# Semen quality analysis of military personnel from six geographical areas of the People's Republic of China

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**Objective:** To examine the determinants of semen quality in a large sample of military personnel from different geographical areas of the People's Republic of China.

**Design:** Cross-sectional study.

**Setting:** Six representative geographical regions in China: Beihai, Lhasa, Germu, Xinzhou, Huhehaote, and Mohe.

**Patient(s):** 1,194 army personnel aged 18 to 35 years at the time of their inclusion in the study, sampled between 2007 and 2009.

**Intervention(s):** None.

**Main Outcome Measure(s):** Semen volume (in milliliters), sperm concentration (in millions per milliliter), percentage of motile spermatozoa, total sperm count (in millions), and relative risk of subfertility.

**Result(s):** The median values were 3.0 mL for semen volume, $39.4 \times 10^6$ per mL for sperm concentration, $120.1 \times 10^6$ for total sperm count, 15.8% for sperm rapid progressive motility, 30.1% for sperm progressive motility, and 43.9% for total motility. We found that 88.3% of the servicemen had at least one semen parameter below normal values according to World Health Organization (WHO) recommendations (1999), and 62.5% according to WHO recommendations (2010). Season, average altitude, and duration of sexual abstinence all were statistically significantly associated with semen quality.

**Conclusion(s):** The men had markedly lower mean sperm concentrations, sperm counts, and sperm motility compared with WHO recommendations. Possible contributory factors included diet, lifestyle, climate, and altitude. (Fertil Steril® 2011;95:2018–23. ©2011 by American Society for Reproductive Medicine.)

**Key Words:** Chinese military personnel, semen parameters, semen quality

Based on 61 reports published between 1938 and 1990, Carlsen et al. (1) conducted a meta-analysis that indicated a significant general decrease in mean sperm concentration from 113 million/mL in 1940 to 66 million/mL in 1990. Although some subsequent studies have confirmed the decline in sperm concentration, others have failed to detect a temporal trend (2–15), with the contradictory results variously attributed to sample selection bias, regional differences, and/or experimental error (16–19).

To our knowledge, most studies of semen quality have been based on men who were long-term or permanent residents of a region and were recruited from the general population (10, 19). With globalization of the world economy, population mobility has been increasing rapidly; by 2007, there were estimated to be 120 million internal migrants in China (20). Given these numbers, reproductive function in the male Chinese migrant population has become an important national health issue. More generally, changes in patterns of migrant fertility may reveal the influence of environmental factors and lifestyle on semen quality.

In China, all military personnel are posted to a region at some distance from their home province. Because all servicemen share comparable living environments and lifestyles, according to the International Union for the Scientific Study of Population (21), they can be regarded as representative of a migrant population within China. We therefore decided to evaluate the semen quality of a cross section of military personnel serving in the People's Liberation Army (PLA), to determine the percentage who had normal semen parameters according to World Health Organization (WHO) recommendations and to investigate the effect of selected potential risk factors on semen quality.

## MATERIALS AND METHODS
### Study Design

China has a wide variety of geographic environments, including tropical and cold zones, upland plateaus and plains, and coastal and inland regions. Six districts where military personnel are posted and which are geographically representative of the country's regional characteristics were selected: Beihai

## TABLE 1

**Characteristics of the study population.**

| Characteristic | Beihai | Lhasa | Germu | Xinzhou | Huhehaote | Mohe | Total |
|---|---|---|---|---|---|---|---|
| Number of participants | 168 | 216 | 174 | 128 | 320 | 188 | 1,194 |
| Mean age (y) | 25.9 | 24.3 | 26.2 | 26.4 | 25.6 | 24.4 | 25.4 |
| Age (y) | | | | | | | |
|   18–20 | 6 | 56 | 12 | 4 | 34 | 30 | 142 |
|   21–25 | 70 | 74 | 56 | 38 | 110 | 84 | 432 |
|   26–30 | 88 | 82 | 100 | 84 | 144 | 74 | 572 |
|   30–35 | 4 | 4 | 6 | 2 | 24 | 0 | 40 |
| Mean time in military service (y) | 6.6 | 3.9 | 6.5 | 5.4 | 5.7 | 3.8 | 5.3 |
|   1–2 | 18 | 17 | 12 | 12 | 17 | 21 | 97 |
|   2–3 | 5 | 27 | 13 | 18 | 22 | 16 | 101 |
|   >3 | 61 | 64 | 62 | 34 | 117 | 57 | 395 |
| Season | | | | | | | |
|   Summer (July) | 0 | 0 | 174 | 0 | 0 | 0 | 174 |
|   Autumn (Sept, Oct) | 168 | 216 | 0 | 128 | 320 | 0 | 832 |
|   Winter (Nov, Jan) | 0 | 0 | 0 | 0 | 0 | 188 | 188 |
| Mean ejaculation abstinence time (d) | 4.1 | 4.8 | 4.1 | 4.5 | 4.7 | 4.5 | 4.5 |
| Mean time to start of semen analysis (min) | 28 | 30 | 29 | 27 | 30 | 30 | 29 |

*Zou. Semen quality in Chinese military. Fertil Steril 2011.*

(Guangxi province, coastal tropical zone), Lhasa (Tibet autonomous region, cold plateau), Germu (Qinghai province, cold plateau), Xinzhou (Shanxi province, inland plains), Huhehaote (Inner Mongolia autonomous region, inland plains), and Mohe (Helongjiang province, cold inland). More detailed climatic and geographical characteristics of these districts are provided in Supplemental Table 1 & Supplemental Figure 1.

Sample collection occurred from September 16 to 23, 2009, in Beihai; September 3 to 12, 2007, in Lhasa; July 18 to 29, 2008, in Germu; October 9 to 17, 2009, in Xinzhou; October 18 to 27, 2009, in Huhehaote; and January 7 to 16, 2008, in Mohe. Administration of the questionnaire, physical examinations, and semen collection and analysis were undertaken at the appropriate local military family planning institutions by the same two staff members of the Airforce General Hospital, Beijing, China. Ethics approval was provided by the Airforce General Hospital Ethics Committee, Beijing, China, which supervises all six regional centers. Approval also was obtained from the Ethics Committees of Capital Medical University, Beijing. Each participant voluntarily signed an informed consent form after the nature of the proposed project was explained at the local test sites. Participation rates in the study were high, with little variation between the different regions (i.e., ranging from 80.4% in Beihai to 85.6% in Lhasa).

## Participants

A total of 1,438 servicemen were initially recruited and screened for entry into the study, with 244 (16.9%) excluded due to reproductive disorders (213, 14.8%) or <2 days or >7days duration of sexual abstinence (31, 2.1%). All 1,194 eligible volunteers who completed the study were Han Chinese drawn from 26 different provinces of China, with 616 volunteers from northern China and 578 from southern China. All participants had been stationed for at least 1 year at their sampling locations, which as previously noted were distant from their birthplace or former residence. A detailed description of the inclusion and exclusion criteria of the study is provided in the Supplemental Materials and Methods (available online).

## Questionnaire

The standardized questionnaire used in each center comprised detailed information on age and birthplace, lifestyle factors, period and nature of military service (e.g., driver, radar serviceman), sexual history, reproductive history, the consumption of tobacco, alcohol, and drugs, and previous or current diseases.

## Physical Examination

All participants had previously undergone a thorough general medical examination on entry to military service. To ensure comparability in the study, all participants were examined by the same experienced urologist. Secondary sexual characteristics and the possible presence of a varicocele, a hydrocele, the location of the testis in the scrotum, and the consistency of the testis and epididymis were examined to exclude men with reproductive or urologic diseases.

## Semen Analysis

Semen samples were assessed according to the WHO 1999 recommendations (22). After liquefaction and within 1 hour of ejaculation, the samples were analyzed for semen volume and pH, sperm concentration, and motility (defined as WHO motility grades A, B, C, and D).

## Statistics

As semen parameters follow markedly skewed (non-normal) distributions, unadjusted mean and median values, standard deviation (SD), and 25th to 75th percentiles were calculated for each variable. Percentages coincident with WHO recommendations (1999, 2010) were also calculated and stratified according to military service location. A nonparametric Kruskal-Wallis analysis of variance was used to compare between-group medians. The effects of possible confounders were tested by multiple regression analysis, initially for all six groups combined and then by individual location. The tests were two-sided, and $P>.05$ was considered statistically significant. Further details of the physical examinations, semen analyses and statistical assessments are provided in the Supplemental Materials and Methods (available online).

## RESULTS

The general biological characteristics of the 1,194 men are summarized in Table 1. A large majority of the men (95.9%) were 18 to 30 years old, their mean ages ranged from 24.3 years old (Lhasa) to 26.4 years old (Xinzhou), and their mean period of military service was 5.3 years. A majority of 1,075 (90.0%) participants also reported zero alcohol consumption, and 2.6% had an average daily tobacco exceeding 10 cigarettes. Only 23 (1.9%) participants were