

Impact of Nutrition on Female Reproductive Disorders

Pasquapina Ciarmela * and Stefania Greco

Department of Experimental and Clinical Medicine, Università Politecnica delle Marche, 60126 Ancona, Italy; s.greco@pm.univpm.it

* Correspondence: p.ciarmela@univpm.it; Tel.: +39-0712206270

The female reproductive system is a delicate and complex system in the body that can be affected by many disorders. Many pathologies may occur during the female reproductive age, from menarche through menopause, and may impair women's fertility and pregnancy outcomes [1].

Nutrition may benefit different female organs, providing an important protective effect on the reproductive system, while specific nutritional deprivation may result in gynecological and fertility health problems [2–4].

This Special Issue of *Nutrients* collected 11 papers (6 original articles, 2 reviews, 1 opinion, 1 systemic review and 1 commentary) focusing on the impact of nutrition on female reproductive disorders.

Among nutrients, vitamins are the most known elements essential for human health. Our body needs only tiny amounts of vitamins; however, they have a big role in maintaining a healthy status, while the deficiencies of different vitamins can harm health in different ways [5–7].

The present Special Issue covers three articles on vitamin D [8–10] and one on vitamin A [8]. The articles on vitamin D are two original articles [9,10] and one commentary [11]. The original articles report two different populations, Swedes [9] and Finns [10], regarding the effect of vitamin D insufficiency on female infertility. These findings are in line with recent literature, as reported in the commentary by Grzeczka et al., which provides an update on the importance of vitamin D and vitamin D deficiency in the oocyte and the follicular microenvironment, wherein vitamin D deficiency has been associated with decreased live birth rates among women undergoing in vitro fertilization [11].

In an in vivo study, Li and colleagues demonstrated that dysbacteriosis of the intestinal flora due to colitis may reduce ovarian function in mice due to reduced vitamin A absorption [8].

The intestinal flora has also been studied in another study included in this Special Issue that reports its important role in pregnancy outcomes for embryo quality as a consequence of short-chain fatty acids produced by the gut microbiota [12].

Two articles focused on carbohydrates [13,14]. Salcedo and colleagues wrote an opinion article that encourages a lifestyle-based intervention such as therapeutic carbohydrate restriction as prevention and potential treatment of all gynecologic disorders that lead to Abnormal Uterine Bleeding [13]. On the other hand, the disaccharide trehalose is a naturally occurring carbohydrate that may be useful to promote good health because of its properties that do not stimulate rapid increases in blood glucose. The experimental study of Kang et al. showed that trehalose suppresses lysosomal anomalies in supporting cells of oocytes, suggesting a possible therapeutic effect on female fertility, although the clinical use remains speculative and limited [14].

Polycystic Ovary Syndrome (PCOS) has been considered in two papers [15,16]. A deficiency in dietary fiber can be associated with a wide range of metabolic abnormalities and with an altered gut microbial ecosystem that can be associated with reproductive abnormalities, including PCOS. Therefore, Leung and colleagues wrote a systematic

Citation: Ciarmela, P.; Greco, S. Impact of Nutrition on Female Reproductive Disorders. *Nutrients* **2023**, *15*, 4576. <https://doi.org/10.3390/nu15214576>

Received: 14 September 2023

Revised: 15 September 2023

Accepted: 28 September 2023

Published: 27 October 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

review that reported a meta-analysis of available evidence on the dietary fiber intake level in PCOS patients [15].

In the second paper about PCOS, Guarano and colleagues reviewed the existing literature to report the efficacy and the limitations of alpha lipoic acid in PCOS treatment since alpha lipoic acid is considered a promising therapeutic strategy for this very complex syndrome due to its multiple actions, including anti-inflammatory, antioxidant, and insulin-sensitizing [16].

With regard to uterine disease, the review of Li et al. supports the potential of melatonin supplements in the development of endometriosis, although more clinical trials are needed to confirm its therapeutic effects and safety [17]. The last paper is an in vitro study that explored the potential of a specific fruit extract on a malignant gynecological disease. It has been observed that the extract of the cultivar Romina strawberry, characterized by a high content of anthocyanins and antioxidant capacity, can reduce the spheroid formation and the extracellular matrix apposition of leiomyoma cell line cultured in three-dimensional agarose gel [18].

Overall, the knowledge of the potential of nutrients in promoting human health and wellbeing is rapidly improving. We are glad that this collection includes interesting studies on the benefits of nutrition in the prevention and therapy of female reproductive disorders.

Author Contributions: Conceptualization, P.C. and S.G.; writing—review and editing, P.C. and S.G. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: The editors like to thank all participating authors.

Conflicts of Interest: The authors declare no conflict of interest

References

- Deffieux X, Rousset-Jablonski C, Gantois A, Brillac T, Maruani J, Maitrot-Mantelet L, Mignot S, Gaucher L, Athiel Y, Baffet H, Bailleul A, Bernard V, Bourdon M, Cardaillac C, Carneiro Y, Chariot P, Corroenne R, Dabi Y, Dahlem L, Frank S, Freyens A, Grouthier V, Hernandez I, Iraola E, Lambert M, Lauchet N, Legendre G, Le Lous M, Louis-Vahdat C, Martinat Sainte-Beuve A, Masson M, Matteo C, Pinton A, Sabbagh E, Sallee C, Thubert T, Heron I, Pizzoferrato AC, Artzner F, Tavenet A, Le Ray C, Fauconnier A. Examen pelvien en gynécologie et obstétrique : recommandations pour la pratique clinique [Pelvic exam in gynecology and obstetrics: Guidelines for clinical practice]. *Gynecol Obstet Fertil Senol.* 2023; 51(6):297-330. French. doi: 10.1016/j.gofs.2023.04.001.
- Izetbegovic S, Alajbegovic J, Mutevelic A, Pasagic A, Masic I. Prevention of diseases in gynecology. *Int J Prev Med.* 2013; 4(12):1347-58. PMID: 24498489; PMCID: PMC3898439.
- Kussmann, M.; Fay, L.B. Nutrigenomics and personalized nutrition: Science and concept. *Per. Med.* 2008, 5, 447–455
- Tan BL, Norhaizan ME, Liew WP. Nutrients and Oxidative Stress: Friend or Foe? *Oxid Med Cell Longev.* 2018; 2018:9719584. doi: 10.1155/2018/9719584.
- Elhusseini, H.; Lizneva, D.; Gavrilova-Jordan, L.; Eziba, N.; Abdelaziz, M.; Brakta, S.; Halder, S.; Al-Hebdy, A. Vitamin d and female reproduction. In *A Critical Evaluation of Vitamin D: Basic Overview*; Gower, S., Ed.; IntechOpen: London, UK, 2017; p. 297
- Shenkin A. Micronutrients in health and disease. *Postgrad Med J.* 2006; 82(971):559-67. doi: 10.1136/pgmj.2006.047670.
- Ryan-Harshman M, Aldoori W. Health benefits of selected vitamins. *Can Fam Physician.* 2005; 51(7):965-8. PMID: 16060174;
- Li, Z.; Chen, C.; Yu, W.; Xu, L.; Jia, H.; Wang, C.; Pei, N.; Liu, Z.; Luo, D.; Wang, J.; et al. Colitis-Mediated Dysbiosis of the Intestinal Flora and Impaired Vitamin A Absorption Reduce Ovarian Function in Mice. *Nutrients* 2023, 15, 2425. <https://doi.org/10.3390/nu15112425>.
- Maaherra Armstrong, P.; Augustin, H.; Bärebring, L.; Osmancevic, A.; Bullarbo, M.; Thurin-Kjellberg, A.; Tsiartas, P. Prevalence of Vitamin D Insufficiency and Its Determinants among Women Undergoing In Vitro Fertilization Treatment for Infertility in Sweden. *Nutrients* 2023, 15, 2820. <https://doi.org/10.3390/nu15122820>.
- Lumme, J.; Morin-Papunen, L.; Pesonen, P.; Sebert, S.; Hyppönen, E.; Järvelin, M.-R.; Herzig, K.-H.; Ojaniemi, M.; Niinimäki, M. Vitamin D Status in Women with a History of Infertility and Decreased Fecundability: A Population-Based Study. *Nutrients* 2023, 15, 2522. <https://doi.org/10.3390/nu15112522>.
- Grzeczka, A.; Graczyk, S.; Skowronska, A.; Skowronski, M.T.; Kordowitzki, P. Relevance of Vitamin D and Its Deficiency for the Ovarian Follicle and the Oocyte: An Update. *Nutrients* 2022, 14, 3712. <https://doi.org/10.3390/nu14183712>.

12. Yao, X.; Dong, S.; Guan, W.; Fu, L.; Li, G.; Wang, Z.; Jiao, J.; Wang, X. Gut Microbiota-Derived Short Chain Fatty Acids Are Associated with Clinical Pregnancy Outcome in Women Undergoing IVF/ICSI-ET: A Retrospective Study. *Nutrients* 2023, 15, 2143. <https://doi.org/10.3390/nu1509214>.
13. Salcedo, A.C.; Yun, J.; Carter, C.; Hart, E. Therapeutic Carbohydrate Restriction as a Metabolic Modality for the Prevention and Treatment of Abnormal Uterine Bleeding. *Nutrients* 2023, 15, 3760. <https://doi.org/10.3390/nu15173760>.
14. Kang, W.; Ishida, E.; Amita, M.; Tatsumi, K.; Yonezawa, H.; Yohtsu, M.; Katano, D.; Onozawa, K.; Kaneko, E.; Iwasaki, W.; et al. Trehalose Suppresses Lysosomal Anomalies in Supporting Cells of Oocytes and Maintains Female Fertility. *Nutrients* 2022, 14, 2156. <https://doi.org/10.3390/nu14102156>.
15. Leung, W.T.; Tang, Z.; Feng, Y.; Guan, H.; Huang, Z.; Zhang, W. Lower Fiber Consumption in Women with Polycystic Ovary Syndrome: A Meta-Analysis of Observational Studies. *Nutrients* 2022, 14, 5285. <https://doi.org/10.3390/nu14245285>.
16. Guarano, A.; Capozzi, A.; Cristodoro, M.; Di Simone, N.; Lello, S. Alpha Lipoic Acid Efficacy in PCOS Treatment: What Is the Truth? *Nutrients* 2023, 15, 3209. <https://doi.org/10.3390/nu15143209>.
17. Li, Y.; Hung, S.-W.; Zhang, R.; Man, G.C.-W.; Zhang, T.; Chung, J.P.-W.; Fang, L.; Wang, C.-C. Melatonin in Endometriosis: Mechanistic Understanding and Clinical Insight. *Nutrients* 2022, 14, 4087. <https://doi.org/10.3390/nu14194087>.
18. Greco, S.; Pellegrino, P.; Giampieri, F.; Capocasa, F.; Delli Carpini, G.; Battino, M.; Mezzetti, B.; Giannubilo, S.R.; Ciavattini, A.; Ciarmela, P. The In Vitro Effects of Romina Strawberry Extract on 3D Uterine Leiomyosarcoma Cells. *Nutrients* 2023, 15, 2557. <https://doi.org/10.3390/nu15112557>.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.