ORIGINAL ARTICLE: ANDROLOGY

Strong adherence to a healthy dietary pattern is associated with better semen quality, especially in men with poor semen quality

Elsje C. Oostingh, M.D.,[a] Régine P. M. Steegers-Theunissen, M.D., Ph.D.,[a,b] Jeanne H. M. de Vries, M.Sc.,[c] Joop S. E. Laven, M.D., Ph.D.,[d] and Maria P. H. Koster, M.D., Ph.D.[a]

[a] Department of Obstetrics and Gynecology, Division of Obstetrics and Prenatal Medicine, Erasmus MC, University Medical Centre Rotterdam, Rotterdam; [b] Department of Pediatrics, Division of Neonatology, Erasmus MC, University Medical Centre Rotterdam, Rotterdam; [c] Department of Human Nutrition, Wageningen University, Wageningen; and [d] Department of Obstetrics and Gynecology, Division of Reproductive Medicine, Erasmus MC, University Medical Centre Rotterdam, Rotterdam, the Netherlands

Objective: To study associations between periconceptional dietary patterns and semen quality parameters.
Design: Prospective periconception cohort study.
Setting: Tertiary hospital.
Patient(s): One hundred and twenty-nine male partners of pregnant women who participated in the Rotterdam Periconception Cohort (Predict study).
Intervention(s): None.
Main Outcome Measure(s): Semen quality parameters—ejaculate volume, sperm concentration, total sperm count, progressive motility, immotile sperm, and total motile sperm count (TMSC).
Result(s): Men included in our study were on average 35 (±6 standard deviation) years old and had a body mass index of 26.4 ± 4 kg/m^2. Two dietary patterns were identified using principle component analysis, which were labeled as "healthy" and "unhealthy." An increase of one factor score (stated as β) represented an increase of 1 standard deviation. Sperm concentration ($\beta = 0.278$; 95% CI, 0.112–0.444), total sperm count ($\beta = 1.369$; 95% CI, 0.244–2.495), progressive motility ($\beta = 4.305$; 95% CI, 0.675–7.936), and TMSC ($\beta = 0.319$; 95% CI, 0.113–0.526) were all positively associated with a strong adherence to the healthy dietary pattern. Subgroup analysis showed that these associations were mainly present in men with a TMSC <10 million spermatozoa. Although there was a trend toward a diminution in semen quality, we found no statistically significant associations with strong adherence to the unhealthy dietary pattern.
Conclusion(s): The positive associations between strong adherence to a healthy dietary pattern and semen parameters in men with poor semen quality support the importance of preconceptional tailored nutritional counseling and coaching of couples who are trying to conceive. (Fertil Steril® 2017;■:■–■. ©2017 by American Society for Reproductive Medicine.)
Key Words: Dietary pattern, male subfertility, semen analysis

Discuss: You can discuss this article with its authors and with other ASRM members at https://www.fertstertdialog.com/users/16110-fertility-and-sterility/posts/14960-23415

Over the past decades, several studies have provided evidence that semen quality in humans might be decreasing, which might lead to an increase in male subfertility (1, 2). This can be caused by intrinsic factors such as genetic or congenital disorders and cancer, but a decline in semen quality is also observed in healthy men without any adverse medical history (2, 3). Besides intrinsic factors, semen quality can also be affected by modifiable lifestyle behaviors. For example, studies have suggested that specific nutritional factors can affect semen quality (4–6).

Parental nutritional status is a crucial determinant of normal reproductive function (7), and the nutritional environment of the fetus affects the future child's health, as stated by the

Received November 18, 2016; revised February 10, 2017; accepted February 11, 2017.
E.C.O. has nothing to disclose. R.P.M.S.-T. has nothing to disclose. J.H.M.d.V. has nothing to disclose. J.S.E.L. is a consultant for Euroscreen, Roche, outside of the submitted work, and holds a grant from Dutch Heart Association, outside of the submitted work. M.P.H.K. has nothing to disclose.
Reprint requests: Maria P. H. Koster, M.D., Ph.D., Department of Obstetrics and Gynecology, Division of Obstetrics and Prenatal Medicine, Erasmus MC, University Medical Centre Rotterdam, P.O. Box 2040, Rotterdam 3000 CA, the Netherlands (E-mail: m.p.h.koster@erasmusmc.nl).

Fertility and Sterility® Vol. ■, No. ■, ■ 2017 0015-0282/$36.00

http://dx.doi.org/10.1016/j.fertnstert.2017.02.103

Developmental Origin of Health and Disease paradigm (8). Malnutrition is known to disturb several metabolic pathways, and prominent among these is the one-carbon (1-C) metabolism (9, 10). The 1-C metabolism is in particular essential for DNA synthesis and phospholipid and protein biosynthesis. Derangements in this metabolism can lead to excessive oxidative stress, which can detrimentally affect gametogenesis and fertilization (11, 12). Several nutrients serve as substrate or cofactor to support the 1-C metabolism, such as folate and vitamin B_{12} (11).

A low intake of full-fat dairy food, sweets, and processed meat and a high intake of folate-rich food sources such as fruits and vegetables have been positively associated with healthy semen quality (5, 6, 13–15). A high intake of fruits, vegetables, fish, and whole grains is associated with less sperm DNA damage than usual (4). Moreover, the use of folic acid and zinc supplements is known to increase the total normal sperm count in subfertile men (16, 17). Despite these findings, the impact of a healthy or unhealthy dietary pattern remains unclear because most studies have only focused on the association between semen quality and a single nutrient or food group or only a few nutrients or food groups. This single nutrient approach may be limited because people consume meals that consist of a varying combination of foods that contain lots of different nutrients (18, 19). Some other studies have used dietary pattern analysis, a more accurate approach, to identify the effect of the balance between food groups and nutrients on semen quality (19–21).

During preconception counseling often little attention is paid to nutrition, especially in men. However, an unhealthy dietary pattern can be modified, so couples planning a pregnancy may benefit from the knowledge of the possible positive effect of nutrition on semen quality. To substantiate this, we identified dietary patterns in men and studied the associations with semen quality parameters.

MATERIALS AND METHODS

Study Population

This study was part of the Rotterdam Periconceptional Cohort (Predict study), an ongoing prospective, tertiary, hospital-based cohort study embedded in patient care and conducted at the department of Obstetrics and Gynecology of the Erasmus University Medical Centre, Rotterdam, the Netherlands. The details of this study have previously been described elsewhere (22).

For the current study, we selected men from the participating couples who were included in the study before 12 weeks of gestation between November 2010 and November 2014. Men were excluded when a semen sample was not available or when there was no information about their dietary patterns based on a food frequency questionnaire (FFQ). The window between the date of semen analysis and the date on which the FFQ was completed was restricted to a maximum of 1 year because of the accumulating evidence that dietary patterns remain reasonably constant over time except for in periods of dieting and illness (23–25). If there was more than one semen sample available, the parameters of the sample closest to the moment of completing the FFQ were used in this study (Fig. 1). The study protocol has been approved by the medical ethical and institutional review board of the Erasmus MC, University Medical Centre in Rotterdam, the Netherlands, and all male participants provided written informed consent (METC Erasmus MC 2004-277).

Data Collection

At study entry, all male participants completed a self-administered general questionnaire covering details on paternal age, ethnicity, educational level, medical history, previous children and periconceptional lifestyle (smoking, alcohol use, and folic acid or multivitamin supplements use) at enrollment. At the same moment, qualified research nurses obtained anthropometric measurements (height, weight, waist-hip ratio, and blood pressure) (22). A validated semi-quantitative FFQ, developed by the division of Human Nutrition, Wageningen University, the Netherlands, was used to estimate habitual food intake over the 4 weeks before study entry (26, 27). The FFQ consists of 196 food items structured according to meal patterns, with questions including consumption frequency, portion size, and preparation method. Intake of food, food groups, and energy and nutrients were determined using the Dutch food composition table (28). At enrollment, the research nurses checked the FFQs in a standardized manner for completeness and consistency.

Semen Analysis

Semen samples were collected via masturbation into polypropylene containers. Within 1 hour the samples were liquefied, and the semen parameters—semen volume, sperm concentration, total sperm count, percentage progressive motility, and percentage immotile motility—were assessed according to World Health Organization (WHO) guidelines (29). We defined normospermia as a total motile sperm count (TMSC) of ≥ 10 million spermatozoa.

All semen analyses were performed by expert laboratory staff at the Erasmus MC, University Medical Center Rotterdam, the Netherlands. Semen samples were not routinely collected as part of the Predict study; they were collected only when there was a medical indication. Semen parameters were retrieved from medical records to obtain all the data required for our study.

Statistical Analysis

First, we compared the baseline characteristics between the men who were included and excluded in our study to investigate whether our study sample was a representative reflection of the entire Predict cohort (selection bias). These characteristics were expressed as medians with interquartile ranges or absolute numbers with percentages and were compared using either Mann-Whitney *U* or chi-square tests.

A total of 196 food items from the FFQs were reduced to 23 predefined food groups based on origin and similar nutrient content (18). Next, we performed a principal