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·*Original Article*·

Do reproductive hormones explain the association between body mass index and semen quality?

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Abstract

Aim: To examine whether reproductive hormones play a role in the association between body mass index (BMI) and semen quality. **Methods:** Semen quality and testosterone (T), luteinizing hormone (LH), follicle-stimulating hormone (FSH) and estradiol (E_2) were evaluated in 990 fertile males with age 38.9 ± 9.7 (mean ± SD) years recruited from the Chinese general population in 2001 and 2002. **Results:** Semen quality was reduced among underweight (BMI < 18.5) compared with normal (BMI 18.5–24.9) and overweight (BMI 25.0–29.9), but the associations were independent of reproductive hormones. After adjustment for the potential confounders, underweight men had reductions in sperm concentration (22.4×10^6/mL), total sperm count (52.9×10^6) and percentage of normal sperm forms (6.9%) compared with men with normal BMI. Being underweight may be a risk factor for low sperm concentration (OR: 4.68, 95% confidence intervals [CI]: 2.01–10.91). Otherwise, being overweight may be a protected factor for low sperm concentration (OR: 0.25; 95% CI: 0.08–0.83) and low total sperm count (OR: 0.37, 95% CI: 0.15–0.87). **Conclusion:** Low BMI was associated with reduced semen quality. The associations between BMI and semen quality were found statistically significant even after adjustment for reproductive hormones. Reproductive hormones cannot explain the association between BMI and semen quality. *(Asian J Androl 2007 Nov; 9: 827–834)*

Keywords: semen quality; reproductive hormones; body mass index

1 Introduction

Being underweight or overweight has adverse effects on reproduction. Even with assisted reproductive technology, both morbidly obese and severely underweight women have a decreased chance of pregnancy. Weight may influence fertility by affecting insulin resistance, androgen binding, and ovulatory function [1]. Some epidemiological studies have investigated the relationships between semen quality and body mass index (BMI) in fertile men. High or low BMI was associated with reduced semen quality [2–4].

Reproductive hormones are also associated with body mass by influencing both fat and muscle tissues, and cause changes for body mass [5–9]. A hypothesis was reasonably proposed by some investigators as to whether

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there was an intermediate role of reproductive hormones in the association between BMI and semen quality. Despite the vast published literature on male semen quality and reproductive hormones and BMI [3–5, 10], no studies could be found in the literature that had comprehensively examined to what extent reproductive endocrines explained the relationship between individual BMI and semen parameters in humans. No study had satisfactorily focused on the hormonal status such as luteinizing hormone (LH), follicle stimulating hormone (FSH), testosterone (T) and estradiol (E_2) and the relationship between BMI and semen quality of fertile males.

Thus the reproductive hormones and BMI of 990 male fertile subjects from five provinces in China were examined. We studied whether reproductive hormones could explain the association between BMI and semen quality in fertile men among the Chinese general population.

2 Materials and methods

2.1 Study population

Nine hundred and ninety male volunteers aged 20–60 years were enrolled in the study from January 2001 to December 2002. All subjects had lived in the localities for at least 5 years and represent the general population for South China and North China in five cities, including Hebei, Shanxi, Guizhou, Zhejiang and Shandong provinces. Half of the subjects were selected in urban areas, and the rest in rural areas. Men who suffered from chronic diseases such as diabetes, kidney disease, atherosclerosis, vascular disease and hypertension were excluded from the study. Subjects with genital diseases, heavy smoking and regular alcohol consumption were also excluded.

The trained staff informed the subjects about the study and obtained their informed consent. They underwent physical examination in Maternal and Child Health Care Centers in the five geographical areas.

2.2 Questionnaire

All subjects completed a questionnaire on the day of the physical examination by face-to-face interview. The questionnaire included information on their demographic characters, period of abstinence and the diseases in reproductive organs (previous or current genital diseases such as cryptorchidism, inguinal hernia, varicocele, epididymitis, gonorrhea, chlamydia, and operation for torsion of the testis). The subjects were asked their education level and the current health situation. Smoking habits were reported as the average number of cigarettes or pipes smoked per day. The total weekly alcohol intake (number of drinks) was estimated by calculating the beer, wine, and liquor intake.

2.3 Physical examinations

Physical examinations were performed by a trained physician in each location. The weight of the subjects was measured in kilograms using one weighing scale by the doctors in each center. Height was measured in centimeters without socks and shoes, with the subject's eyes and ears on the same horizontal line. The BMI was calculated as weight in kilograms divided by the squared height in meters (kg/m^2). The possible presence of a varicocele, a hydrocele, the location of testis in scrotum, and the consistency of the testis and epididymis were also recorded.

2.4 Semen collection and analysis

Semen specimens were collected in a sterile plastic container in a private room near the laboratory after a period of 2 to 6 days of sexual abstinence. The duration of sexual abstinence and season at semen collection were recorded. All the semen samples were kept at 37ºC to liquefy to make routine semen analysis according to the World Health Organization guidelines [11]. The semen smears were air-dried, stained and preserved, and the same technician assessed all the smeared slides to determine sperm morphology.

The following semen variables were used as outcome variables: semen volume, sperm concentration, total sperm count, percentage of motile spermatozoa (percentage of sperm with rapid and linear progressive motility and sluggish linear motility), and percentage of normal sperm forms. Normal values for standard sperm parameters were considered as sperm concentration $\geq 20 \times 10^6$/mL, total sperm count $\geq 40 \times 10^6$ and percentage of normal sperm forms $\geq 30\%$.

The laboratory had been under the external quality assessment scheme for the andrology laboratory by the trained staff. Weekly laboratory controls were performed by examining the same semen samples blindly. The variations of all semen parameters were less than 5% throughout the study period.

2.5 Hormone analysis

All blood samples were collected from a cubital vein into 10 mL vacuum tubes for serum collection for each subject at 8:00–10:00 in the morning. After cooling at room temperature, the tubes were centrifuged at 3 000 × *g* for 10 min. Blood samples were separated and frozen immediately. After a maximum of 7 days in the refrigerator, sera were stored at –70ºC and kept frozen until analysis. All analyses were performed by the trained technician at the Obstetrics and Gynecology Hospital of Medical Center, Fudan University (Shanghai, China).

Serum concentrations of hormones (T, FSH, LH and E_2) were measured by radioimmunoassay (Kit Coat-A-Count; Diagnostic Products Corporation, Los Angeles, CA, USA). The lower limits of detection (LODs) for the assays were 0.1 nmol/L, 0.2 IU/L, 0.2 IU/L, and 8.0 pmol/L, respectively. Inter- and intra-assay coefficients of variation (CV) for both FSH and LH were 3% and 4.5%. The intra- and inter-assay CV for T were 6% and 8%. The intra- and inter-assay CV for E_2 were 7.5% and 13%, respectively.

2.6 Statistical analysis

Overall differences in sperm concentration, total sperm count, percentages of morphologically normal and motile spermatozoa and semen volume between BMI groups categorized into four BMI groups as 'underweight' (BMI < 18.5), 'normal' (18.5–24.9), 'overweight' (25.0–29.9), and 'obese' (BMI ≥ 30) based on World Health Organization classification [12] were analyzed by ANOVA. Once significance was established, post hoc tests (Tukey's or Bonferroni's) were performed to make comparisons among different BMI groups. Multivariate ANOVA and logistic regression were used to control for potential confounders. Correlations between semen parameters and BMI were tested by partial correlation method.

The potential confounders included smoking (yes/no), alcohol intake (> 1 alcohol drink per week, yes/no), season of semen sampling (April–September/October–March), period of abstinence (less than 3 days or 4–5 days or 6 days later), and age (years, as a continuous variable). Previous history of urogenital disorder (all disorders were grouped into one binary variable). Reproductive hormones were categorized as three groups (subjects with normal reproductive hormones taken as a reference) and entered as dummy variables in stepwise (the laboratory's internal normal reference range: LH [3.3–13.5 IU/L], FSH [4.4–20.2 IU/L], testosterone [12.7–39.7 nmol/L], E_2 [32.8–207.4 pmol/L]). The characteristics of the study populations with respect to potential confounders are shown in Table 1.

The risk of abnormal semen quality between different BMI groups was estimated by their odds ratios. The potential confounders were added to the model step-by-step according to their effect on the risk estimate, but were excluded stepwise only if they were not statistically significant at a 10% level. Data analyses were performed with an SAS 8.1e package (SAS Institute, Cary, NC, USA).

3 Results

Characteristics of subjects were shown in Table 1. Almost all participants (97.4%) reported no previous history of urogenital disorders. The subjects had the BMI of 23.2 ± 2.9 kg/m^2 (mean ± SD) and a mean age of 38.9 ± 9.7 years (mean ±SD). Forty-two subjects (4.2%) were classified as underweight, 690 (69.8%) as normal weight, 241 (24.3%) as overweight and 17 (1.7%) as obese. Mean ages ± SD in four BMI groups were 37.3 ± 10.1 years, 38.4 ± 9.9 years, 39.9 ± 9.9 years and 39.0 ± 9.9 years. And their mean BMIs ± SD were 17.7 ± 0.7 kg/m^2, 22.2 ± 1.8 kg/m^2, 26.6 ± 1.2 kg/m^2 and 31.4 ± 1.6 kg/m^2, respectively. The mean duration of abstinence was 4.9 ± 1.6 days among all the subjects. Mean ± SD of abstinence days in four BMI groups were 4.6 ± 1.4, 4.8 ± 1.3, 5.1 ± 2.3 and 4.8 ± 1.0, respectively. Fifty-one percent of the subjects had their semen collected in October–March and 49% in April–September. A weekly alcohol intake and regular smoking were reported by 46.1% and 49.3%, respectively. The mean ± SD of serum T, LH, FSH and E_2 were 19.09 ± 7.75 nmol/L, 4.43 ± 1.08 IU/L, 5.02 ± 3.05 IU/L and 18.93 ± 6.59 pmol/L, respectively. Only serum T and FSH were different across BMI groups. Serum T of underweight men (26.37 ± 1.62 nmol/L) was the highest among all the BMI groups, whereas FSH of obese men was the highest (7.38 ± 1.22 IU/L) (data not shown).

Sperm concentration, total sperm count and percent of normal sperm forms of the underweight (BMI < 18.5) men were 45.2 × 10^6/mL, 117.8 × 10^6 and 35.8%, respectively, which were lower than the normal men (BMI 18.5–24.9) and overweight men (BMI 25.0–29.9). The percentage of motile sperm was 74.5%, which was higher than those men with normal BMI and overweight men. The semen volumes of different BMI groups were not

Table 1. Characteristics of study population according to different body mass index (BMI) groups.

Characteristics	BMI groups < 18.5 (n = 42) n (%)	18.5–24.9 (n = 690) n (%)	25.0–29.9 (n = 241) n (%)	≥ 30.0 (n = 17) n (%)
Centers				
Hebei	1 (2.4)	140 (20.3)	52 (21.6)	3 (17.6)
Shanxi	2 (4.8)	145 (21.0)	49 (20.3)	1 (5.9)
Guizhou	30 (71.4)	152 (22.0)	9 (3.7)	1 (5.9)
Zhejiang	6 (14.3)	137 (19.9)	56 (23.2)	6 (35.3)
Shandong	3 (7.1)	116 (16.8)	75 (31.1)	6 (35.3)
Educational levels				
Illiterate	1 (2.4)	2 (0.3)	1 (0.4)	0 (0.0)
Elementary school	7 (16.7)	62 (9.0)	16 (6.6)	2 (11.8)
Junior high school	16 (38.1)	279 (40.4)	73 (30.3)	10 (58.8)
Senior high school	12 (28.6)	235 (34.1)	96 (39.8)	2 (11.8)
College	6 (14.3)	112 (16.2)	55 (22.8)	3 (17.6)
Period of abstinence (days)				
≤ 3	13 (31.0)	125 (18.1)	38 (15.8)	1 (5.9)
4–5	16 (38.1)	346 (50.1)	117 (48.5)	11 (64.7)
6–8	13 (31.0)	219 (31.7)	86 (35.7)	5 (29.4)
Season at semen collection				
April–September	21 (50.0)	335 (48.6)	121 (50.2)	6 (35.3)
October–March	21 (50.0)	355 (51.4)	120 (49.8)	11 (64.7)
Diseases in reproductive organs				
No	40 (95.2)	674 (97.7)	233 (96.7)	17 (100.0)
Yes	2 (4.8)	16 (2.3)	8 (3.3)	0 (0.0)
Alcohol intake (>1 time/week)				
No	33 (78.6)	386 (55.9)	111 (46.1)	4 (23.5)
Yes	9 (21.4)	304 (44.1)	130 (53.9)	13 (76.5)
Smoking				
No	12 (28.6)	336 (48.7)	146 (60.6)	8 (47.1)
Yes	30 (71.4)	354 (51.3)	95 (39.4)	9 (52.9)
Age (years, mean ± SD)	37.3 ± 10.1	38.4 ± 9.9	39.9 ± 9.9	39.0 ± 9.9
BMI (kg/m^2, mean ± SD)	17.7 ± 0.7	22.2 ± 1.8	26.6 ± 1.2	31.4 ± 1.6
Abstinence (days, mean ± SD)	4.6 ± 1.4	4.8 ± 1.3	5.1 ± 2.3	4.8 ± 1.0

statistically significant (Table 2). After adjustment for study centers, age, diseases in reproductive organs, smoking, alcohol and period of abstinence, underweight men had reductions in sperm concentration (22.4 × 10^6/mL), total sperm count (52.9 × 10^6/mL) and percentage of normal sperm forms (6.9%) compared with men with normal BMI. Semen volume and the percentage of motile spermatozoa were, however, not associated with a reduced BMI. After adjustment for the above cofounders together with reproductive hormones, underweight men still had significant reductions in sperm concentration (18.4 × 10^6/mL), total sperm count (46.7 × 10^6/mL) and percentage of normal sperm forms (5.7%) compared with men with normal BMI, although the reductions seemed to be slightly smaller.

After controlling for no variable or the serum T, LH, FSH, E_2 or all four reproductive hormones, respectively, partial correlation analyses showed that a significant positive correlation between BMI and sperm concentration, the total sperm count and percentage of spermatozoa of

Table 2. Estimated marginal mean ± SD of semen quality between different body mass index (BMI) groups. †Crude mean ± SD of semen quality. ‡Adjusted for study centers, age, diseases in reproductive organs, smoking, alcohol intake and period of abstinence. §Adjusted for the study centers, age, diseases in reproductive organs, smoking, alcohol intake, period of abstinence and reproductive hormones. #Significantly different from normal BMI group and overweight group.

Variables of semen quality (Mean ± SD)	BMI groups < 18.5	18.5–24.9	25.0–29.9	≥ 30.0	P value
Model 1†					
Semen volume (mL)	2.8 ± 0.20	2.5 ± 0.04	2.5 ± 0.07	2.5 ± 0.29	0.18
Sperm concentration ($\times 10^6$/mL)	45.2 ± 4.74#	69.1 ± 1.35	76.2 ± 3.35	70.6 ± 10.35	0.00
Total sperm count (10^6)	117.8 ± 14.25#	175.3 ± 4.63	196.6 ± 9.51	149.5 ± 25.47	0.00
Motile sperm (%)	74.5 ± 1.58#	70.2 ± 0.45	69.1 ± 0.87	72.4 ± 2.83	0.05
Morphologically normal forms (%)	35.8 ± 1.26#	41.2 ± 0.53	44.3 ± 0.97	44.4 ± 3.67	0.00
Model 2‡					
Semen volume (mL)	2.8 ± 0.16	2.5 ± 0.04	2.6 ± 0.07	2.2 ± 0.25	0.15
Sperm concentration ($\times 10^6$/mL)	46.7 ± 6.24#	69.1 ± 1.53	75.8 ± 2.6	70.2 ± 9.73	0.00
Total sperm count (10^6)	121.5 ± 19.43#	174.4 ± 4.76	196.1 ± 8.1	148.2 ± 30.29	0.00
Motile sperm (%)	72.3 ± 1.79	70.0 ± 0.44	70.0 ± 0.75	72.9 ± 2.79	0.46
Morphologically normal forms (%)	36.2 ± 2.13#	43.1 ± 0.52	44.7 ± 0.89	44.1 ± 3.32	0.00
Model 3§					
Semen volume (mL)	2.8 ± 0.17	2.5 ± 0.04	2.6 ± 0.07	2.2 ± 0.25	0.12
Sperm concentration ($\times 10^6$/mL)	50.6 ± 6.41#	69.0 ± 1.54	74.4 ± 2.67	70.3 ± 9.74	0.00
Total sperm count (10^6)	126.7 ± 19.97#	173.4 ± 4.81	195.2 ± 8.32	149.8 ± 30.35	0.00
Motile sperm (%)	69.9 ± 1.76	69.7 ± 0.42	71.1 ± 0.73	73.3 ± 2.67	0.27
Morphologically normal forms (%)	35.4 ± 2.17#	41.1 ± 0.52	45.5 ± 0.91	44.7 ± 3.31	0.00

Table 3. Partial correlation coefficients between body mass index (BMI) and semen quality indices. ${}^bP < 0.05$, ${}^cP < 0.01$, compared with 0, the partial correlation coefficients were statistically significant. T, testosterone; LH, luteinizing hormone; FSH, follicle-stimulating hormone; E_2, estradiol.

Controlling for	Semen volume	Sperm concentration	Total sperm count	Percentage of motile sperm	Percentage of sperm of normal morphology
None	0.0150	0.1120c	0.0930c	–0.1100c	0.1030c
T	0.0388	0.0693b	0.0763b	–0.0427	0.1124c
LH	0.0079	0.1147c	0.0907	–0.1098c	0.1139c
FSH	0.0222	0.1141c	0.1043	–0.0110b	0.1608c
E_2	0.0210	0.1117c	0.1004	–0.0839b	0.1563c
T, LH, FSH, E_2	0.0288	0.0724c	0.0743b	–0.0387	0.1268c

normal morphology. A significant negative correlation between BMI and percentage of motile sperm was found. But the correlation between BMI and semen volume was not found (Table 3).

Abnormal cases of semen quality in obese men (BMI ≥ 30.0) were too few to conduct separate analyses. In the unadjusted model 1, underweight men (BMI < 18.5) had a higher, but insignificant, risk of low sperm concentration (OR: 1.87; 95% confidence intervals [CI]: 0.74–4.73), low total sperm count (OR: 1.70; 95% CI: 0.25–1.97), and low percentage of normal sperm forms (OR: 1.91; 95% CI: 0.91–4.01). Overweight men (BMI 25.0–29.9) had a lower, but insignificant, risk of low sperm concentration (OR: 0.45; 95% CI: 0.13–1.61), low total sperm count (OR: 0.70; 95% CI: 0.27–1.80) and low percentage of normal sperm forms (OR: 0.71, 95%

Table 4. Odds-ratios (OR) and 95% confidence intervals (CI) according to body mass index and abnormal semen quality[&]. [†]Crude ORs and 95% CI. [‡]Adjusted for the study centers, age, diseases in reproductive organs, smoking, alcohol intake and period of abstinence. [§]Adjusted for the study centers, age, diseases in reproductive organs, smoking, alcohol intake, period of abstinence and reproductive hormones. *OR is statistically significant. [&]The analyses of obese men was omitted for the small cases of abnormal semen quality.

OR (95% CI)	BMI groups		
	< 18.5	18.5–24.9	25.0–29.9
Sperm concentration < 20×10^6/mL			
Model 1[†]	1.87 (0.74–4.73)	1.00 (–)	0.45 (0.13–1.61)
Model 2[‡]	4.68 (2.01–10.91)*	1.00 (–)	0.25 (0.08–0.83)*
Model 3[§]	5.56 (2.36–13.12)*	1.00 (–)	0.20 (0.05–0.84)*
Total sperm count < 40×10^6			
Model 1[†]	1.70 (0.25–1.97)	1.00 (–)	0.70 (0.27–1.80)
Model 2[‡]	1.94 (0.73–5.17)	1.00 (–)	0.37 (0.15–0.87)*
Model 3[§]	2.69 (0.99–7.29)	1.00 (–)	0.25 (0.08–0.83)*
Percentage of normal sperm forms < 30%			
Model 1[†]	1.91 (0.91–4.01)	1.00 (–)	0.71 (0.44–1.13)
Model 2[‡]	1.98 (0.98–3.98)	1.00 (–)	0.76 (0.50–1.16)
Model 3[§]	1.39 (0.62–3.09)	1.00 (–)	0.76 (0.41–1.41)

CI: 0.44–1.13). No association between BMI and low percentage of normal sperm forms was found (Table 4).

Associations between BMI and abnormal semen quality after adjustment for study centers, age, diseases in reproductive organs, smoking, alcohol and period of abstinence are presented in model 2. The proportion of abnormal semen quality as a function of BMI in the underweight, overweight and obese groups tended to be uniform compared with the normal BMI group. Being underweight may have an increased risk of low sperm concentration (OR: 4.68; 95% CI: 2.01–10.91). Otherwise, being overweight may have protected factors for the low sperm concentration (OR: 0.25; 95% CI: 0.08–0.83) and low total sperm count (OR: 0.37; 95% CI: 0.15–0.87) compared with men with normal BMI, respectively. Association between BMI and low percentage of normal sperm forms was not found as yet (Table 4).

Additional analyses were conducted to determine whether the reproductive hormones were caused by a specific source of abnormal semen quality or whether they were consistent among those BMI from either low or high. Among model 3, the same tendency for the point ORs estimate were present after adjustment for study centers, age, diseases in reproductive organs, smoking, alcohol and period of abstinence and reproductive hormones. The same tendency of ORs for the associations between BMI and low sperm concentration and low total sperm count was found, although the strength of associations differed. Being underweight may have an increased risk of low sperm concentration (OR: 5.56; 95% CI: 2.36–13.12). Otherwise, being overweight may have protected factors for low sperm concentration (OR: 0.20; 95% CI: 0.05–0.84) and low total sperm count (OR: 0.25: 95% CI: 0.08–0.83) compared with men with normal BMI, respectively. No association between BMI and low percentage of normal sperm forms was found after adjustment for reproductive hormones (Table 4).

4 Discussion

Slight changes of the associations between BMI and semen quality were found when reproductive hormones were taken into consideration, but most of the associations remained significant after adjustment. Similar results were reproduced when semen indices were examined as either continuous variables or categorized as abnormal. Even after adjustment for the T, LH, FSH, E_2 and all the reproductive hormones, BMI had a statistically significant correlation with the semen quality.

The significant association between BMI and lower sperm concentrations and total sperm counts has been reported in previous studies, but none took reproductive hormones into consideration in the association between BMI and semen quality [2–5, 13–15]. The current study indicated that the association between BMI and semen quality was clearly more complex than could be accounted for simply by reproductive hormones. It has also been suggested that high T was not a predictor of semen quality [2], however, the mean serum FSH concentration was higher in obese men with slightly reduced semen quantity. Thus, the finding of FSH hypersecretion in the obese group suggests that there were other factors resulting into reduced semen quality. In addition, the concentration of FSH did not differ between the underweight, normal and overweight groups. A word of caution is warranted, however, as we collected only a single blood sample, and this may have been insufficient to reveal true changes because of marked fluctuations of the reproductive hormones' concentration.

The significant correlation between BMI and sperm concentration, total sperm count, percentage of motile sperm and sperm with normal morphology was found even after adjustment for the reproductive hormones. These findings were unlikely to explain the effect of the reproductive hormones.

It is well known that the testicle is responsible for both the production of sperm and the synthesis of testosterone (T) in adult males. Control of both functions is guided by the central nervous system in a classic endocrine feedback loop with FSH and LH as the key hormonal signals. LH acts on Leydig cells in the testicular interstitium to promote the synthesis of T, while FSH affects the Sertoli cells thereby facilitating spermatogenesis. FSH and LH secretion from the anterior pituitary is regulated by hormonal signals from both the hypothalamus and the testes, including T, E_2, dihydrotestosterone (DHT) and inhibin B. It is clear that reproductive hormones regulate the development of sperm in a wide range of mechanisms [16]. It has also been suggested that higher concentrations of T may be a facilitating factor for spermatogenesis, and FSH could positively influence the quality [17]. Indeed, a previous report indicated that reproductive hormones can be predictors for semen quality in couples without known reduced fertility [18].

Further studies are needed to assess whether the changes in an amplitude range of reproductive hormones may be attributed to an intermediate effect on the association between BMI and semen quality or to a masking effect. Likewise, to what extent the differences between various levels of the reproductive hormones can affect the BMI or the semen quality should be further explored. Our results with regard to hypersecretion of T and FSH levels in underweight and obese males of general population indicated that measurements of T and FSH may not represent natural function.

In conclusion, the current study indicated that semen quality was reduced among underweight men compared with normal BMI, but the associations were independent of reproductive hormones. It did not support the hypothesis that reproductive hormones play an intermediate or confounding role in the association between BMI and semen quality. Potential confounding bias, however, could not be ruled out completely. It remains unknown how BMI plays a role in the changed semen quality. Clearly, these findings must be confirmed by other studies. However, it seems reasonable to advise underweight men to avoid being too thin, as it may cause adverse semen quality.

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