Self-rated health and semen quality among 3,457 young Danish men

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Objective: To study the relationship between self-rated health (SRH) and semen quality.
Design: Cross-sectional study of men attending a compulsory physical examination to determine their fitness for military service from 1996 to 2005.
Setting: Young men were approached when they were summoned for a compulsory physical examination to determine their fitness for military service in two major Danish cities.
Patient(s): A total of 3,457 Danish young men delivered a semen sample, had a physical examination performed, and responded to a questionnaire including a question about SRH.
Intervention(s): None.
Main Outcome Measure(s): Semen quality and testis size.
Result(s): After control for confounders, men with good and poor SRH had, respectively, 0.5 mL (95% CI: −0.8, −0.1) and 0.8 mL (95% CI: −2.4, 0.8) smaller testes size compared to men with very good SRH, the trend was statistically significant. Men with good and poor SRH had, respectively, 12.2% (95% CI: −21.2%, −2.2%) and 26.9% (95% CI: −55.7%, 20.8%) lower total sperm count compared to men with very good SRH, the trend was statistically significant, and had +0.4% (−1.4%, 2.2%) and 1.4% (−3.5%, 0.7%) fewer morphologically normal sperms (trend statistically significant). Percentages of motile spermatozoa and semen volume were not significantly associated with SRH.
Conclusion(s): We found significant associations between SRH and semen quality and testicular size. Given the cross-sectional study design, we cannot establish a causal relationship but argue that SRH may be associated with semen quality. Our findings need to be validated and confirmed with other study designs (preferably prospective) and in populations of different age structure and fertility status. (Fertil Steril® 2007;88:1366–73. ©2007 by American Society for Reproductive Medicine.)

Key Words: Fertility, semen quality, epidemiology, self-rated health

In Denmark, the semen quality among young men from the general population has been found to be surprisingly low; 21% have sperm counts of <20 million per milliliter (lower WHO limit for normal sperm count), and 43%, of <40 million per milliliter. A study indicated that men with sperm counts of <40 million per milliliter had reduced ability to impregnate their partner compared with men with higher sperm count (1, 2). A large number of these men may therefore be expected to experience fertility problems in the future. The reasons for this poor semen quality are not well elucidated, but environmental factors have been suspected to contribute. Semen quality has been found to be reduced among smokers, men exposed to smoking in utero (3–6), and men who are overweight or underweight (7). However, semen quality may also be affected by psychological factors. Occupational stress and burnout have been related to male infertility and reduced semen quality (8, 9). Case–control studies have shown higher stress levels among infertile men than among fertile controls (10, 11), but infertility may be a stressor in itself. Stress may also affect semen quality, although the results are inconsistent (12–14).

Self-rated health (SRH) has in a large number of prospective studies proved to be a significant predictor for important endpoints such as total mortality, hospitalizations, preterm retirement, absence from work, and use of medicine and other health services (15–17). Many studies have shown SRH to be a better predictor for these events than medical diagnoses that are based on clinical examinations. This has been explained by pointing at a number of the specific features of SRH, such as the following: [1] SRH includes all the diagnoses and symptoms of the individual, [2] SRH is not only based on negative deviations from normal health such as diseases but also on positive phenomena such as a high level of vitality and good quality of life, and [3] SRH includes somatic as well as psychological health (15).

There are to our knowledge no studies investigating the relationship between SRH and semen quality. We therefore studied the association between SRH and semen quality among Danish young men from the general population.

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MATERIALS AND METHODS

Population

Because of the military drafting system in Denmark, all 18-year-old men are required to attend a compulsory physical examination to determine their fitness for military service. Trained staff personally approached all young men from the general population when they presented for this compulsory physical examination in two cities in Denmark (Copenhagen and Aalborg) from June 1996 to March 2005. Men who had chronic diseases (corresponding to 10%–14% of the population) were not summoned to the military board and were therefore not approached in this study.

The trained staff informed the men about the study and handed out written information. The men could fill in informed consent for participation and book an appointment immediately or could return the consent form by mail. For a young man to participate in the study, he and his mother had to be born and raised in Denmark. The participants received economic compensation (80$). The participation rate in the centers varied over time from 19%–30% (mean participation rate, 24%). Nonparticipants did not differ from participants with regard to age or education. Ethical approval was obtained from the local ethics committee, which is common practice for clinical studies in Denmark. A detailed description of the study can be found elsewhere (2, 7).

Semen Analysis

Each man provided a semen sample by masturbation into a wide-mouthed plastic container in a room close to the semen laboratory. The period of abstinence and time from ejaculation until motility assessment were recorded, and the semen sample was analyzed according to the World Health Organization 1993 guidelines (18), modified in accordance with Jørgensen et al. (19). From all semen samples, a smear was stained and preserved but had not yet been analyzed. Therefore, we nested a matched exposure cohort within the cohort. The morphologic slides for the 40 men with poor SRH were found, and morphology was assessed. We randomly selected an unexposed control group by assessing the morphology of the next man with good and very good SRH who was included in the study just before or after a man with poor SRH. A single experienced technician blindly assessed all morphologic slides (including approximately 400 other samples) within 4 working weeks, using strict criteria.

A previous study found interobserver variability in semen analysis between different laboratories, especially concerning motility assessments (19). In the present study, only three technicians from our laboratory were involved in the semen analyses. Our technicians performed a monthly intralaboratory control by examining the same semen samples blindly, and the between-technician variation in sperm concentration was $<10\%$ throughout the study period. The following semen variables were used as outcome variables: semen volume (mL), sperm concentration (million/mL), percentage of motile and morphological normal spermatozoa, and the calculated total sperm count (concentration $\times$ volume, in millions).

Physical Examination

All physical examinations were performed by six physicians (four in Copenhagen and two in Aalborg). Tanner stage of pubic hair and genital development, testicular volumes (determined by use of a Prader orchidometer and mean of both testes was calculated), and the possible presence of a varicocele, a hydrocele, the location of testis in scrotum, and the consistency of the testis and epididymis were recorded. Weight was measured in kilograms, with only one weighing scale in each center; height was measured in centimeters; and body mass index was calculated as weight in kilograms divided by the squared height in meters. Body mass index was categorized as <20 kg/m^2, 20–25 kg/m^2, and >25 kg/m^2, normally described as under-, normal-, and overweight in the literature (20).

Questionnaire

All participants completed a questionnaire that was handed out to them at the day of the military examination or mailed by post when they signed up for the study. It was returned to the physician at the time of physical examination. The questionnaire included information on previous and/or current diseases and on genital diseases such as cryptorchidism, inguinal hernia, varicocele, epididymitis, gonorrhoea, chlamydia, and operation for torsion of the testis. The following question about SRH was included: "How would you consider your health status"? (Answer categories were as follows: "very good", "good", "poor", and "very poor").

From 2001, the questionnaire was extended and included more questions about diseases (hypertension, hepatitis, arthritis, cancer, diabetes, asthma, and thyroid and other diseases). In addition, the men reported temperature of $>38^\circ$C 3 months before the delivery of the semen sample.

The men also reported on smoking and alcohol intake during the week before completion of the questionnaire. Smoking habits were reported as the average number of cigarettes, cigars, or pipes smoked per day. The total weekly alcohol intake (number of drinks) was calculated by summarizing the beer, wine, and liquor intake. In addition, men were asked whether their mothers smoked while pregnant with them. They were questioned as to whether they experienced psychological distress "rarely", "every week", or "every day."

Statistics

Data on sperm concentration and total sperm count were not normally distributed, so the median and 25–75 percentiles were calculated for these variables. Data on testis size, semen volume, and motile spermatozoa were all normally distributed, so the mean and SD were calculated for these variables.

Self-rated health was categorized into three groups ("very good", "good", and "poor"), because no men reported having very poor SRH; very good SRH was used as the reference. The distribution of information obtained from the questionnaire and physical examination was compared for different SRH groups to determine possible confounders.

Multiple linear regression analyses were performed by taking into account confounders that were found to affect outcome variables and to be distributed differently among men in different SRH groups. The SRH was entered into the model as two dummy variables. Normally distributed outcome variables were entered directly as continuous variables in the linear multiple regression analysis, whereas sperm concentration, total sperm count, and period of abstinence were transformed by use of the natural logarithm to obtain normality. Confounders were excluded stepwise if they were not statistically significant at the 10% level. Self-rated health was also entered in the model as one variable, with three values to test *P* values for trends, assuming the same distance between very good, good, and poor health.

Finally, the analyses were repeated without adjustment for diseases in reproductive organs and only with adjustment for period of abstinence.

The results are presented with 95% confidence intervals (95% CI). The fit of the regression models was evaluated by testing the residuals for normality and by inspecting the residual plots.

RESULTS

A total of 3,497 men participated in the study; 40 men did not respond to the question on SRH and were therefore excluded, leaving a final study population of 3,457. A total of 1,687 men (48.8%) reported having "very good" SRH; 1,730 (50.0%), "good" SRH; and 40 (1.2%), "poor" SRH. No men rated their health as very poor. The mean age of the participants was 19.4 years (SD, 1.2 y). Mean testes size was 19.9 mL (SD, 4.6 mL), mean semen volume was 3.3 mL (SD, 1.5 mL), median sperm concentration was 45.0 million/mL (25th and 75th percentiles, 22.0 and 81.0 million/mL), median total sperm count was 140 million (25th and 75th percentiles, 63 and 255 million), and mean percentage of motile and morphological normal spermatozoa was 65.3% (SD, 13.1%) and 8.7% (4.7%), respectively.

Table 1 shows the relationship between semen quality and SRH. Men with very good, good, and poor SRH had a median semen concentration of, respectively, 48.0 million/mL (25th and 75th percentiles, 24.0 and 84.0 million/mL), 44.0 million/mL (21.0 and 80.0 million/mL), and 45 million/mL (20 and 68 million/mL). The median total sperm count within the three groups of SRH was, respectively, 151 million (70 and 266), 131 million (59 and 247), and 106 million (42 and 170). Mean testes size were 20.2 mL (SD 4.6), 19.7 mL (4.6), and 18.9 mL (4.3), respectively. Among men with very good, good, and poor SRH, 20.3%, 22.7%, and 25.0%, respectively had a sperm concentration of <20 million per milliliter. The sensitivity for detecting poor sperm concentration on the basis of poor SRH was 25%, whereas the specificity was 80% (the ability to detect normal sperm concentration on the basis of very good SRH).

Semen quality and testis size were smaller in men in whom testes were hard or soft or in whom a varicocele was found at the physical examination, as well as in men who reported being treated for cryptorchidism or having had epididymitis or being operated on for torsion of the testicles. This information was transformed into one variable (present or not). Semen volume was not significantly associated with any of these conditions.

Table 1 illustrates the distribution of SRH in relation to possible confounders. A gradient in exposures among men with very good, good, and poor SRH was found. Men with poor and good SRH had a shorter period of abstinence, were older, more often from Aalborg, and more often overweight or underweight than men with very good SRH. They had a higher alcohol intake, took more medicine and supplements, and more often reported stress than did men with very good SRH. In addition, they were more often smokers and exposed to smoking in utero.

Linear regression was performed, with testes size and semen-quality parameters as dependent variables and with SRH categorized and inserted as two explanatory dummy variables (Table 2). The residuals fitted. Before adjustment, a dose–response gradient in semen quality and testis size was found, so testes size and semen quality were lower in men with poorer SRH. The findings were not significant for semen volume or percentage of motile spermatozoa (Table 2).

After control for diseases in reproductive organ size, body mass index, and in utero exposure to smoking, men with good and poor SRH had, respectively, 0.5 mL (95% CI: −0.8, −0.1) and 0.8 mL (95% CI: −2.4, 0.8) smaller testes size (Table 2; test for trend, $P=.005$) than did men with poor SRH. After adjustment for diseases in reproductive organs, body mass index, in utero exposure to smoking, current smoking, and period of abstinence, men with good and a poor SRH also had a lower sperm concentration, −9.5% (95% CI: −18.1%, −0.01%) and −18.2% (95% CI: −48.5%; 29.9%), respectively (test for trend, $P=.04$), and a lower total sperm count, −12.2% (95% CI: −21.1%, −2,2%) and −26.9% (95% CI: −55.7%; 20.8%), respectively; test for trend, $P=.009$; Table 2) than did men with very good SRH. They had fewer morphologically normal sperms after adjustment for diseases in reproductive organs and in utero exposure to smoking, 0.4% (−1.4%; 2.2%) and −1.4% (−3.5%; 0.7%; test for trend, $P=.43$), respectively, although this difference was not significant. No significant associations between SRH and semen volume or percentage of motile spermatozoa were found after adjustment (Table 2).

It can be argued that because these young men were asked about their reproductive health, diseases in reproductive

TABLE 1

Sperm and testis parameters as well as demographic information obtained from questionnaires of 3,457 Danish military conscripts with differing self-rated health.

Variable	N	Percentage	Self-rated health: Very good (n = 1,687)	Self-rated health: Good (n = 1,730)	Self-rated health: Poor (n = 40)	*P* value (χ^2 test)
Mean testis size (mL)[a]	3,410	19.9 (4.6)[b]	20.2 (4.6)	19.7 (4.6)	18.9 (4.3)	
Mean semen volume (mL)	3,457	3.3 (1.5)[b]	3.3 (1.5)	3.2 (1.4)	3.0 (1.6)	
Median sperm concentration (million/mL)	3,457	45 (22–81)[c]	48 (24–84)	44 (21–80)	45 (20–68)	
Median total sperm count (million)	3,457	140 (63–255)[c]	151 (70–266)	131 (59–247)	106 (42–170)	
Mean morphological normal sperm (%)[d]	160	8.6 (4.7)[c]	9.2 (4.7)	8.9 (4.3)	7.2 (4.9)	
Mean motile sperm (%)	3,457	65.3 (13.1)[b]	65.3 (12.9)	65.3 (13.2)	66.7 (11.1)	
Period of abstinence (h)						
0–95	2,802	81.1	80.8	81.7	87.2	.51
96+	643	18.9	19.2	18.3	12.8	
Season						
April–September	324	9.4	8.3	1.4	10.0	.11
October–March	3,133	90.6	91.7	89.6	90.0	
Diseases in reproductive organs[e]						
No	2,560	84.5	84.4	84.7	84.8	.98
Yes	468	15.5	15.6	15.3	15.2	
Questionnaire information						
City						
Copenhagen	3,227	93.4	93.7	93.3	82.5	.02
Aalborg	230	6.6	6.3	6.7	17.5	
Age (y)						
<20	2,740	79.6	81.2	78.4	67.5	.02
20+	701	20.4	18.8	21.6	32.5	
BMI (kg/m^2)						
<20	507	14.7	11.6	17.6	20.0	<.001
20–25	2,269	65.9	71.9	6.5	45.0	
25+	668	19.4	16.5	21.9	35.0	
Alcohol intake (units/wk)						
0–19	2,612	79.1	81.2	77.2	70.3	.008
20+	691	21.9	18.8	22.8	29.7	
Smoking						
No	2,050	59.5	70.9	48.9	38.5	<.001
Yes	1,394	40.5	29.1	51.1	61.5	
Daily medicine or supplement intake during last 3 mo						
No	2,823	83.6	84.6	82.6	82.5	.30
Yes	555	16.4	15.4	17.4	17.5	
Self-reported stress						
Rarely	1,295	57.7	62.8	52.9	33.3	<.001
Every week	815	36.3	31.9	4.8	40.0	
Every day	134	6.0	5.3	6.4	26.7	
Exposed to smoking in utero						
No	1,945	59.9	61.9	58.3	46.2	.02
Yes	1,300	40.1	38.1	41.7	53.8	

Note: BMI = body mass index.

[a] Mean for left and right testicle.

[b] Mean (SD).

[c] Median (25–75 percentiles).

[d] Counted on 160 randomly selected samples, including all 40 with poor self-reported health.

[e] Indicates varicocele or abnormally hard or soft testes found at physical examination or questionnaire information about cryptorchidism, epididymitis, or torsion of the testicle.

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organs may make these young men report a poorer SRH. Self-reported health may therefore be an intermediary factor between diseases and semen quality. The analyses were therefore repeated without adjustment for diseases in reproductive organs, which did not affect our findings (Table 2).

A total of 1,925 men examined from 2001 and onwards were questioned more specifically about diseases. Less than 1% reported having hypertension, hepatitis, arthritis, cancer, diabetes, or thyroid diseases, and none of these reported having poor SRH. Among men with very good, good, and poor SRH, 7.5%, 12.5%, and 15.4%, respectively, had self-reported asthma. The corresponding proportion of men with temperature of >38°C 3 months before was 3.4%, 6.0%, and 8.3%. Temperature was related to poorer semen quality, whereas asthma was not.

Self-rated health is a measure of health status, and it can be argued that no adjustment for health risks should be made. We therefore repeated the analyses, adjusting only for period of abstinence (Table 2), which did not change the strength or direction of our findings.

DISCUSSION

We found significant associations between SRH and sperm concentration, total sperm count, percentages of morphologically normal sperm, and testis size in the expected direction, although not all the findings for men with poor SRH were significant (probably because this group only included 40 men). To our knowledge, no studies have related SRH to semen quality. The strength of the associations were unaffected by adjustments for diseases in reproductive organs. Our study was cross-sectional, so in principle we cannot determine the direction of the association between SRH and semen quality. In the present study, however, we do not see this as a serious shortcoming, because the men had no knowledge of their semen quality when they reported their SRH. It is therefore unlikely that the respondents' SRH could be affected by their semen quality.

Several studies have reported a relationship between SRH and mortality and morbidity, for example, heart disease and functional health (21–23). Men with a poor health status may have poor semen quality as a result of their health status. However, none of the men with chronic diseases (hypertension, hepatitis, arthritis, cancer, diabetes, and thyroid disease) reported poor SRH, but more men with poor SRH reported having asthma or having had elevated temperature 3 months before. Asthma was, however, not related to semen quality, but men with temperature of >38°C had poorer semen quality. This supports the hypothesis that infectious diseases may result in a poorer SRH and a reduction in semen quality.

Case–control studies have shown higher stress levels among infertile men than among fertile controls (10, 11). Infertile men may be more distressed or especially vulnerable to the stress, and therefore, the importance of stress exposure on semen quality needs to be studied among normal unselected men. Giblin et al. (12) assessed semen quality among 28 healthy volunteers who also reported perceived stress and social support. Stress was negatively correlated with the proportion of normal sperms. A study among 164 men found no association between work stress or life events and semen quality (13). However, reduced motility was found among 12 men who had experienced a recent death of a family member. A Danish study among 430 first-pregnancy planners found no effect of daily perceived stress (measured by general health questionnaire), work stress (measured with the Job Content Questionnaire developed by Karasek), and semen quality (14, 24). In this study, men with poor and good SRH more often experienced self-reported stress, but stress had no independent effect on any semen parameters. The questionnaire, however, only included one question about stress, which was not very sensitive, and it can therefore not be excluded that the effect on semen quality of SRH may be mediated through a higher stress level.

Our participation rate was 20%–25%, which is higher than or at the same level as similar studies of semen quality among men from the general population (25–27). We were concerned whether the participants were selected in some way. However, the men had essentially no prior knowledge of their own fertility potential, and this therefore is unlikely to have affected their motivation to participate. We also conducted a study in which reproductive hormones among participants and nonparticipants were compared (2). We found no significant difference with regard to reproductive hormones between the two groups, indicating that our participants represented the general population with respect to reproductive health. However, men with knowledge about previous diseases in reproductive organs may have been more eager to participate. Diseases in reproductive organs were not related to SRH and therefore cannot explain the reported association between SRH and semen quality and testis size.

Men with known chronic diseases were not summoned for military drafting. This probably explains why so few men reported having poor SRH. However, this study compared semen quality in groups of men with different SRH, and it therefore is of less importance whether the groups of men in fact represented the total population.

It is well known that interobserver variability in semen analysis between different laboratories exists. However, all analyses were performed in a blinded manner, all morphologies were assessed by the same technician, and our laboratory participated in an external quality-control program. The physical examinations were performed by six physicians. Interindividual variation in semen quality and testis size may therefore be present. It is, however, unlikely that this variation is related to SRH and that the misclassification caused is therefore likely to be nondifferential and to underestimate a true effect. Also, the changes in the various semen parameters were all in the same direction: men with good and poor SRH showed the poorest results.

Only four answer categories to the SRH question were provided in our questionnaire. Other studies used five categories

TABLE 2

Semen quality and testis size among men with good and poor self-rated health compared with very good health (reference). Both unadjusted and adjusted results from linear regression analyses are shown with 95% confidence intervals.

Self-rated health	Differences in sperm concentration (%)	Differences in total sperm count (%)	Differences in semen volume (mL)	Differences in testes size (mL)	Differences in morphological normal spermatozoa (in %)*	Differences in motile spermatozoa (in %)
Unadjusted						
Very good	Reference	Reference	Reference	Reference	Reference	Reference
Good	−9.3 (−12.2; −0.8)	−11.7 (−19.9; −2.6)	−0.06 (−0.16; 0.04)	−0.5 (−0.8; −0.2)	−0.3 (−2.0; 1.3)	−0.1 (−0.9; 0.9)
Poor	−18.0 (−46.3; 25.3)	−25.6 (−53.2; 18.1)	−0.28 (−0.74; 0.18)	−1.3 (−2.1; 0.2)	−2.0 (−3.8; −0.1)	1.4 (−2.7; 5.5)
Test for trend (*P* value)	.03	.008	.23	.001	.05	.86
Adjusted for confounders, including diseases in reproductive organs						
Very good	Reference	Reference	Reference	Reference	Reference	Reference
Good	−9.5[a] (−18.1; −0.01)	−12.2[a] (−21.2; −2.2)	−0.07[b] (−0.16; 0.03)	−0.5[c] (−0.8; −0.1)	0.4[d] (−1.4; 2.2)	−0.2[e] (−1.1; 0.7)
Poor	−18.2[a] (−48.5; 29.9)	−26.9[a] (−55.7;20.8)	−0.22[b] (−0.68; 0.23)	−0.8[c] (−2.4; 0.8)	−1.4[d] (−3.5; 0.7)	0.3[e] (−3.9; 5.0)
Test for trend (*P* value)	.04	.01	.11	.005	.43	.76
Adjusted for confounders, excluding diseases in reproductive organs						
Very good	Reference	Reference	Reference	Reference	Reference	Reference
Good	−9.8 (−17.9; −0.4	−11.8 (−20.4; − 2.4)	−0.07 (−0.16; 0.03)	−0.1 (−1.7; 1.7)	−0.1 (−1.8; 1.7)	−0.1 (−1.0; 0.9)
Poor	−19.0 (−47.4; 24.6)	−26.4 (−53.8; 17.4)	−0.22 (−0.68; 0.23)	−1.5 (−3.6; 0.5)	−1.9 (−3.8; 0.1)	1.5 (−2.7; 5.6)
Test for trend (*P* value)	.03	.009	.11	.18	.08	.90
Adjusted for period of abstinence only						
Very good	Reference	Reference	Reference	Reference	Reference	Reference
Good	−9.7 (−17.5; −1.2)	−12.2 (−20.4; −1.6)	−0.07 (−0.17; 0.03)	−0.2 (−1.9; 1.5)	−0.2 (−1.9; 1.5)	−0.01 (−0.9; 0.9)
Poor	−18.2 (−46.7; 25.4)	−25.3 (−53.0; 18.6)	−0.25 (−0.70; 0.20)	−2.1 (−4.0; −0.3)	−2.1 (−4.0; −0.3)	1.2 (−3.0; 5.3)
Test for trend (*P* value)	.02	.005	.10	.04	.04	.85

* Counted on 160 randomly selected samples, including all 40 with poor self-reported health.

[a] Adjusted for period of abstinence (transformed by the use of the natural logarithm), in utero exposure to smoking, current smoking, body mass index, and diseases in reproductive organs.

[b] Adjusted for period of abstinence (transformed by the use of the natural logarithm) and center of investigation.

[c] Adjusted for in utero exposure to smoking, body mass index, and diseases in reproductive organs.

[d] Adjusted for diseases in reproductive organs and in utero exposure to smoking.

[e] Adjusted for in utero exposure to smoking, time from ejaculation until start of analysis, and diseases in reproductive organs.

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to describe SRH. The fifth category describes excellent health, so that the rating is more like a continuum, from very poor and poor through to good, very good, and excellent. Because no "excellent" health category was included in our study, some of the men who would actually have described their health as excellent may have used the "very good" category instead, because most people perceive their health in favorable terms (28, 29). A misclassification of some of the men within SRH may therefore have occurred. This would, however, only affect our results if related to semen quality. Because the men were unaware of their semen quality when they responded to the question of SRH, this is unlikely to have affected our findings.

Self-rated health is a global measure of an individual's own perception of his or her health status, and participants consider a variety of dimensions when asked about their health: chronic conditions, functional limitations, and psychological well-being (29–31). Self-rated health has proved to be valid as compared with more objective information sources, especially when health conditions are severe and clearly defined. It has been shown to be a powerful predictor of mortality, morbidity, use of health services, preterm retirement, absence, and so on. (15). In a Danish follow-up study (32), the same question on SRH with five response options was given to 1,007 employees in the health care sector at an interval of 2 years. More than half (56%) of the respondents had the same response, whereas 39% changed one step up or down. Thus, only 5% had experienced major changes in SRH over this period. International comparisons show major differences in SRH between countries (33). These differences can be explained by cultural differences with regard to language as well as real differences in health status. Comparisons within countries show very similar patterns, however. Most studies of SRH have used one item only, such as in the present study. Multi-item scales on SRH have higher precision, whereas single-item measures have higher face validity and are easier to communicate and interpret.

Self-rated health is a measure of how the participant considers his or her own health, which is influenced by the health risks to which that individual is exposed. These health risks could be medicine intake, smoking, alcohol, body weight, diseases, and so on. It may therefore be argued that these health risks should not be considered as confounders, because they are a part of the context of the question to SRH and should therefore not be adjusted for. We repeated the analyses only adjusting for period of abstinence, which did not affect our findings. In addition, we controlled for known confounders like current smoking, exposure to smoking in utero, and body mass index, which did not affect our findings.

We do not have any physiological explanation for the association between SRH and semen quality, apart from the suggestion that SRH and semen quality share a common cause (poor health) that is supported by the relation between SRH and fever and asthma. Understanding how these psychophysiological mechanisms function may be an important challenge for future research. It can also be argued that psychological distress reduces the SRH and affects the reproductive hormones, thereby reducing semen quality. Many animal studies have reported that stress may cause changes in reproductive hormone secretion and suppression of fertility in a variety of primates (34). A newly published Danish study found reduced risk of breast cancer among women with high self-reported stress (35) and speculated that this may be a result of decreased serum estrogen levels. In addition, men with higher sex hormone levels may have increased libido and thereby a better SRH. We found a not statistically significantly lower serum testosterone and free androgen index among men with poor SRH, compared with men with very good or good SRH, which may support the hypothesis that SRH may affect semen quality through altered reproductive hormone levels, or visa versa. The findings, however, need to be confirmed in other populations.

In conclusion, men with very good SRH had better sperm concentration, total sperm count, percentages of morphologically normal sperms, and larger testicular size compared with men with good or poor SRH. Although we cannot pinpoint a likely mechanism, we argue that SRH may be associated with semen quality or share common causes with poor semen quality. To our knowledge, we are the first to demonstrate this association, and our study is cross-sectional and thereby not able to establish a causal relationship. Our findings need to be validated and confirmed with other study designs (preferably prospective) and in populations of different age structure and fertility status.

REFERENCES

1. Bonde JP, Ernst E, Jensen TK, Hjollund NHI, Kolstad H, Henriksen TB, et al. The relation between semen quality and fertility. A population based study of 430 first-pregnancy planners. Lancet 1998;352:1172–7.
2. Andersen AG, Jensen TK, Carlsen E, Jorgensen N, Andersson AM, Krarup T, et al. High frequency of sub-optimal semen quality in an unselected population of young men. Hum Reprod 2000;15:366–72.
3. Jensen TK, Jorgensen N, Punab M, Haugen TB, Suominen J, Zilaitiene B, et al. Association of in utero exposure to maternal smoking with reduced semen quality and testis size in adulthood: a cross-sectional study of 1,770 young men from the general population in five European countries. Am J Epidemiol 2004;159:49–58.
4. Vine MF, Margolin BH, Morrison HI, Hulka BS. Cigarette smoking and sperm density: a meta-analysis. Fertil Steril 1994;61:35–43.
5. Ratcliffe JM, Gladen BC, Wilcox AJ, Herbst AL. Does early exposure to maternal smoking affect future fertility in adult males? Reprod Toxicol 1992;6:297–307.
6. Storgaard L, Bonde JP, Ernst E, Spano M, Andersen CY, Frydenberg M, et al. Does smoking during pregnancy affect sons sperm counts? Epidemiology 2003;14:278–86.
7. Jensen TK, Andersson AM, Jorgensen N, Andersen AG, Carlsen E, Petersen JH, et al. Body mass index in relation to semen quality and reproductive hormones among 1,558 Danish men. Fertil Steril 2004;82:863–70.
8. Sheiner EK, Sheiner E, Carel R, Potashnik G, Shoham-Vardi I. Potential association between male infertility and occupational psychological stress. J Occup Environ Med 2002;44:1093–9.
9. Clarke RN, Klock SC, Geoghegan A, Travassos DE. Relationship between psychological stress and semen quality among in-vitro fertilization patients. Hum Reprod 1999;14:753–8.
10. Wright J, Allard M, Lecours A, Sabourin S. Psychosocial distress and infertility: a review of controlled research. Int J Fertil 1989;34:126–42.

11. Bents H. Psychology of male infertility—a literature survey. Int J Androl 1985;8:325–36.
12. Giblin PT, Poland ML, Moghissi KS, Ager JW, Olson JM. Effects of stress and characteristic adaptability on semen quality in healthy men. Fertil Steril 1988;49:127–32.
13. Fenster L, Katz DF, Wyrobek AJ, Pieper C, Rempel DM, Oman D, et al. Effects of psychological stress on human semen quality. J Androl 1997;18:194–202.
14. Hjollund NH, Bonde JP, Henriksen TB, Giwercman A, Olsen J. Reproductive effects of male psychologic stress. Epidemiology 2004;15:21–7.
15. Bjorner J, Kristensen TS, Orth-Gomér K, Tibblin G, Sullivan M, Westerholm P. Self-rated health. A useful concept in research, prevention and clinical medicine. Stockholm, Sweden: Swedish Council for Planning and Coordination of Research, 1996.
16. Idler EL, Benyamini Y. Self-rated health and mortality: a review of twenty-seven community studies. J Health Soc Behav 1997;38:21–37.
17. Idler EL, Kasl S. Health perceptions and survival: do global evaluations of health status really predict mortality? J Gerontol 1991;46:S55–65.
18. World Health Organization. Laboratory manual for the examination of human semen and semen-cervical mucus interaction. 3rd ed. New York: Cambridge University Press, 1993.
19. Jørgensen N, Auger J, Giwercman A, Irvine DS, Jensen TK, Jouannet P, et al. Semen analysis performed by different laboratory teams: an intervariation study. Int J Androl 1997;20:201–8.
20. Mokdad AH, Bowman BA, Ford ES, Vinicor F, Marks JS, Koplan JP. The continuing epidemics of obesity and diabetes in the United States. JAMA 2001;286:1195–200.
21. Heistaro S, Jousilahti P, Lahelma E, Vartiainen E, Puska P. Self rated health and mortality: a long term prospective study in eastern Finland. J Epidemiol Community Health 2001;55:227–32.
22. Froom P, Melamed S, Triber I, Ratson NZ, Hermoni D. Predicting self-reported health: the CORDIS study. Prev Med 2004;39:419–23.
23. Nybo H, Gaist D, Jeune B, McGue M, Vaupel JW, Christensen K. Functional status and self-rated health in 2,262 nonagenarians: the Danish 1905 Cohort Survey. J Am Geriatr Soc 2001;49:601–9.
24. Hjollund NH, Bonde JP, Henriksen TB, Giwercman A, Olsen J. Job strain and male fertility. Epidemiology 2004;15:114–7.
25. Swan SH, Brazil C, Drobnis EZ, Liu F, Kruse RL, Hatch M, et al. Geographic differences in semen quality of fertile U.S. males. Environ Health Perspect 2003;111:414–20.
26. Jouannet P, Wang C, Eustache F, Jensen TK, Auger J. Semen quality and male reproductive health: the controversy about human sperm concentration decline. APMIS 2001;109:333–44.
27. Jorgensen N, Andersen AG, Eustache F, Irvine DS, Suominen J, Petersen JH, et al. Regional differences in semen quality in Europe. Hum Reprod 2001;16:1012–9.
28. Okosun IS, Choi S, Matamoros T, Dever GE. Obesity is associated with reduced self-rated general health status: evidence from a representative sample of white, black, and Hispanic Americans. Prev Med 2001;32:429–36.
29. Cott CA, Gignac MA, Badley EM. Determinants of self rated health for Canadians with chronic disease and disability. J Epidemiol Community Health 1999;53:731–6.
30. Helweg-Larsen M, Kjoller M, Thoning H. Do age and social relations moderate the relationship between self-rated health and mortality among adult Danes? Soc Sci Med 2003;57:1237–47.
31. Idler EL, Russell LB, Davis D. Survival, functional limitations, and self-rated health in the NHANES I Epidemiologic Follow-up Study, 1992. First National Health and Nutrition Examination Survey. Am J Epidemiol 2000;152:874–83.
32. Borritz M, Rugulies R, Bjorner JB, Villadsen E, Mikkelsen OA, Kristensen TS. Burnout among employees in human service work: design and baseline findings of the PUMA study. Scand J Public Health 2006;34:49–58.
33. Wagner AK, Gandek B, Aaronson NK, Acquadro C, Alonso J, Apolone G, et al. Cross-cultural comparisons of the content of SF-36 translations across 10 countries: results from the IQOLA Project. International Quality of Life Assessment. J Clin Epidemiol 1998;51:925–32.
34. Cameron JL. Stress and behaviorally induced reproductive dysfunction in primates. Semin Reprod Endocrinol 1997;15:37–45.
35. Nielsen NR, Zhang ZF, Kristensen TS, Netterstrom B, Schnohr P, Gronbaek M. Self reported stress and risk of breast cancer: prospective cohort study. BMJ 2005;331:548.