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MACLEOD REVISITED: SPERM COUNT DISTRIBUTIONS IN 374 FERTILE MEN FROM 1971 TO 1994

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ABSTRACT

Objectives. There has been an enormous amount of interest as to whether sperm counts are declining over time. We sought to compare a contemporary group of fertile men to those from the MacLeod study of 1951 to ascertain whether sperm counts in fertile men have changed over time.

Methods. We obtained sperm count data from 374 fertile men who banked sperm in Minnesota prior to vasectomy from 1971 to 1994 and compared them to sperm count distributions from the 1000 fertile men of MacLeod's study. Semen analyses were performed as per World Health Organization guidelines using identical techniques in both the present and MacLeod studies.

Results. The contemporary group had a mean sperm count of $102 \pm 81 \times 10^6$/mL (median 85×10^6/mL) compared to $107 \pm 74 \times 10^6$/mL (median 90×10^6/mL) for MacLeod's data. There are no significant differences in mean or median sperm counts or sperm count distributions between the groups.

Conclusions. We find remarkable similarities in sperm count distributions in cohorts of fertile men from 1951 and 1971 to 1994. Sperm counts in fertile men have not changed appreciably in the 40 years since MacLeod's report. UROLOGY **51:** 86–88, 1998.

There has been enormous interest as to whether sperm counts have declined over time.[1–5] In 1992 Carlsen *et al.*[1] in a meta-analysis of 61 studies published from 1938 to 1991 suggested a worldwide decline in semen quality over the last 50 years. Auger *et al.*[3] in 1995 reported a 30% decrease in sperm concentration over a 20-year period among fertile sperm donors from a single sperm bank in Paris, France. Irvine *et al.*[4] evaluated sperm counts from Scottish men between 1984 and 1995 and reported decreased values.

Recently each of these studies has been criticized for various reasons. In the meta-analysis by Carlsen *et al.*,[1] criticism has focused on differing protocols for semen analysis in the 61 included studies, variations in inclusion criteria, methodologic inconsistencies, patient selection bias, and geographic bias. When the data from the meta-analysis were reanalyzed by Olsen *et al.*,[5] an increase in sperm counts was noted from 1970 to 1990. The studies by Auger *et al.*[3] and Irvine *et al.*[4] are widely criticized due to significant selection bias in that only fertile sperm donors were included for study and therefore excluded important data from fertile men who attempted to become sperm donors but were rejected.

In contrast, we have previously found no decline in semen quality in 1283 men evaluated at three locations in the United States. In fact we found a statistically significant increase in sperm counts in the United States from 1970 to 1994.[6] To further evaluate whether there has been a change in sperm count distributions over time, we compared sperm count distributions from a group of men with proven fertility from 1971 to 1994 to those from the first study on sperm count distributions published by MacLeod and Gold in 1951.[7]

MATERIAL AND METHODS

Semen analysis data was obtained from all men who banked sperm prior to vasectomy at the nation's oldest sperm bank, Cryogenic Laboratories, Inc. (Roseville, Minn). Cryogenic Laboratories, Inc. was chosen because the technique used for semen analysis is identical to that used in the analysis of semen parameters in the patients from MacLeod and Gold's[7] study. Six hundred thirty-two men banked sperm prior to vasectomy at this sperm bank from 1971 to 1994. This group has previously been reported on.[6] Although all of these men presumably had been fertile in the past, only 374 definitively reported on a prevasectomy questionnaire that they had fathered children. These men are the subject of the remainder of this paper.

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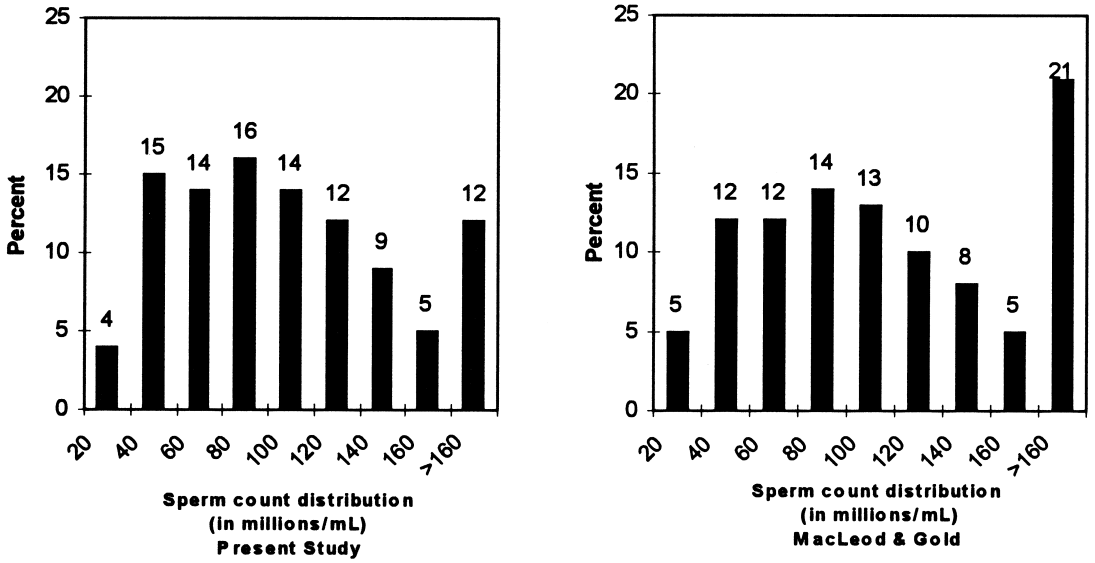

FIGURE 1. *Sperm count distributions (percent of patients with sperm count below each increment of 20 × 10^6/mL).*

Data gathered included the year of sperm banking, age, and the sperm count. Where multiple specimens were banked, only the initial semen sample was used for analysis. Men were asked to abstain from ejaculation for a minimum of 3 days prior to specimen collection by masturbation.

Semen Analysis Technique

In brief, specimens were brought to the laboratory within 1 hour after masturbation. After liquefaction, volume was measured. Semen was diluted 1 to 50. A 0.01-mL aliquot of this diluent was placed on a Neubauer hemacytometer (Hausser Scientific, Horsham, Pa) and allowed to sit for 2 minutes. Under high power, the number of spermatozoa in 8 of the 16 large squares on the corners of the analysis grid were counted. This count was then repeated using a different eight squares. The average of these two values was taken as the sperm count $\times 10^6$/mL. MacLeod and Gold[8] had also described use of a hemacytometer with an identical technique to determine sperm counts.

Statistical Methods

Statistical methods included calculation of the mean, median, and the standard deviation for this population using standard methods. In addition, sperm count distributions using 20 × 10^6/mL increments, identical to that used by MacLeod and Gold,[7] were performed. Results were then compared to MacLeod and Gold's data from 1951.

RESULTS

The studied group included 374 sperm counts from men with documented fertility. This was compared to the sperm counts of 1000 fertile men from MacLeod and Gold's[7] 1951 study. The contemporary group had a mean sperm count of 102 ± 81 × 10^6/mL (median 85 × 10^6/mL) compared to 107 ± 74 × 10^6/mL (median 90 × 10^6/mL) for MacLeod's[7] data. Comparison of the mean and median of these two groups fails to produce a statistically significant difference. Further analysis of the data using sperm count distributions in a fashion identical to MacLeod and Gold's[7] reveals remarkable similarities between the two groups (Fig. 1).

COMMENT

Although many investigators have attempted to define absolute or relative semen parameters that indicate fertility, none have found any that are reliable to define male fertility. Despite decades of work, the study cited most frequently is that of MacLeod and Gold[7] from 1951. These authors compared semen analyses from 1000 men with proven fertility (wives were pregnant at the time of the analysis) to those of 1000 men from infertile couples. They concluded at that time that there was no absolute sperm count level at which fertility was defined, but that there was a step up in fertility potential above the level of 20 × 10^6/mL. Specifically, of the 211 men with sperm counts below 20 × 10^6/mL, 22% were from the fertile group and 78% were from the infertile group. If this sperm count level were not a discriminator, one would expect that 50% of the patients in this low sperm count group would be contributed by both the fertile and the infertile men. At all sperm count distribution levels above 20 × 10^6/mL, approximately 50% of the total was contributed by the fertile group and 50% by the infertile group.

Recently, there has been an enormous amount of interest in both the scientific and the lay press about declining sperm counts over time.[1–5] We have recently published data showing no decline in sperm counts in men who banked sperm prior to vasectomy from 1970 to 1994 from three United States sperm banks at different geographic locations.[6] Since MacLeod and Gold[7] is still cited most prominently in defining a "normal" sperm count, we compared our

sperm count data from 374 men with proven fertility who banked sperm prior to vasectomy in Minnesota from 1971 to 1994 to MacLeod and Gold's data from 1951 to look at whether sperm count distributions have changed over the last 40 years. We calculated the mean, median, standard deviation, and sperm count distributions exactly as MacLeod and Gold[7] did to compare the two populations. Comparison of the mean and median of these two groups fails to demonstrate a significant difference. As illustrated in Figure 1, comparing sperm count distributions by 20×10^6/mL intervals, there is no dramatic change from 1951 to the present. The only area of significant difference is at counts over 160×10^6/mL. MacLeod and Gold[7] found 21% of their population above this level while we found only 12%. Possible reasons for this difference include differences in duration of abstinence as well as age. Both parameters have been shown in previously published reports to have effects on sperm counts.[8,9] Whereas we do have data on duration of abstinence and age for each man in the contemporary cohort, and have used this data to correct sperm counts for differences in these parameters in our other publications, no such data are available in the MacLeod and Gold[7] study.

CONCLUSIONS

By revisiting MacLeod and Gold,[7] the most cited reference for semen parameters indicative of fertility, we have shown that sperm count distributions in fertile men have not changed appreciably over the last 40 years. This challenges the assertions of previously published reports indicating a decline in sperm counts over a similar period of time.[1–5]

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