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Masculine gender affects sex differences in the prevalence of chronic health problems - *The Doetinchem Cohort Study*

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ABSTRACT

Both (biological) sex and (socio-cultural) gender are relevant for health but in large-scale studies specific gender measures are lacking. Using a masculine gender-score based on 'traditional masculine-connotated aspects of everyday life', we explored how masculinity may affect sex differences in the prevalence of chronic health problems. We used cross-sectional data (2008–2012) from the Doetinchem Cohort Study to calculate a masculine gender-score (range 0–19) using information on work, informal care, lifestyle and emotions. The sample consisted of 1900 men and 2117 women (age: 40–80). Multivariable logistic regressions including age and SES were used to examine the role of masculine gender on sex differences in the prevalence of diabetes, coronary heart disease, CVA, arthritis, chronic pain and migraine. Men had higher masculine gender-scores than women (12.2 vs 9.1). For both sexes, a higher masculine gender-score was associated with lower prevalence of chronic health problems. Diabetes, CHD, and CVA were more prevalent in men, and gender-adjustment resulted in greater sex differences: e.g. for diabetes the OR_{sex} changed from 1.21 (95 %CI 0.93–1.58) to 1.60 (95 %CI 1.18–2.17). Arthritis, chronic pain, and migraine were more prevalent in women, and gender-adjustment resulted in smaller sex differences: e.g. for chronic pain the OR_{sex} changed from 0.53 (95 %CI 0.45–0.60) to 0.73 (95 %CI 0.63–0.86). Gender measured as 'everyday masculinity' is associated with lower prevalence of chronic health problems in both men and women. Our findings also suggest that the commonly found sex differences in the prevalence of chronic health problems have a large gender component.

1. Introduction

Sex and gender are related but distinct concepts though often used interchangeably in health research (e.g. Hammarström et al., 2014; Hammarström and Annandale, 2012; Krieger, 2013; Europe, 2020). Sex refers to biological and physiological characteristics of an individual, such as hormones, genes, and anatomy (Krieger, 2013; Europe, 2020). For 'sex' the sex assigned at birth (men or women) is often used as the basis for classification, but more diversity is present. Gender is a socio-cultural construct and associated with social expectations about how men and women are supposed to think and (inter-)act in society (Europe, 2020). In Western societies*;* masculinity, involving agentic characteristics (e.g. invulnerability and independence), is expected in men, and femininity, involving communal characteristics (e.g. selflessness, caring), is expected in women (Hammarström et al., 2014; Hammarström and Annandale, 2012; Krieger, 2013; Connell, 2012; West and Zimmerman, 1987; Eagly and Steffen, 1984). The construction of gender is determined by societal norms and can be recognized in aspects of everyday life (e.g. division of (care) work (Connell, 2012; Presland and Antill, 1987). Also, gender is often viewed binary in health research, though a broad range is more realistic.

In the past, clinical trials were primarily based on young male respondents; this prevailing androcentric norm was translated to both men and women resulting in unbalanced disease management between men

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Table 1
Characteristics of the Doetinchem Cohort study population (measurement round five) by sex: socio-demographics, masculine gender-score variables, somatic chronic health problems.

	Men (n = 1900)	Women (n = 2117)
Age (mean ± SD)	60.5 ± 9.5	59.4 ± 9.7
Socioeconomic status (SES) (%)		
	39.3	52.2
Low	33.0	26.9
Intermediate	27.7	20.9
High		
Gender (mean ± SD)	12.2 ± 2.5	9.2 ± 2.4
Division of paid work compared with partner (%)		
Partner most responsible for paid work	33.1	45.9
Equal division in paid work	28.1	23.1
Respondent most responsible for paid work/no partner	38.8	31.0
Education level compared with partner (%)		
Respondent has a lower level than partner	9.4	24.1
Same level of education or no partner	55.3	52.5
Respondent has a higher level than partner	35.3	23.4
Average hours spent weekly on household chores(%)		
>= 10 h	12.5	64.1
5–10 h	21.1	23.5
<5 h	66.4	12.5
Hours spent weekly doing odd jobs (%)		
<5 h	80.6	96.8
5–10 h	9.7	2.3
>= 10 h	9.7	0.9
Taking care of sick people (other than partner) (%)		
(Almost) never	96.4	87.8
Couple of times every month	1.1	2.6
Daily, weekly	2.6	9.6
Smoking cigars or pipe (%)		
Yes	7.3	2.4
Type of alcoholic beverage (%)		
Not or almost never drinking alcohol	19.3	42.0
Wine and / or port sherry vermouth	16.0	46.8
Beer and / or liquor	64.7	11.2
Physical intensity of sport (excl. work) (%)		
Not exercising or light intensity	49.8	
Moderate	19.2	45.7
Heavy or masculine type of sports	31.0	35.6
		18.7
Limited in work/activities due to emotional problems (%)	12.0	16.0
Yes		
Feeling of nervousness (%)		
Often, mostly or constantly	3.1	4.9
Sometimes, seldom or never	96.9	95.1
Feeling energetic and vibrant (%)		
Often, mostly or constantly	73.9	63.8
Sometimes, seldom or never	26.1	36.2
Feeling exhausted and tired (%)		
Often, mostly or constantly	17.3	23.8
Sometimes, seldom or never	82.7	76.3
Diabetes (%)	7.1	5.8
Coronary Heart Disease (%)	4.8	1.5
CVA (%)	3.2	2.0
Arthritis (%)	4.5	8.0
Chronic pain(%)	41.7	57.2
Migraine (%)	3.1	6.9

*Note: P-values for the comparison between men and women.

and women regarding the diagnoses and treatment of health problems (Hammarström et al., 2014; Europe, 2020; Appelman et al., 2015; Mauvais-Jarvis et al., 2020; Branković et al., 2013). One problem with this is that for many health problems there are sex differences. For instance, in Western societies women have higher life expectancies than men but more often suffer from chronic health problems in the years they live longer. In addition to the biological sex differences, socio-cultural gender or the interplay of both sex and gender are (part of) the explanation of the commonly found differences in health between men and women (e.g. Hammarström et al., 2014; Connell, 2012; Branković et al., 2013; Humphries et al., 2017; Johnson et al., 2008; Tannenbaum, 2020; Bartz et al., 2020). In recent decades, more attention has been paid to health-, disease- and care differences between men and women and by gender. The perspective on gender beyond the binary distinction of masculinity and femininity might lead to a shift in understanding the differences in health between men and women (Hammarström and Annandale, 2012; Connell, 2012; Johnson et al., 2008; Lacasse et al., 2020; Smith and Koehoorn, 2016; Tannenbaum et al., 2016; Pelletier et al., 2015; Connell, 1995).

Gender is a multidimensional social construct that refers to socially prescribed and experienced dimensions of maleness and femaleness (Johnson et al., 2008). Johnson et al. propose four dimensions in which gender occurs: gender roles, identity, relations, and institutionalized gender (Johnson et al., 2008). These dimensions are usually not part of large-scale epidemiological studies on health such as monitoring and cohort studies. However, as recent research shows, data from such studies can be used to get an indication of gender by using information on e.g. education, employment status, family status, stress management and emotional feelings (Nauman et al., 2021; Levinsson et al., 2022; Lacasse et al., 2020; Smith and Koehoorn, 2016; Tannenbaum et al., 2016; Pelletier et al., 2015). Using a similar approach, we calculated a masculine gender-score based on aspects of everyday life that are traditionally seen as the norm for men, using existing data from a cohort study and explored how masculine gender may affect sex differences in the prevalence of chronic health problems.

2. Method

2.1. Study design and source

For this explorative study cross-sectional data from the Doetinchem Cohort Study (DCS) were used. The DCS provides data that allow examining biological and lifestyle factors and their influence on health throughout the life course (Picavet et al., 2017; Verschuren et al.). Every five years, participants are asked to complete questionnaires and to engage in a medical examination. All participants are residents in the rural mid-sized town Doetinchem in the eastern part of the Netherlands. Written informed consent was obtained from all participants. The study has been approved by the Medical Ethics Committees (Picavet et al., 2017; Verschuren et al.).

2.2. Study population

We used data from measurement round five (2008–2012). The sample in round 1 was an age-sex stratified random sample of the population register. All participants that were still alive, not emigrated, and did not actively withdraw from the study were invited for the 5th measurement round. A response rate of 78% resulted in a study population of both men (n = 1900) and women (n = 2117) aged between 40 and 80 (Nauman et al., 2021).

2.3. Measures

2.3.1. Gender

In order to measure the possible effect of masculinity, we developed a one-dimensional masculine gender-score. We decided to base this score on aspects of everyday life that are seen as the traditional norm for men (Lacasse et al., 2020; Smith and Koehoorn, 2016) such as being the main earner in the household, doing odd jobs and engaging in masculine typed sports (Lacasse et al., 2020; Smith and Koehoorn, 2016; Verdonk et al., 2010). The variables we chose are comparable to the gender related variables used in similar studies (Lacasse et al., 2020; Smith and Koehoorn, 2016; Nauman et al., 2021; Levinsson et al., 2022) and cover the four gender dimensions proposed by Johnson (Johnson et al., 2008). The gender-related variables from the existing DCS data were discussed

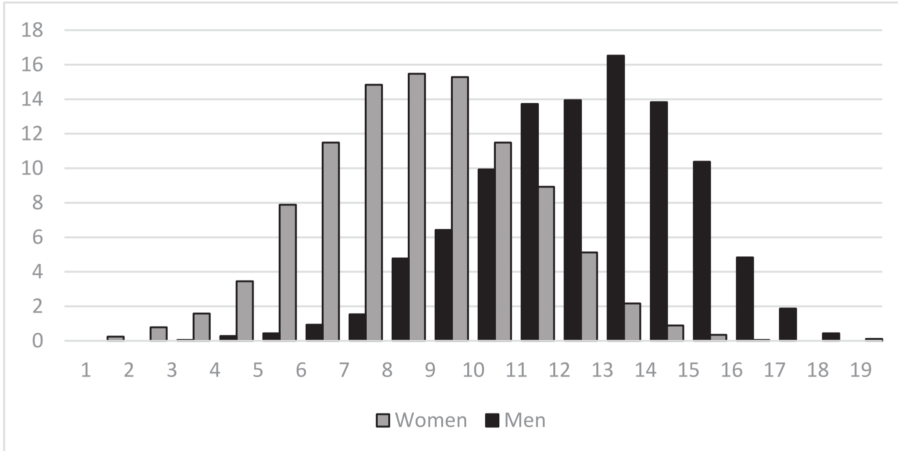

Fig. 1. Distribution of men and women on the masculine genderscore.

among all the co-auteurs that include two gender-experts. Thirteen of these variables were conceived by the team to be connected to the four dimensions of gender and seen as the norm for men in the current Dutch society and therefore selected for the gender scale. The variables were then clustered in four domains: work & education, informal care, lifestyle and emotions. In all domains, higher scores represent higher masculinity.

2.3.1.1. Work & education. This domain consisted of three variables: division of paid work between respondent and partner, physical intensity of work, and educational level compared to the partner. Masculinity in relation to the division of paid work was categorized into: 0 = the partner is most responsible, 1 = equal division, 2 = the respondent is most responsible or does not have a partner (in both cases the respondent is (most) responsible for the household income). Masculinity in relation to the physical intensity of the respondents' paid work was categorized into: 0 = light or no intense work (sedentary or standing work), 1 = moderate-intensity (often carrying moderately heavy-weights), 2 = heavy intensity (often carrying heavy weights). For educational level masculinity was scored as: 0 = respondent has a lower degree than partner, 1 = equal degree or respondent does not have a partner, 2 = the respondent has a higher degree.

2.3.1.2. Informal care. Three variables were used: time spent doing household chores, time spent on odd jobs, and taking care of sick people. Participants were asked for an estimate of the average number of hours spent weekly doing household chores in winter and summertime. The mean was used to summarize the variable hours spent doing household chores: 0 = spending >= 10 h, 1 = spending 5–10 h, 2 = spending < 5 h. Hours spent doing odd jobs was classified vice versa. Masculinity in relation to taking care of sick persons other than the partner was classified as follows: 0 = daily or weekly, 1 = a couple of times every month, 2= (almost) never.

2.3.1.3. Lifestyle. Physical intensity of or specific type of sports, smoking cigars, and type of alcohol consumption were included as masculinity connotated aspects of everyday life. Sport participation was included as follows: 0 = not exercising or exercise of light intensity, 1 = exercise of moderate-intensity, 2 = heavy or masculine typed sports (such as body building and weight lifting). Intensity of sports activity was based on (MET) values (<4 = light intensity, 4–6.5 = moderate intensity, and > 6.5 = heavy intensity) (Ainsworth et al., 2000). For smoking, only the smoking of cigars or pipe was included as masculine: 0 = not smoking pipe or cigars, 1 = smoking pipe or cigars. Alcohol consumption was classified as: 0 = almost or never drinking, 1 = drinking wine and/or port, sherry, vermouth, 2 = drinking beer and/or liquor.

2.3.1.4. Emotions. Masculinity in relation to the reporting of emotions was classified as follows: The reporting of being limited in work or activities due to emotional problems'' was included as 0 = yes and 1 = no. The variables ''experiencing a feeling of nervousness'', ''feeling energetic and vibrant'', and ''feeling exhausted and tired'' were dichotomized: 0 = often, mostly or constantly, and 1 = sometimes, seldom or never.

For 116 participants we missed data to calculate the gender score and thus were excluded. High correlation (correlation coefficient value > 0.8) between selected gender-related variables was used as an exclusion criterium for such variables: the method of tetrachoric correlations was used for binary and that of polychoric correlation for other categorical variables. No variables were excluded based on this criterium. The gender-score was calculated by summing all variables (range 0–19): a higher score refers to an individual presenting more masculine connotated aspects of everyday life.

2.3.2. Chronic health problems

For this first exploration of the role of gender for sex differences in chronic conditions we included the prevalence of diabetes (type I or type II), coronary heart disease (CHD), cerebral vascular accident (CVA), arthritis, chronic pain, and migraine. These conditions are common enough to be studied within this population-based study. Both cancer and lung conditions were also considered as outcome measures based on this criterium but were excluded because cancer represents a large variety of specific cancers and COPD and asthma – the main lung disease diagnoses - are medically incomparable. The included chronic conditions were measured as self-reported as diagnosed by a doctor. Chronic pain was based on a question of having pain lasting for at least three months.

2.3.3. Socio-demographics

The sex assigned at birth was included as (biological) sex: women and men. In addition to age (in years), we used an indicator of socio-economic status (SES) based on educational level measured in round 3 or 4, and categorized into: low (intermediate secondary or less), intermediate (intermediate vocational and higher secondary), and high level (higher vocational or university) (van Oostrom, et al., 2017).

2.4. Analyses

Besides standard descriptive statistics we examined how gender affected the sex differences using multivariable logistic regression models both without and with the gender score, for each chronic health

Table 2
Sex differences in chronic health problems and the role of masculine gender on sex differences, logistic regression analyses, (a) chronic health problems that were more prevalent among men, and (b) chronic health problems that were more prevalent among women of round five of the Doetinchem Cohort Study.

a.	Diabetes		CHD		CVA	
	Model 1	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*
	OR (95% CI)	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*
Sex	1.21 (0.93; 1.58)	1.60 (1.18; 2.17)	3.70 (2.40; 5.71)	4.69 (2.92; 7.53)	1.48 (0.97; 2.26)	2.33 (1.40; 3.89)
Age	1.07 (1.06; 1.09)	1.07 (1.05; 1.08)	1.10 (1.07; 1.12)	1.09 (1.07; 1.12)	1.11 (1.08; 1.13)	1.09 (1.06; 1.12)
SES Low	Ref	Ref	Ref	Ref	Ref	Ref
Intermediate	0.80 (0.58; 1.10)	0.86 (0.62; 1.19)	0.88 (0.58; 1.38)	0.97 (0.61; 1.52)	0.94 (0.57; 1.56)	1.11 (0.66; 1.89)
High	0.56 (0.39; 0.81)	0.64 (0.44; 0.93)	0.67 (0.41; 1.10)	0.73 (0.44; 1.20)	0.68 (0.39; 1.20)	0.87 (0.48; 1.56)
Gender-score		–		–		0.86 (0.78; 0.94)
Quartile 1		Ref		Ref		–
Quartile 2		0.62 (0.44; 0.88)		1.15 (0.70; 1.87)		–
Quartile 3		0.79 (0.51; 1.22)		0.41 (0.19; 0.89)		–
Quartile 4		0.44 (0.29; 0.66)		0.60 (0.35; 1.04)		–

b.	Arthritis		Chronic pain		Migraine	
	Model 1	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*
	OR (95% CI)	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*
Sex	0.53 (0.40; 0.70)	0.94 (0.67; 1.31)	0.53 (0.45; 0.60)	0.73 (0.63; 0.86)	0.45 (0.33; 0.62)	0.69 (0.48; 0.998)
Age	1.05 (1.03; 1.06)	1.03 (1.02; 1.05)	1.02 (1.01; 1.03)	1.01 (1.01; 1.02)	0.98 (0.96; 0.99)	0.97 (0.95; 0.98)
SES						
Low	Ref	Ref	Ref	Ref	Ref	Ref
Intermediate	0.80 (0.57; 1.11)	0.92 (0.65; 1.30)	0.89 (0.76; 1.03)	0.98 (0.83; 1.15)	0.97 (0.69; 1.37)	1.15 (0.81; 1.64)
High	0.71 (0.50; 1.01)	0.997 (0.69; 1.45)	0.78 (0.67; 0.92)	0.92 (0.78; 1.09)	0.92 (0.64; 1.34)	1.16 (0.78; 1.72)
Gender-score		0.81 (0.76; 0.86)		0.90 (0.87; 0.92)		0.86 (0.81; 0.92)

Note: Ref = reference group; Gender was analyzed as a continuous variable for health outcomes CVA, arthritis, chronic pain, and migraine. For diabetes and CHD, gender was analyzed in categories; Model 2 is the gender-adjusted model comparing men to women.

problem separately. Before conducting logistic regressions, continuous independent variables were checked on linearity with the outcome variables: if dummy variables increased or decreased relative to the reference category, the variable was treated as a continuous variable in subsequent analyses. Otherwise, the variable was analyzed in categories of quartiles. The analyses were adjusted for age and SES. To further explore the contributions of each domain of the gender-score, separate domains - instead of the total gender-score - were added to the gender-adjusted models. Odds ratios (ORs) and 95% confidence intervals (95% CIs) are reported and p-values < 0.05 were considered statistically significant. SAS program (version 9.4) was used.

3. Results

Socio-demographics, gender-score variables, and the prevalence of chronic health problems are presented in Table 1. Women were more likely to spend more hours on household chores and were more often limited in daily activities due to emotional problems. All variables in the gender-score that were conceived as more masculine are more often found among men than among women. The total gender-score is on average higher among men ($M = 12.2$, $SD = 2.5$) than women ($M = 9.1$, $SD = 2.4$), though both men and women can be found within a broad gender range (Fig. 1).

The regression analyses are presented in Table 2a & b. The results of the models without gender (model 1), considering the role of sex, showed that three chronic health problems were more prevalent in men – diabetes, CHD and CVA – and three were more prevalent in women – arthritis, chronic pain, and migraine – which is in line with the raw data (Table 1).

The gender-adjusted models all showed a change in the estimates of sex (comparing men to women), depending on whether the chronic health problems were more prevalent in men (Table 2a) or more prevalent in women (Table 2b). For chronic health problems that were more prevalent in men it was shown that sex differences were greater after adjustment for gender: for diabetes the OR of sex increased from 1.21 (95 %CI 0.93–1.58) to 1.60 (95 %CI 1.18–2.17), for CHD from 3.70 (95 %CI 2.40–5.71) to 4.69 (95 %CI 2.92–7.53) and for CVA from 1.48 (95 %CI 0.97–2.26) to 2.33 (95 %CI 1.40–3.89). For health problems that are more prevalent in women the gender-adjustment resulted in smaller sex differences: for chronic pain, the OR of sex increased from 0.53 (95 %CI 0.45–0.60) to 0.73 (95 %CI 0.63–0.86), and for migraine from 0.45 (95 %CI 0.33–0.62) to 0.69 (95 %CI 0.48–0.998). The OR of arthritis almost became equal to one (0.53 (95 %CI 0.40–0.70) to 0.94 (95 %CI 0.67–1.31)).

All domains of the gender-score seem to contribute to the study findings (Table 3): for diabetes, CHD and CVA all domains of the gender-score showed ORs greater than one and for arthritis, chronic pain, and migraine ORs smaller than one.

4. Discussion

Our findings suggest that higher scores on the masculine gender scale is associated with a lower prevalence of chronic health problems for *both* men and women and that the role of masculine gender on sex differences in chronic health problems depends on whether chronic health problems are more often found among men or among women. For chronic health problems that were more prevalent in men (diabetes, CHD, and CVA), the sex differences between men and women widened after adjustment for gender. This might indicate that the effect of biological sex on chronic health problems would be underestimated, and that gender suppresses this effect. For chronic health problems that were more prevalent in women (arthritis, chronic pain, and migraine), sex differences between men and women narrowed or almost disappeared after adjustment for gender. So, if men and women would not differ in gender, sex differences in those chronic health problems would not exist. This suggests that gender might operate as a mediator of sex differences in chronic health. This possibly mediating role of gender is in line with the suggestion from Smith and Koehoorn (Smith and Koehoorn, 2016) that gender can be included as a mediator in retrospective analyses when information on health aspects is available. However, given the cross-sectional nature of this study, nothing can be stated about causal pathways because reversed causation might have biased results. Future research, using longitudinal data, is recommended to investigate the

Table 3
Exploring the contribution of the separate gender domains on the sex differences in six chronic health problems of participants of round five of the Doetinchem Cohort Study: results of logistic regression of:

	DiabetesOR (95% CI)	CHD OR (95% CI)	CVA OR (95% CI)	Arthritis OR (95% CI)	Chronic pain OR (95% CI)	Migraine OR (95% CI)
Original sex difference:	1.21 (0.93; 1.58)	3.70 (2.40; 5.71)	1.48 (0.97; 2.26)	0.53 (0.40; 0.70)	0.53 (0.45; 0.60)	0.45 (0.33; 0.62)
Sex difference after controlling for masculine gender in						
Work-eduction	1.25 (0.95; 1.64)	3.78 (2.43; 5.88)	1.63 (1.05; 2.53)	0.57 (0.43; 0.76)	0.54 (0.48; 0.62)	0.44 (0.32; 0.61)
Informal care	1.08 (0.77; 1.51)	4.26 (2.55; 7.11)	1.70 (0.99; 2.90)	0.61 (0.43; 0.86)	0.53 (0.45; 0.62)	0.54 (0.37; 0.80)
Lifestyle	1.47 (1.11; 1.94)	4.45 (2.84; 6.95)	1.71 (1.10; 2.65)	0.60 (0.45; 0.81)	0.56 (0.49; 0.64)	0.52 (0.38; 0.73)
Emotions	1.33 (1.01; 1.75)	3.83 (2.46; 5.98)	1.53 (0.99; 2.36)	0.59 (0.44; 0.79)	0.56 (0.49; 0.64)	0.48 (0.35; 0.67)

mediating and/or suppressing role of gender on sex differences in chronic health.

As this is quite a new research area, we only can compare our findings to a limited number of previous studies. Comparing our findings to studies from Smith and Koehoorn (Smith and Koehoorn, 2016) and Lacasse, Pagé (Lacasse et al., 2020), we found similar overlapping scores between men and women. In addition, we found that a higher level of masculinity was associated with lower prevalence of chronic health problems. This finding is in line with a study by Azizi et al. who, using similar variables in their gender score, in which sociocultural gender referring to personality traits and social characteristics typically ascribed to women, was associated with poorer cardiovascular health and a higher prevalence of heart disease regardless of sex (Azizi et al., 2021) The association between masculinity and wellbeing can according to Doyal partly be explained because it offers "privileged access to a range of recourses" (Doyal, 1061).

The considerable overlap of the distributions of men and women on the gender-score (Fig. 1) is in line with other studies stating that a clear binary distinction between masculinity and femininity for respectively men and women does not apply (e.g. Connell, 2012; West and Zimmerman, 1987; Verdonk et al., 2010). The observed effects of masculine gender on health in both men and women can be compared to somewhat similar studies where - independent of sex - masculine gender was associated with better health (Annandale and Hunt, 1990), better coping with stressors (Lacasse et al., 2020), decreased risk for cardiovascular risk factors (in younger patients) (Pelletier et al., 2015), and decreased risk for burn out (Abrahams et al., 2013). It seemed that all domains of the gender-score (work-related, informal care, lifestyle, and emotions) contributed to our study findings. Variables of the gender-score that are consistent with variables that were most related to gender-scores from other studies were: occupation (Smith and Koehoorn, 2016), numbers of hours work, home-related workload, and financial responsibility (Pelletier et al., 2015).

Several limitations regarding the gender-score and the representativity of the study population should be considered in the interpretation of these findings and reconsidered in future research. First, the gender-score is based on aspects that may have a negative impact on health, such as smoking or alcohol consumption. It may seem contradictory that the presence of these aspects in the gender-score is associated with a lower prevalence of chronic health problems. However, the gender-score does not focus on the quantity but on the type of alcoholic beverages and smoking. Second, although the face validity of the masculine gender-score seems high: the positioning on the masculine gender-score is related to but distinct from sex, and the distribution of the score among men and women is comparable to that of other studies (Lacasse et al., 2020; Smith and Koehoorn, 2016; Pelletier et al., 2015; Nauman et al., 2021; Levinsson et al., 2022), the gender score has its flaws. As no specific gender measures were included in the DCS, the masculine gender-score was composed from limited data resulting in small coverage of the concept of masculine gender that is far from being accurate or all-encompassing. Like gender, masculinity is plural, not unambiguous, subject to constant change and different with regard to place and time (Connell, 1995). We chose variables that in current western societies are connected to gender in general and to masculine gender in particular. Using this literature driven deductive approach we risk reproducing (old) gender norms and stereotypes. One way to avoid this is by using an inductive approach like Fleming et al. (Fleming et al., 2017) demonstrated in their article. Instead of using existing ideas of masculinity and femininity they used variables based on same-gender behaviour as a basis for their gender score. Thus we recommend cohort studies to also explore specific and more inductive driven gender measures, so it will become possible to gain insight into the relation between gender, health and disease.

Furthermore, it is important to emphasize that for this masculine gender-score we used masculine connotated aspects of everyday life, that are not necessarily feminine-typed aspects. In gender research, masculinity and femininity are seen as two distinct continuums (Verdonk et al., 2019). Second, for this study a mainly Caucasian population of middle and old age, and residing within a specific - not highly urbanized - region was used. In addition, those with severe diseases and worse health are under-represented in such studies. The findings will therefore not be entirely representative of the Dutch population. Third, the use of self-reported measures might have generated biased information since it requires a certain level of literacy (Rosenman et al., 2011).

It is becoming clearer that gender may be important for health and disease, and thus important to evaluate in large-scale studies as cohort and monitoring studies. More research can be done using gender measures 'when we do not have a gender measure', an approach exploited in the current study. This can be done using data from other cohort studies and also using a broader range of health measures, such as mental health and health problems such as auto-immune disease and infectious diseases. However, in addition it is necessary to expand the measurement approaches of gender in cohort and monitoring studies e.g. with measures on gender identity. Only when the data are available, the role of gender for health and disease, and also prevention, ageing, management, and care can be studied. If scientists, medical schools, and clinicians consider more sex and gender in all its diversity in health, this can contribute to quality improvements in prevention and better-balanced disease management and prevention for both men and women. (e.g. Mauvais-Jarvis et al., 2020; Bartz et al., 2020).

5. Conclusion

Masculine gender affects sex differences in chronic health problems: masculine gender measured on a scale of masculine connoted aspects is associated with a lower prevalence of chronic health problems in both men and women, but particularly men benefit more due to higher masculinity scores. After gender-adjustment, the sex differences for chronic health problems with a male disadvantage increased and those with a female disadvantage decreased. This study provides a first indication of the role of masculine gender on sex differences in health and may inspire researchers to further explore the impact of (different approaches to) gender on health.

CRediT authorship contribution statement

Sarah S. Vader: Writing – review & editing. **Shirley M. Lewis:** Writing – original draft. **Petra Verdonk:** Writing – review & editing. **W. M. Monique Verschuren:** Writing – review & editing. **H. Susan J. Picavet:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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