Journal of Applied Life Sciences International

Volume 25, Issue 7, Page 8-14, 2022; Article no.JALSI.81479
ISSN: 2394-1103

Nutrition-therapy in the Management of Infertility

A. A. Oladejo [a*], C. R. Abah [b] and C. S. Anarado [b]

[a] Department of Applied Biochemistry, Faculty of Biosciences, Nnamdi Azikiwe University, Awka, Nigeria.
[b] Department of Food Science and Technology, Nnamdi Azikiwe University, Awka, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JALSI/2022/v25i7588

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/81479

Review Article

Received: 17/12/2021
Accepted: 22/02/2022
Published: 20/12/2022

ABSTRACT

Apart from aging, smoking, consumption of caffeine and alcohol, stress, agonist sports, chronic exposure to environmental pollutants, and other nutritional habits which are most often non-modifiable have detrimental effect on both man and woman's fertility. Specifically, metabolic disorders such as diabetes, obesity and hyperlipidemia usually associated with the intake of excess calorie have been reported to have direct and indirect effect on fertility by causing damage to the health and differentiation of oocyte/spermatocyte and interference with the pituitary-hypothalamic axis respectively, which consequently lead to dysfunctional oogenesis/spermatogenesis. Obese women have lower insulin sensitivity, resulting in prolonged hyperinsulinemia, which may play a role in the development of Polycystic Ovary Syndrome. Thus, reduction in insulin secretion which could be brought about by dietary adjustments remain an effective non-pharmacological treatment to prevent infertility, and a Mediterranean diet aimed at maintaining normal body mass could be effective in promoting ovarian health and physiology. since oxidative stress have been implicated in defective oocyte/spermatocyte maturation, a proper intake of antioxidants and methyl-donor supplements (1-Carbon Cycle) may decline the toxic oxidants bioavailability and this could ultimately promote the maturation of the oocyte and the spermatocyte.

**Corresponding author: E-mail: aa.oladejo@unizik.edu.ng;*

Keywords: Infertility; nutrition; lifestyle.

1. INTRODUCTION

Infertility is now considered a key problem in our present day society and this occurs in about 20–30% of the female population [1]. Infertility according to the American Society of Reproductive Medicine (ASRM) is the inability of a woman of reproductive age to conceive after one or more years of regular unprotected copulation. According to World Health Organization (WHO), about 80 million women globally have been affected to date, with a incidence of ~50% of all women in developing countries [2]. Although series of gynecological and systemic diseases are known to affect an individual's fertility, lifestyle factors and environmental conditions like stressful jobs, unbalanced nutrition and unhealthy diet unite to interfere with fertility in both men and women. Hence, abnormal body weight as well as unhealthy diets exerts a detrimental effect on both spermatogenesis and ovulatory function. Aside from interfering with the safety of gametes, various substances found in common diets impair the implantation of a healthy embryo. This review examines how various lifestyles and poor dietary regimens might affect women's reproductive health, as well as how sufficient nutritional support may improve fertility.

1.1 Major Lifestyle Factors Affecting Fertility

Obesity, smoking, strenuous physical activity, alcohol intake, drug addiction, and other substance abuse have all been found to have a negative impact on both male and female fertility [2,3]. To Yet, Assisted Reproductive Technology (ART) methods are often used in the treatment of most infertility cases. This method is known to restore normal oocyte maturation. However, the major factors influencing infertility are discussed below.

1.1.1 Age

Apart from lifestyle factors, age is a major factor that affects conception in women. The chances of conception have been said to be on the decline from the ages of 25–30 years [4]. As a result of the decline in ovarian reserve and oocyte quality, it is projected that the global trend of deferring maternity would lead to an increase in involuntary childlessness. The increase in oocyte vitrification leading in pregnancy and live birth rate rises comparable to using fresh oocytes has given cryopreserved oocytes a chance for future practise presenting women with the possibility to delay their motherhood [4].

1.1.2 Tobacco smoking, coffee and alcohol abuse

Smoking of tobacco has been reported to have a detrimental effect on the reproductive health of both men and women, albeit acting in different ways. When associated with nutritional or secondary health problems, heavy alcohol use has an indirect effect on fertility [5].

Smoking is linked to a quick loss in ovarian reserves, delayed conception, a higher risk of spontaneous miscarriage, and a poorer ART success rate in women, while it is linked to a considerable reduction in the percentage of normal semen morphology and motility in men [5]. Several researchers have investigated the influence of alcohol intake on reproductive outcomes in several studies, yet a significant relation between alcohol intake, oocyte maturation, decreased fertilization and the rate of lost pregnancies remain unclear [6]. Ferroni et al. [7] studied the effects of these lifestyle factors on in vitro fertilization (IVF) outcomes in 351 couples who visited the PIVET Medical Center in Western Australia. The regression analyses indicated that smoking significantly reduces the quality of gametes in both sexes, resulting in reduced in ovarian reserve in women and a massive reduction in density, count, mobility, and morphology of sperm in men, when considering the quantity of collected oocytes, fertilisation rates, pregnancy, and pregnancy loss. Female alcohol use, on the other hand, had no link with fertility parameters, however male alcohol consumption had a beneficial influence on fertilisation rate in the cohort with an accompanying fruit and vegetable diet [6]. In addition, research suggests that high intake of caffeine has a potential dose-response association which results to delayed conception and increased risk of loss of pregnancy [8]. Therefore, based on the available evidences, there is an important impact of tobacco smoking on IVF clinical outcomes. However, the link between alcohol consumption and infertility needs to be well explored.

1.1.3 Stress

Many recent studies have discovered a link between women's daily stress levels and their chances of becoming pregnant. Women with high amounts of alpha amylase, a stress-related enzyme in their saliva, take 29 percent longer to conceive than those with lower levels [9]. In a study carried out by Purewal et al. [10], the authors reported a favorable success of ART treatments and an improved conception was linked to the absence of depression and anxious mental states. In addition, constant relaxation has been shown to be helpful in decreasing psychological distress in infertile women which could consequently increase conception rates [11,12].

1.1.4 Environmental pollutants

There has been strong evidence that links environmental pollutants with increased rate of infertility. According to the Occupational Safety and Health Administration (OSHA), continous exposure to chemical agents such as organic solvents, heavy metals, aromatic amines, pesticides and vegetal toxins increased the incidence of infertility and recurrent miscarriages. In addition, environmental pollutants have been implicated in the induction of DNA modifications and consequently lead to genetic mutations [13,14].

2. NUTRITIONAL DISORDERS

A healthy nutrition is required for a normal reproductive performance. Consumption of foods with high calories has been linked to the root cause of obesity which is often implicated in the development of infertility especially in western societies. Abnormal nutrition have been reported to be capable of causing permanently oocyte immaturation [14].

2.1 Malnutrition

There is an increase evidence that increased infertility and alterations of the physiological ovarian cyclicity are caused by deficient food intake, inadequate alimentary regimes, strong dietary restrictions which consequently leads to delayed puberty, lengthening of the post-partum interval to conception and lower gonadotropin secretion levels. Because a change in energy balance is linked to a decrease in ovulatory maturation in women [15], a lack of protein, micro and macrominerals, as well as vitamins, is linked to a decrease in reproductive effectiveness. As a result, poor nutrition is associated to the pathophysiology of female reproduction [16].

2.2 Overweight and Obesity

According to World Health Organization, about 9 – 25 % of women in the developed countries are overweight and obese. Since overweight and obesity are implicated in the pathological conditions of woman's reproductive age, these factors pose greater risk especially when affected by gestational diabetes [15]. The adipose tissue is responsible for ovulatory abnormalities in affected people due to insulin resistance (IR) and elevated levels of insulin and androgens, and anovulation associated with obesity is linked to a higher risk of miscarriages and infertility [15]. In obese women, management of anovulation includes diet and exercise. However, in patients without ovulatory disorders, overweight and obesity prolong the time of conception and increase the rates of gestational diabetes, hypertension, perinatal mortality and morbidity [15]. A number of studies have reported that Western food patterns and regular physical activity reduce infertility and improve the efficiency of ART pregnancy programmes in overweight women. In females wanting to conceive, the review of lifestyle patterns and the change of unhealthy behaviours through suitable help or particular management, such as acid folic supplements, must be systematic [13].

2.3 Polycystic Ovary Syndrome (PCOS)

PCOS is a hormonal disorder that is common among women of reproductive age. About 20 % of women of reproductive age is being affected across the globe [17]. Women with PCOS may have prolonged menstrual periods or excess male hormone (androgen) levels. The ovaries may often develop several small collection of fluid and consequently fail to release egg regularly. Symptoms of PCOS often develop around the time of first menstrual period during puberty and it is characterized with irregular periods, elevated levels of androgen and enlarged ovaries. The signs and symptoms of PCOS is typically severe in obese people [17]. Although the exact cause of PCOS remain unclear, factors such as excess insulin, low-grade inflammation, heredity as well as excess androgen could trigger it [18]. Researchers have however link the complications of PCOS to infertility, gestational diabetes, premature birth, metabolic syndrome, sleep apnea, depression as well as endometrial cancer among others [19].

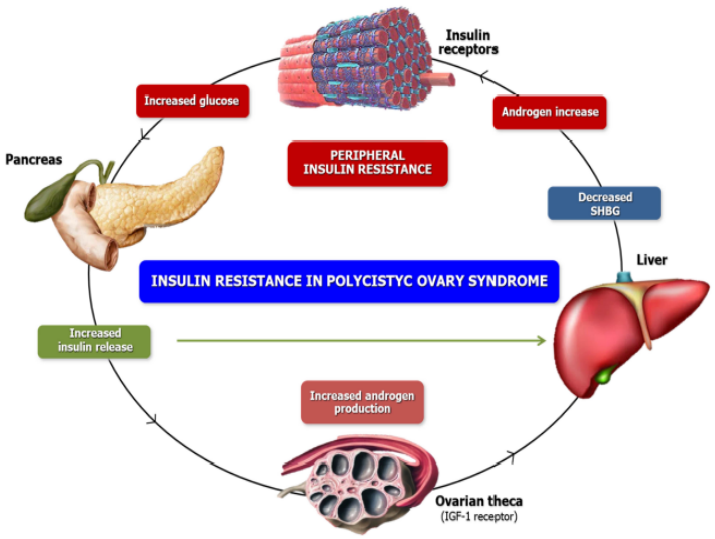

Fig. 1. Mechanism of hyperandrogenism [5]

2.4 Metabolic Syndrome (MS)

MS is a cluster of conditions that occur together which increases the risk of heart diseases, stroke and type 2 diabetes. These conditions include elevated blood pressure, increased blood glucose, excess fat around the waist as well as increased cholesterol levels. MS remain a crucial health challenge especially in the developed countries as it affects approximately 30% of the population [20]. Sedentary lifestyle and intake of hypercaloric diet have been documented to be the leading cause of metabolic syndrome. MS is also thought to play a role in the development of cancer, particularly in the gastrointestinal tract. Females with MS, poor metabolic control, and primary or secondary amenorrhea had low levels of luteinizing hormone (LH) and follicle stimulating hormone (FSH), as well as a lack of residual insulin secretion, according to several studies [21]. It's interesting to note that all therapeutic options for restoring insulin homeostasis in obese and MS patients, such as Thiazolidinediones, Metformin, weight-loss lifestyle modifications, or bariatric surgery, have been shown to restore ovulation and hyper-androgenemia [22] (Fig. 1).

3. HEALTHY NUTRITION FOR A HEALTHY OVULATION

Nutrition is important in promoting reproductive efficiency in both men and women. Even though the function of diet in female fertility is unclear, the association between nutrition and reproductive performance, as well as the connection between ovulatory problems and metabolic diseases, suggests that dietary variables may have an etiological role in some infertility variations [23,24]. The following table summarises the role of many nutrients that may affect female fertility.

3.1 Proteins

Adequate consumption of high quality protein is crucial for the creation and repair of all body tissues, as well as for the production of hormones, enzymes and blood cells. However, excessive consumption of animal protein may impair fertility [25,26]. Studies have suggested that women who consume high animal protein were 41 % more likely to struggle with ovulatory infertility than women who consume plant-based protein. In roughly 20% of women, ovulatory disorders have been recognised as the fundamental cause of infertility. Hence, women who desire to achieve pregnancy are advised to avoid continuous intake of processed meat.

3.2 Carbohydrates

Carbohydrate is a naturally occurring compound, or derivatives of such a compound, with the general chemical formular $C_x(H_2O)_y$. They are the most widespread organic substances and they play a crucial role in all life especially as the main source of energy for the body. According to Chavarro et al. [27], the quality of carbohydrate in the diet influenced the incidence of ovulatory infertility, with women who consumed more carbohydrate having a 78 percent higher risk. Similar assertion was made by Clifton et al. [28].

3.3 Lipids

Lipids are necessary components of the diet for both energy production and the delivery of important fatty acids. As a result, the effect of fats on female reproductive is a major topic of investigation. Trans fatty acids are hypothesised to have an unfavourable effect on reproductive health by altering the membrane lipid content of the ovum, which then impacts metabolic pathways [28,29]. Toivonen [30] claims that trans fatty acids cause insulin resistance by altering the fatty acid content of adipocyte membranes.

3.4 Antioxidants

The hallmark characteristic of the Mediterranean diet is the high content of antioxidant. Antioxidants are nutrients that help to fight inflammation and neutralize free radicals that are detrimental to cellular health and the DNA [31,32]. Since the ovum are highly sensitive to oxidative stress caused by free radicals, antioxidants helps to protect the ovum from possible corresponding damage. Therefore, current clinical practice suggests that integrating diet with some nutritional supplements that are rich in antioxidant and capable improving fertility is essential for reproductive health [33]. Antioxidants are best sourced from brightly coloured fruits and vegetables such as citrus fruits, spinach, avocados and beets among others. Glutathione is a natural molecule with a significant detoxifying action that helps the cell mainta in its redox state by minimising the formation of free radicals. Beta-carotene, Vitamin E, Vitamin C, and Coenzyme Q10 (CoQ10) are further antioxidants whose lack or changed concentrations, alone or in combination, can seriously damage the operation of the entire detoxifying system [34]. The antioxidant beta-carotene, predominantly found in deep yellow orange, carrots and sweet potatoes have been reported to boost cell growth as well as prevent early miscarriage. Furthermore, beta-carotene is thought to play a role in hormonal regulation since it is concentrated within the corpus luteum, which produces the majority of the progesterone needed to keep a pregnancy going. Watermelon is high in the antioxidant glutathione, which is important for the quality of eggs. Pineapple is also getting a lot of attention for helping with conception since it contains an enzyme called bromelain, which has been proven in tests to help with implantation by having anti-inflammatory characteristics. The effect of regular ascorbic acid consumption has been well documented in the literature, with evidence that it can boost human placental/trophoblastic steroidogenesis, which physiologically supports gestation [34].

3.5 Folates

Folic acid (vitamin B9) is another vital nutrient throughout the period before conception and early pregnancy. Proper intake of folic acid has been linked to improvement in female fertility. Research has shown that women who consume about 400 µg of folic acid per day are 40 % less likely to be diagnosed with ovulatory infertility over a period of years. A good quantity of folic acid are also essential to prevent major abnormalities of the fetal brain and spinal cord (Fig. 2). Dietary sources of folic acid include corn, whole grains, Papaya, berries, green leafy vegetables, peanuts, almonds, sunflower seeds among others.

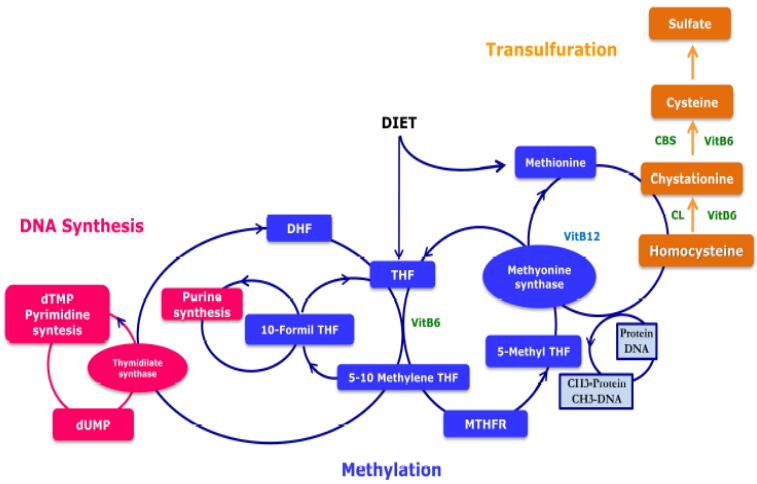

Fig. 2. Metabolism of folates [5]

4. CONCLUSION

Infertility is a worldwide medical and social problem caused by a variety of pathophysiological changes. Because dietary supplements containing folic acid, -carotene, Vitamin C, and E are effective in increasing ovulation and, as a result, female fertility, an adequate intake of antioxidants improves female reproductive functions. As a result, a proper mix of proteins, carbs, fats, antioxidants, and folate in the daily diet is critical for female reproductive health and lowers the risk of infertility.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Habbema JD, Collins J, Leridon H, Evers JL, Lunenfeld B, Velde ER. Towards less confusing terminology in reproductive medicine: Aproposal. Human Reproduction. 2014;19(1):497-501.
2. Ombelet W, Cooke I, Dyer S, Serour G, Devroey P. Infertility and the provision of infertility medical services in developing countries. Human Reproduction Update. 2015;14:605–21.
3. Anderson K, Nisenblat V, Norman R. Lifestyle factors in people seeking infertility treatment - a review. Austr. N Zeal J Obstetr Gynaecol. 2010;50:8–20.
4. De Jong AM, Menkveld R, Lens JW, Nienhuis SE, Rhemrev JP. Effect of alcohol intake and cigarette smoking on sperm parameters and pregnancy. Andrologia. 2014;46:112–7.
5. Silvestris E, Cohen M, Cornet D, Jacquesson-Fournols L, Clement P, Chouteau J. Supporting the one-carbon cycle restores ovarian reserve in subfertile women: absence of correlation with urinary bisphenolA concentration. Bio Res Open Access. 2019;6:104–9.
6. Mutsaerts MA, Groen H, Huiting HG, Kuchenbecker WK, Sauer PJ, Land JA. The influence of maternal and paternal factors on time to pregnancy–aDutch population-based birth-cohort study: the GECKO Drenthe study. Hum Reproduc. 2012;27:583–93.
7. Ferroni P, Barbanti P, Della-Morte D, Palmirotta R, Jirillo E, Guadagni F. Redox mechanisms in migraine: Novel therapeutics and dietary interventions. Antioxidants Redox Signal. 2018;28: 1144–83.
8. Oostingh EC, Hall J, Koster MPH, Grace B, Jauniaux E, Steegers-Theunissen RPM. The impact of maternal lifestyle factors on periconception outcomes: a systematic review of observational studies. Reproduc Biomed Online. 2019;38:77–94.
9. Klonoff-Cohen H, Natarajan L. The concerns during assisted reproductive technologies (CART) scale and pregnancy outcomes. Fertility Steril. 2013;81:982–8.
10. Purewal S, Chapman SCE, van den Akker OBA. Depression and anxiety scores during assisted reproductive treatment are associated with outcome: A meta-analysis. Reproduc Biomed Online. 2018;36:646–57.
11. Miller N, Herzberger EH, Pasternak Y, Klement AH, Shavit T, Yaniv RT. Does stress affect IVF outcomes? A prospective study assessing cortisol levels and stress questionnaires for women undergoing IVF treatments. Reproduc Biomed Online. 2019;19:S1472-1483.
12. Rich-Edwards JW, Goldman MB, Willett WC, Hunter DJ, Stampfer MJ, Colditz GA. Adolescent body mass index and infertility caused by ovulatory disorder. Am J Obstetr Gynecol. 1994;171:171–7.
13. Sivestris E, Cohen M, Menezo Y. Oxidative stress (OS) and DNA methylationerrors in reproduction. A place for a support of the one carbon cycle (1-Ccycle) before conception. Womens Health Gynecol. 2016;2:30.
14. Domenica L, Silvestris E, Raffaele P. Nutrition and Female Fertility: An Interdependent Correlation. Frontiers in Endocrinology. 2019;10(4):2-12.
15. Jokela M, Elovainio M, Kivimäki M. Lower fertility associated with obesityand underweight: the US National Longitudinal Survey of Youth. Am J Clin Nutr. 2008; 88:886–93.
16. Bellver J, Ayllon Y, Ferrando M, Melo M, Goyri E, Pellicer A. Female obesity impairs in vitro fertilization outcome without affecting embryo quality. Fertility Steril. 2010;93:447–54.
17. Azziz R, Carmina E, Chen Z, Dunaif A, Laven JS, aLegro RS. Polycystic ovary syndrome. Nat Rev Dis Primers. 2016; 2:16057.
18. Amato MC, Vesco R, Vigneri E, Ciresi A, Giordano C. Hyperinsulinism and

polycystic ovary syndrome (PCOS): Role of insulin clearance. J Endocrinol Invest. 2015;38:1319–26.
19. Hillier SG. Current concepts of the roles of follicle stimulating hormone and luteinizing hormone in folliculogenesis. Hum Reproduc. 2014;9:188–91.
20. Poretsky L, Grigorescu F, Seibel M, Moses AC, Flier JS. Distribution and characterization of insulin and insulin-like growth factor I receptors in normal human ovary. J Clin Endocrinol Metabol. 2015;61: 728–34.
21. Polak K, Czyzyk A, Simoncini T, Meczekalski B. New markers of insulin resistance in polycystic ovary syndrome. J Endocrinol Invest. 2017;40:1–8.
22. Collier CA, Bruce CR, Smith AC, Lopaschuk G, Dyck DJ. Metformin counters the insulin-induced suppression of fatty acid oxidation and stimulation of triacylglycerol storage in rodent skeletal muscle. Am J Physiol Endocrinol Metabol. 2016;291:E182–9.
23. Iniguez G, Torrealba IM, Avila A, Cassorla F, Codner E. Adiponectin serum levels and their relationships to androgen concentrations and ovarian volume during puberty in girls with type 1 diabetes mellitus. Hormone Res. 2008;70:112–7.
24. Vujkovic M, de Vries JH, Lindemans J, Macklon NS, van der Spek PJ, Steegers EA. The preconception Mediterranean dietary pattern in couples undergoing in vitro fertilization/intracytoplasmic sperm injection treatment increases the chance of pregnancy. Fertility Steril. 2010;94: 2096–101.
25. Hammiche F, Vujkovic M, Wijburg W, de Vries JH, Macklon NS, Laven JS. Increased preconception omega-3 polyunsaturated fatty acidintake improves embryo morphology. Fertility Steril. 2015; 95:1820–3.
26. Mumford SL, Alohali A, Wactawski-Wende J. Dietary protein intake and reproductive hormones and ovulation: The bio cycle study. Fertility Steril. 2015;104:e2.
27. Chavarro JE, Rich-Edwards JW, Rosner BA, Willett WC. Diet and lifestyle in the prevention of ovulatory disorder infertility. Obstetr Gynecol. 2007;110:1050–8.
28. Mioni R, Chiarelli S, Xamin N, Zuliani L, Granzotto M, Mozzanega B. Evidence for the presence of glucose transporter 4 in theendometrium and its regulation in polycystic ovary syndrome patients. J Clin Endocrinol Metabol. 2014;89:4089–96.
29. Chavarro JE, Rich-Edwards JW, Rosner BA, Willett WC. A prospective study of dietary carbohydrate quantity and quality in relation to risk of ovulatory infertility. Eur J Clin Nutr. 2009;63:78–86.
30. Toivonen KI. Lacroix E, Flynn M, Ronksley PE, Oinonen KA, Metcalfe A. Folic acid supplementation during the preconception period: a systematic review and meta-analysis. Prevent Med. 2018;114:1–17.
31. Birben E, Sahiner UM, Sackesen C, Erzurum S, Kalayci O. Oxidative stress and antioxidant defense. World Allergy Organ J. 2012;5:9–19.
32. Wu X, Iguchi T, Itoh N, Okamoto K, Takagi T,Tanaka K. Ascorbic acid transported by sodium-dependent vitamin C transporter 2 stimulates steroidogenesis in human choriocarcinoma cells. Endocrinology. 2008;149:73–83.
33. Chavarro JE, Rich-Edwards JW, Rosner BA, Willett WC. Protein intake and ovulatory infertility. Am J Obstetr Gynecol. 2008;198:210 e1–7.
34. Lacatusu CM, Grigorescu ED, Floria M, Onofriescu A, Mihai BM. The Mediterranean Diet: from an environment-driven food culture to an emerging medical prescription. Int J Environ Res Public Health. 2019;16:E942.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/81479