolic blood pressure, mmHg, m ± SD	86 ± 12	83 ± 11	92 ±12	85 ± 11	< 0.0001	92 ± 10	82 ± 11	< 0.0001
Triglycerides, mmol/l, m ± SD	1.5 ± 1.0	1.3 ± 0.8	2.4 ± 1.5	1.4 ± 0.7	< 0.0001	1.8 ± 0.9	1.2 ± 0.7	< 0.0001
HDL cholesterol, mmol/l, m ± SD	1.4 ± 0.3	1.7± 0.4	1.2 ± 0.2	1.5 ± 0.3	< 0.0001	1.3 ± 0.3	1.7 ± 0.3	< 0.0001
Fasting plasma glucose, mmol/l, m ± SD	5.6 ± 1.1	5.5 ± 1.3	6.0 ± 1.2	5.5 ± 1.1	< 0.0001	6.0 ± 0.9	5.4 ± 1.4	< 0.0001
Total Cholesterol, mmol/l, m ± SD	5.4 ± 0.9	5.6 ± 1.0	5.3 ± 1.1	5.4 ± 0.9	0.349	5.5 ± 1.0	5.6 ± 1.0	0.549
LDL Cholesterol, mmol/l, m ± SD	3.3 ± 0.9	3.3 ± 0.8	3.1 ± 0.9	3.4 ± 0.8	0.036	3.4 ± 0.8	3.3 ± 0.8	0.661
Lipid lowering treatment, % (n)	8.6 (36)	5.5 (23)	20.5 (15)	10.2 (51)	0.002	6.6 (5)	5.5 (28)	0.701
* Hypertension, % (n)	28.3 (142)	25.0 (126)	45.2 (33)	26.0 (109)	<0.0001	43.4 (33)	21.7 (91)	< 0.0001
Hypertension and antihypertensive treatment, % (n)	17.1 (86)	16.6 (84)	28.8 (21)	15.5 (65)	0.006	32.9 (25)	13.8 (58)	< 0.0001
* Diabetes, % (n)	6.0 (30)	6.3 (32)	0	6.4 (27)	0.022	0	7.6 (32)	0.014
Smoking, % (n)	14.7 (74)	15.4 (78)	11.0 (8)	15.2 (64)	0.284	14.5 (11)	15.5 (65)	0.985

* Respondents self reported that they had hypertension and diabetes diagnosed by a physician.

Table 2. Prevalence of the metabolic syndrome (MS), in percent (%). Results from the LSH study (in corresponding age and gender groups) in comparison with previous Swedish studies according to different definitions of MS.

Data source and year of data collection,	Women aged 37 - 49.9	Women aged 49.9 - 61	Men aged 37 - 49.9	Men aged 49.9 - 61	Men aged 58	Men aged 62 – 64	Women and men aged 46-68 *	Women aged 31-65 **	Women and men aged 46-68***
<i>MS according to the NCEP definition</i>									
LSH study, 2004	10 %	15 %	13 %	17 %	16 %	8 %			
Larsson et al, 1994-1999	7 %	11 %	10 %	18 %					
Wallenfeldt et al, 1995-1997					19 %				
Sjögren et al, 1997-1999						8 %			
<i>MS according to a modified NCEP definition</i>									
LSH study, 2004							25 %		
Nilsson et al, 1992-1995							21 %		
<i>MS according to the definition by Horsten et al, Wamala et al</i>									
LSH study, 2004								22 %	
Horsten et al / Wamala et al, 1993								12 %	
<i>MS according to the IDF definition</i>									
LSH study, 2004									32 %
Nilsson et al, 1992-1995									22 %

Studies by Larsson et al [21], Wallenfeldt et al [22], Sjögren et al [23] are based on the NCEP definition of MS. * For comparison with Nilsson et al [24] LSH data was adjusted to the NCEP definition with plasma glucose ≥ 5.6 mmol/L. **For comparison with results of Horsten et al [25] and Wamala et al [26], the LSH data was adjusted according to the definition used in their studies. ***For comparison with the IDF definition, the LSH data was adjusted according to the IDF definition.

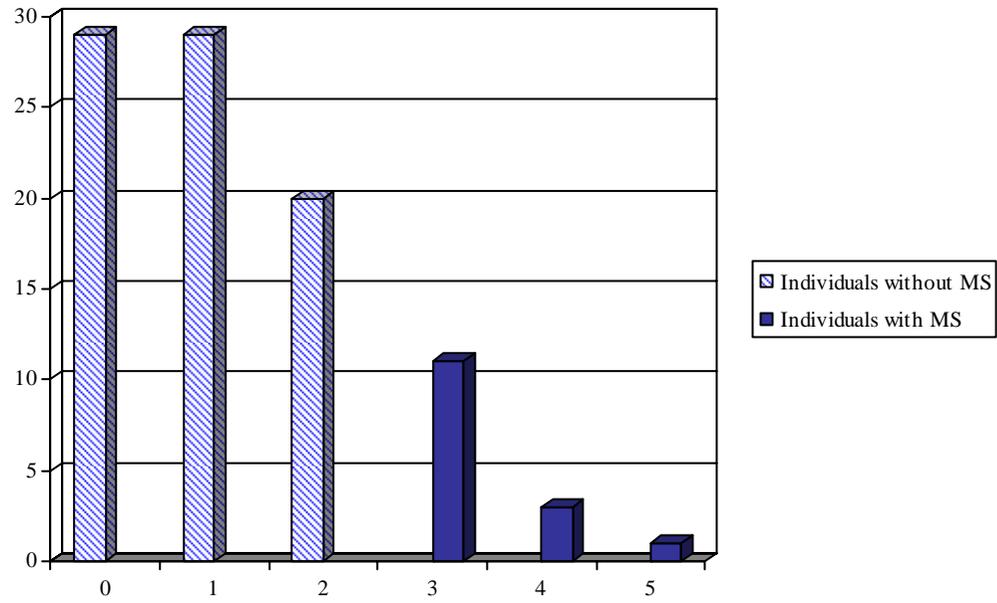


Figure 1. Proportion of participants (n=1007), with 0-5 risk factors for the metabolic syndrome (MS).

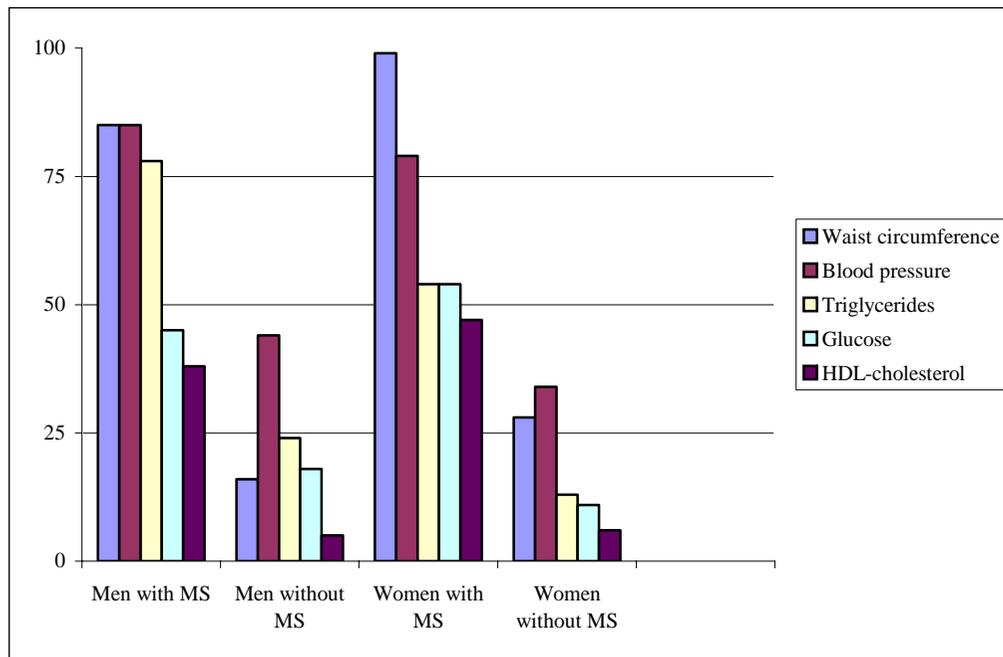


Figure 2. Prevalence of risk factors for the metabolic syndrome (MS) among men and women with and without MS.

Cut off values for waist circumference > 102 cm for men and > 88 cm for women, blood pressure \geq 130/80 mmHg, triglycerides \geq 1.7 mmol/L, HDL cholesterol, < 1.0 mmol/L for men and < 1.3 mmol/L for women, fasting plasma glucose \geq 6.1 mmol/L.