

Role of Dietary Items as a Nidana (etiological factors) of Kalibya (Male Infertility) - An Ayurvedic Scope Review

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Abstract- Infertility is defined as the inability to conceive within one or more years of a regular relationship. Male infertility is one of the most sensitive problems nowadays incidences of this problem increases day by day due to change in lifestyle. The causes of male infertility are explained elaborately in Ayurvedic texts which can be categorized under “Paristhitijanya, Sahaj hetu, Aharaja hetu, Viharaja hetu, Vyadhi upadrva swarup, vaidykrut (Iatrogenic), aghataja hetu etc. Therefore ‘Nidan’ (Hetu, Causes) itself has more significance in Ayurveda. The ancient wisdom of medicine describes similar conditions in various classical texts, such as *Ashukra, Alpa shukra, Ksheena shukra, Ksheena Retas, Shanda, Klaibya, Napumsaka, Shukra dosha* in various contexts so There is a need for the systematic review of these classical references of causes of male infertility. Factors which are affecting semen quality & sperm motility i.e. air pollution, use of pesticides and harmful chemicals, exposure to excessive heat, and can lead to decreased male fertility. Through this research paper authors aimed to establish the collaboration of present etiological factors(lifestyle changes, decreased nutrient value in food items due to the use of huge amounts of fertilizers & pesticides in the Agriculture sector) Environmental changes (heatwave, extremely cold)along with mentioned in Ayurvedic text as ancient food items in relation Male Infertility

Keywords: Ayurveda, Klaibya, Male Infertility, Nidana

INTRODUCTION

According to Ayurveda, the body is mainly composed of seven biological elements known as *Sapta Dhatus*. That are *Rasa, Rakta, Mamsa, Meda, Asthi, Majja and Shukra*. *Shukra dhatu* is the last dhatu of all seven dhatus and is known as the ultra-purified part of all dhatus. Hence, we can say *shukra dhatu* is the essence of all the dhatus. It is well spread all through the body. *Prajotpadana* (Fertility) is the main karma of *Shukra dhatu* and one of the main *purushartha artha*’s to be fulfilled by the individual in his lifespan but now present Era very fast lifestyle and to focus on career, late married fashion and many more lifestyle changes like (continuous use of fast food, smoking, alcohol consumption, sedentary life, mental stress & family problems) are the main cause of male Infertility. Globally it is a very serious problem and affects 10% to 15% of worldwide whereas male factors are responsible for almost 50% of cases. As per the World Health Organization, the overall prevalence of primary infertility ranges between 3.9% to 16.8% in India. Environmental pollution has as a major issue for systemic disease (Lung disease, Cardiovascular disease, Skin disease etc.) but along with that it also hampered male fertility in today’s era all over the world due to the universal presence of environmental contaminants. Recent studies have revealed that air pollution has a significant impact on human fertility and sperm quality. Semen quality is the major predictor of male fertility outcome. It was observed that environmental pollution unfavourably affects semen quality by impairing the process of spermatogenesis, steroidogenesis, Sertoli cell, and sperm functions, thereby leading to decreased male fertility

In Ayurveda, these are called *Aharja, Viharja, and Mansika Nidan* which is responsible for Male Infertility and have dramatically decreased the reproductive capacity of male, leading to oligozoospermia (*Ksheena Shukra*) and ultimately to infertility.

To study the Ayurvedic aspects of the cause of Male Infertility i.e. (*Ksheena Shukra, Ashukra, Saptadhatu dusti* like that) as mentioned in Ayurveda Classical texts.

Materials and Methods:-

- i. All classical texts available in Ayurvedic Literature were reviewed.
- ii. Various research articles and manuscripts on Male Infertility from PubMed, Scopus, Google etc. were thoroughly reviewed.
- iii. Meet various Industrial workers & know about their social life as well as personal life.

Definition of Male Infertility

Male Infertility is defined as the inability to have children after one year or more regular relationship. Globally it is a very serious problem and affects 10% to 15% of worldwide whereas male factors are responsible for almost 50% of cases. It can cause significant distress, stigma, and financial hardship, affecting people's mental and psychosocial well-being. Among them male factor is present in one-half of couples around 40-50% Oligozoospermia i.e. sperm count less than 15 million /ml is one of the causes of infertility. Nowadays oligozoospermia and infertility are common problems due to disturbing daily routines, disturbed food habits and mental stress on account of the fast life. Male infertility associate, defined as the complete absence of spermatozoa in the ejaculate, accounts for 10–15% of male infertility cases and is called Azoospermia.

Disease Burden of Male Infertility in The World:-

Large numbers of people are affected by infertility in their lifetime, according to a new report published by WHO. Around 17.5% of the adult population roughly 1 in 6 worldwide – experience infertility, The rates of comparatively higher in high, middle and low-income countries, indicating that this is a major health challenge globally. Lifetime prevalence was 17.8% in high-income countries and 16.5% in low- and middle-income countries. “The report reveals an important truth: infertility does not discriminate,” said Dr Tedros Adhanom Ghebreyesus, Director-General at WHO. “The sheer proportion of people affected shows the need to widen access to fertility care and ensure this issue is no longer sidelined in health research and policy so that safe, effective, and affordable ways to attain parenthood are available for those who seek it.”

Disease Burden of Male Infertility in India and Eastern Uttar Pradesh

In India, according to WHO, the overall prevalence of primary Male Infertility ranges between 3.9% and 16.8%. Also, the estimates of infertility vary widely among Indian states from 3.7% in Uttar Pradesh, Maharashtra & Himachal Pradesh, 5% in Andhra Pradesh, and 15% in Kashmir.

Types of Male Infertility (Klaibya): -

According to *Aacharya Charak* and *Sushrut* as following:-

चत्वारिक्लैब्यानीतिबीजोपघाताद्ध्वजभङ्गाज्जरायाःशुक्रक्षयाच्च (Cha.Su. 19/4)

Four types of *klaibya* (sterility) are *beejopaghataja* (affliction of sperm), *dhwajabhangaja* (atonia of genital organs/erectile dysfunction), *jaraaja* (senility) and *shukrakshayaja* (decreased production of sperm).

क्लैब्यमेतच्चतुर्थं स्यात्त्राणां पुंस्त्वोपघातजम् |

जन्मप्रभृति यः क्लैबः क्लैब्यं तत् सहजं स्मृतम् ||१३||

बलिनः क्षुब्धमनसो निरोधाद् ब्रह्मचर्यतः |

षष्ठं क्लैब्यं मतं तत्तु खरशुक्रनिमित्तजम् [१] ||१४||

असाध्यं सहजं क्लैब्यं मर्मच्छेदाच्च यद्भवेत् |

साध्यानामितरेषां तु कार्यो हेतुविपर्ययः ||१५|| (Su. Chi. 26/10-14)

Acharya Sushruta has explained six types of Impotency in *Chikitsa Sthana* these are following as-

- (1) A cessation of the sexual desire owing to the rising of bitter thoughts of recollection in the mind of a man, or forced intercourse with a disagreeable woman (who fails to sufficiently rouse up the sexual desire in the heart of her mate) illustrates an instance of **mental impotency (Manas)**.
- (2) Excessive use of pungent, acid, or saline taste, or of heat-making food items of fare leads to the loss of the *Saumya Dhatu* (watery principle) of the organism. This is **Aharaja impotency**.
- (3) Virile impotency resulting from the loss of semen in persons addicted to excessive sexual pleasure without using any aphrodisiac remedy is the merit form of virile **Shukrakshayaj impotency**.
- (4) A long-standing disease of the male generative organ (syphilis, etc.), or the destruction of a local Marma such as the spermatic cord) destroys the powers of coition altogether This is known as **Marmachedaj impotency**.
- (5) Sexual incapacity from the very birth is called the congenital **Sahaja impotency**.
- (6) Voluntary suppression of the sexual desire by a strong man observing perfect continence, or through utter apathy produces a hardness of the spermatic fluid and is the cause of **Shukranirodhaj impotency**.

<i>Cha.Su. 19/4 (9)</i>	<i>Su. Chi. 26/10-14</i>
<i>Bijopghatajanya</i>	<i>Manas</i>
<i>Dhwajbhajanya</i>	<i>Aharaja</i>
<i>arawasthajanya</i>	<i>Shukrakshayaj</i>
<i>Shukrakshajanya</i>	<i>Marmachedaj</i>
	<i>Sahaj</i>
	<i>Shukranirodhaj</i>

Etiological factor of Male Infertility-

In *Ksheena Shukra* Roga, different etiological factors are indicated as the causative factors (Nidana). *Shukra Dushtikara Aharaja* and *Viharaja* can be considered as the primary cause of *Ksheena Shukra*. *Shukra* is the Sara of *Sapta Dhatus*. So the factors which cause *Kshaya* of *Dhatus* can also be considered as its *Nidana*.

1.Aharaja Nidana. Atisevana of *Lavana Rasa*, *Katu Rasa* and *Kashaya Rasa* leads to loss of sexual potency and causes *Shukravaha* *Srotokharatha*, *Tikta Rasa* leads to *Shukra Upshoshana*. *Katu Vipaka* is *Shukrahara* and *Amla Vipaka* is *Shukranashana*. *Prameha* (Diabetes), *Rajyakshama* (Tuberculosis) *Sthaulya* (Obesity), *Karshya* (Emaciation) are also *aharaja Nidan vyadhi* which also affects the fertility of Males. According to Modern Science, many Dietary items are present in our daily routine life which affects Male fertility these are the following as-

- ❖ In several studies that find eating processed red meat with decreased sperm counts and altered sperm motility.
- ❖ In many research are primarily concerned about trans fats (e.g. Frozen pizza, fried food, cookies, snacks, cakes etc.) which increase the risk of heart disease. Unfortunately, the concerns don't stop there. In 2011 Spanish study proved the increased intake of trans fats also decreased sperm count.
- ❖ Although Milk helps in body buildup but is high in fatty dairy products (cream butter, cheese & sweets) which decrease sperm motility & abnormal sperm shape.
- ❖ Dependency on Antioxidants medicine rather than Antioxidants foods & fruits items.

2.Viharaja Nidana:-

Excessive coitus (*Ati-Maithuna*), untimely coitus (*Akala Maithuna*), coitus in other than vagina (*Ayoni Maithuna*), abstinence, intercourse with unaroused partner, coitus in old age (*Jaraya Gamana*), excessive exercise (*Ati Vyayama*), excessive exposure to heat (*Ushna Sevana*) and suppression of ejaculation (*Shukravega Nigraha*) may cause the *Ksheena Shukra*. According to modern views In recent times, the crucial role of change in lifestyle patterns which plays a major role in the development of Male Infertility has generated a growing interest in this field of study, i.e. ageing, psychological stress, nutrition, physical activity, caffeine, high scrotal temperature, hot water, mobile telephone use. Nowadays Youths are motivated to making six packs, eight packs Body type structures. Youths are influenced by social media platforms they are consumed steroid protein powder which enhances their muscular structure but these steroids are very harmful to maintain balance (*tridosha*) overall body so finally these are also hampered Male Fertility. Excessively indulged in Sexual activity i.e. Masturbation, Nightfall, LGBT etc. Stress is a prominent part of any society and Male Infertility itself is stressful, due to social pressures, testing, diagnosis, treatments, failures, unfulfilled desires and even economic costs with which it is associated. In the 21st Century increased life expectancy, the advanced age of marriage, various socio-economic factors and an overall change in the role of women in society have led couples to start their family at a later age with the help of IVF, ART Technique so these are also responsible for Male Infertility. Regarding environmental pollution, a retrospective observational study in China carried out during the COVID-19 outbreak showed higher susceptibility to poorer sperm motility. Due to that, air pollution and COVID-19 may be currently considered hazardous to male fertility.

Manasika Nidana (Psychological Causes):-

Sometimes the person looks physically fit but not able to cohabit; and reasons for such are mostly related to psychological factors. *Chinta* (worry), *Shoka* (depression) *Bhaya* (fear), *Avisrambha* (Suspicion), *Krodha* (anger), *Tarsha* (Apprehension), *Irshya* (jealousy), *Abhichara*, are causative factors of *ksheena Shukra* and *Shukravaha Sroto dushti*. According to Modern Science, although Male Infertility is not a life-threatening issue, it is still considered a stressful life experience for couples. The high stress of infertility might be attributed to the fact having a child is considered to be important in general society. Male Infertility can cause psychological distress, emotional stress and financial difficulties. Male individual may feel emotions like anger, guilt, sadness, depression, anxiety, and loss of self-confidence and self-esteem. Apart from this, the financial cost of infertility treatment also significantly contributes to stress. Now further male individuals are detachment from their families, Friends and also decreased

social interaction (parties, seminars, playing etc). Psychological stress is also perceived as a potential clinical risk factor that may reduce male fertility.

4. Congenital Nidana:-

abnormal or vitiated *Bija* (whole sperm) or *Bija Bhaga* (chromosome) or *Bijabhaga Avayava* (gene) by which reproductive organs represented by these vitiated entities are deformed According to Ayurveda his genetic anomaly depending on the nature and severity of the condition produces primary defect at various functional aspects of Shukra i.e., *Sarvadaihika* (androgens), *Retasa* related (semen) or *Bija* (sperm), the ultimate outcomes of *Shukra dushti*. According to Modern Science, The complexity of the genetics underlying male infertility is explained by the number of genes involved in spermatogenesis the most common genetic causes of male infertility are chromosomal abnormalities such as translocations or aneuploidy of the sex chromosomes. It has been estimated that nearly 50% of infertility cases are due to genetic defects. ; there are more than 2,300 genes expressed in the testis alone, and hundreds of those genes influence reproductive function in humans and could contribute to male infertility. At present, there are only a handful of genes or genetic defects that have been shown to cause or to be strongly associated with primary infertility. Chromosome Y contains genes which are essential for spermatogenesis and proper development of the male gonads. Microdeletions on the Y chromosome are the leading genetic cause of Male Infertility. Male Individuals who have chromosome number 47(22pair Autosomes+XXY) or Klinefelter syndrome (Numerical abnormalities) karyotype have compromised spermatogenesis, with severe oligozoospermia or azoospermia leading to Male Infertility. Translocation of the *SR Y* gene to an X chromosome is known as De la Chapelle syndrome. Mutations in the **AR gene**, located on the X chromosome are causing a variety of defects collectively known as androgen insensitivity syndrome. Mutations in the **AR gene** cause azoospermia

5. Acquired Nidana-

Aharaja Nidana, *Viharaja Nidana* & *Manasika Nidana* are responsible for this factor. Some systemic diseases and local genital disorders may cause deprivation in Semen (*shukrakshaya*) or in-ability to cohabit (temporary or permanent) or *shukra-dushti*.

6. Iatrogenic (*Vaidyakrauta*):-

Some therapeutic procedures are contraindicated or advised to take special precautions while doing such procedures e.g. *Swedana* (Hot Fomentation), *Pratisarniya ksharkarma* (local application of kshar), surgical procedure for the urinary system also one of the most causes of Male Infertility.

The exact reason for the decline of Male Fertility is not clear, but it may be due to some environmental, nutritional, socioeconomic or other unknown causes are as following-

Fast food diet as the main etiological factor of male infertility:-

In recent decades, the main nutritional model of developing and developed countries has become the so-called Western diet. The Western diet is characterized by a high intake of animal proteins, saturated and trans fatty acids, and simple carbohydrates, as well as a low supply of dietary fibre and essential unsaturated fatty acids (EFA). Additionally, it is a hypercaloric diet that is pro-inflammatory, with low nutritional density. i.e. High intake of red & processed meat, High intake of sweet drinks & snacks, High intake of fatty Dairy products, Low consumption of Vegetables and fruits, and Nuts. So It is clear that with the spread of the Western diet pattern, the parameters evaluating semen quality have deteriorated

Relation between Socio-Economic Factors and Infertility

Considering the increasing trend of infertility and its association with geographic, environmental and lifestyle-related factors, it can be presumed that the prevalence of infertility is likely to vary with socioeconomic background. There are two types of arguments in the literature regarding the variation with respect to socio-economic variables. One set of studies has shown that the infertility rates may be higher among couples from the high socio-economic strata mainly because people from these strata may have greater exposure to changing environmental conditions, thereby higher lifestyle-related changes(leading to higher infertility. Another set of studies has shown that infertility levels may be high among the low socio-economic groups because their access to infertility treatment may be poor. Further, considering the cultural dimensions of infertility, it will be interesting to see whether infertility is different across different religions and caste groups

Radiation effect:-

We are surrounded by several types of ionizing and non-ionizing radiations and both have recognized causative effects on spermatogenesis. Since it is impossible to cover all types of radiation sources and their biological effects under a single title, this review is focusing on radiation deriving from cell phones, laptops, Wi-Fi and microwave ovens, as these are the most common sources of non-ionizing radiation, which may contribute to the cause of infertility by exploring the effect of exposure to radiofrequency radiations on the male fertility pattern. Radiation may also destroy sperm cells and the stem cells that make sperm. Radiation therapy to the brain can damage the pituitary gland and decrease the production of testosterone and sperm. For some types of cancers, the testicles can be protected from radiation through a procedure called testicular shielding. X-rays, γ -rays and α -particles are forms of ionizing radiation. Ionizing radiation is much more dangerous than non-ionizing radiation. The most radiosensitive organ reported is the male testis with the germinal epithelium including the spermatogonia which is more sensitive to radiation exposure than other cells

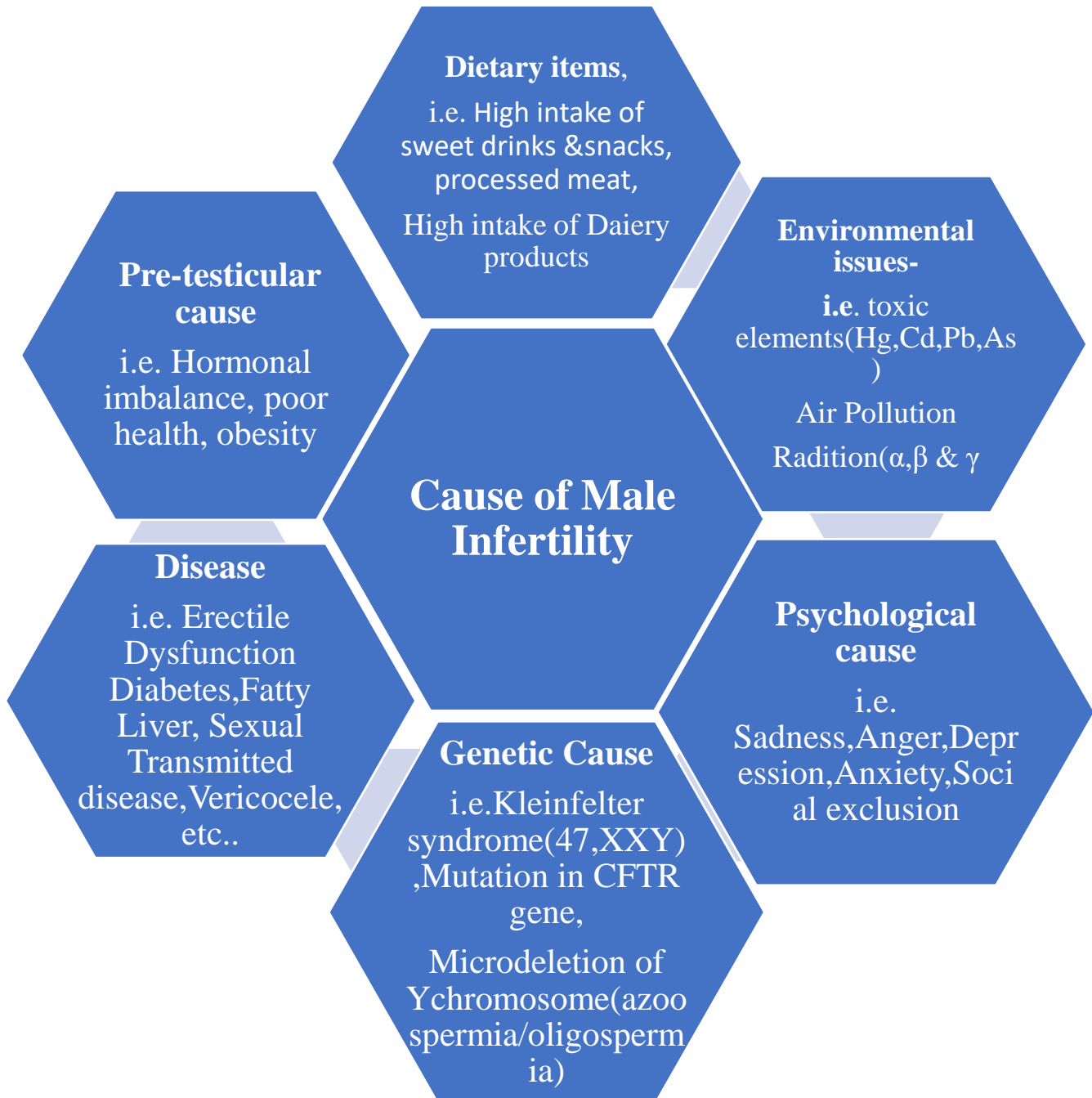
Heavy metals:-

Heavy metals like lead (Pb), cadmium (Cd), mercury (Hg), and metalloids like arsenic (As) are associated with the main threats to human health. They may be found in food, water, and air and, if consumed, can cause intoxication or alter the biological function and damage vital function. Nickel(Ni) hampers spermatogenesis mainly by producing reactive oxygen species (ROS). Moreover, interfering with protamine replaces the histone in spermiogenesis. Cadmium (Cd) causes erectile dysfunction in adult males. Lead(Pb) can cause atrophy of the seminiferous tubule. Mercury(Hg) exposure has also reduced testosterone levels, and sperm

speed, motility, Hg also decreased the total size of the testis, diameters of seminiferous tubules, and the total size of seminiferous tubules, the quantity of Sertoli cells, spermatogonia, spermatocytes, and spermatids inducing degenerative changes in the spermatogenic cells and atrophy of seminiferous tubules. Drinking water contaminated with Arsenic(As) has arisen as an important health problem in Asia, India and China, among other countries. Workers exposed to heavy metals present a high risk of suffering reproductive dysfunction. Pb was one of the most studied elements which had a negative relationship with male fertility. Others, such as Cd and Cr, also have negative effects on fertility. Occupational exposure to heavy metals such as inorganic Pb and Hg occurs in professions related to metal melting or welding, or boron mining. Specifically, welding is considered one of the main occupational agents that negatively affects male fertility.

Temperature which affects the Male Fertility:-

Temperature plays a crucial role in maintaining normal spermatogenesis in testes. Constant exposure to high temperatures as seen in cases of occupational exposure to radiant heat in people working in furnaces, bakeries, welding or ceramic factories, those working for long hours in kitchens, laundries, dry cleaning shops, or drivers can result in loss of thermoregulatory function of scrotum affecting one or more component of semen quality in males. India is situated on the equator so the temperature of the maximum area varies from 28°C to 34°C throughout the year. We follow the Western civilization's dress, due to which the temperature there is very low (10°C to 18°C) throughout the year therefore they wear tight and heavy clothes to protect the Winter season, but in India that condition is not found that is why the sperm count & sperm motility is decrease in Indian population so temperature variation is one of the most factors which is cause Male Infertility.

Causes of Male Infertility:-**Why are sperm counts dropping?**

No one knows why sperm counts are falling precipitously. Some say sperm are vanishing due to men resting laptops on their laps. Others blame the heat generated from cell phones sitting in pants pockets. Obesity is a likely factor. But as a Medical Professional

we are know that dropping in sperm count /Male Infertility is likely due to a variety of factors What we eat is always a culprit for any health problem but on the other hand good news is that there are also foods that may increase Male Fertility.

CONCLUSION

The more detailed and systematic explanation given in ayurvedic texts regarding causes of male infertility so *Shukra Dhātu* is an important part of Human Physiology which needs to be maintained and preserved as it is responsible for progeny which is the most essential part of life. Male infertility trend is increasing in India due to lifestyle changes (*Ahara, Vihara,*) etc. In Modern science also mentioned most of same causes of male infertility like congenital syndromes, pretesticular, testicular, post testicular causes which includes some diseases of the genital organ, traumatic causes, obstructive cause, psychological causes etc. Thus, modification of lifestyle through a structured program of educational, environmental, nutritional/physical exercise and psychological support, combined with the use of nutraceutical antioxidants can prevent infertility Therefore, it's the need to present era all Medical Sciences looking forward towards Ayurveda to rule out the root cause of such type of rise in male infertility because in ancient Ayurvedic Text. (Charaka Samhita, Sushruta Samhita) his treatment by classical medicine is very effectively mentioned so this is a very huge area of research in Ayurveda preventive measures should be formulated. Ayurveda can provide solutions for such a rising incidence of infertility through a healthy lifestyle, preventive measures and effective treatment.

Advices to improve sperm health through Foods and exercises:-

Eating a healthy and varied diet may be a key part of maintaining good overall health. However, there are certain vitamins and food groups that could have a greater impact on reproductive health than others.

Aspects of a male's diet may have an impact on his fertility. Consuming a diet rich in carbohydrates, fibre, folate, and lycopene as well as consuming fruit and vegetables correlates with improved semen quality. Another potential benefit could be antioxidants, which play an important role in the body by scavenging reactive oxygen species (ROS). A healthy amount of exercise in men can be beneficial. Physically active men who exercised at least three times a week for one hour typically scored higher in almost all sperm parameters in comparison to men who participated in more frequent and rigorous exercise. The consumption of natural antioxidants seems to increase the total antioxidant capacity. In agreement with this, a diet rich in carotenoids, for instance, could improve sperm motility and morphology

REFERENCES:

1. Charaka Samhita of Agnivesh Revised by Charaka Acharya, Purwardha, Chaukhamba Sanskrit Pratisthana, Varanasi, Sutra sthana, Asthodareeya Adhyaya, Chapter 19/4
2. Acharya Sushruta, Sushruta Samhita, Nibandha Sangrahaateeka of Dalhana, edited by Vaidya Yadavji Trikamji Acharya, Chaukhamba Krishnadas Academy, Varanasi, reprint 2004 Chikitsa Sthana; Chapter 26/10-14
3. Agarwal A, Baskaran S, Parekh N, Cho CL, Henkel R, Vij S, Arafa M, Panner Selvam MK, Shah R (2021) Male infertility. *Lancet* (London, England) 397(10271):319–333. [https://doi.org/10.1016/S0140-6736\(20\)32667-2](https://doi.org/10.1016/S0140-6736(20)32667-2)
4. Krausz C (2011) Male infertility: pathogenesis and clinical diagnosis Best practice & research. *Clin Endocrinol Metab* 25(2):271–285. <https://doi.org/10.1016/j.beem.2010.08.006>
5. Karavolos S, Panagiotopoulou N, Alahwany H, Martins da Silva S (2020) An update on the management of male infertility. *TOG* 22(4):267–274. <https://doi.org/10.1111/tog.12688>
6. Psychosocial aspects of infertility and its treatment. Malina A, Błaszkiwicz A, Owczarż U. *Ginekol Pol.* 2016;87:527–531. [[PubMed](#)] [[Google Scholar](#)]
7. Agarwal, A., Baskaran, S., Parekh, N., Cho, C.-L., Henkel, R., Vij, S., et al. (2021). Male Infertility. *The Lancet* 397, 319–333. doi:10.1016/s0140- 6736(20)32667-2
8. <https://www.who.int/news/item/04-04-2023-1-in-6-people-globally-affected-by-infertility>
9. Rai S.K., Fung T.T., Lu N., Keller S.F., Curhan G.C., Choi H.K. The dietary approaches to stop hypertension (DASH) diet, western diet, and risk of gout in men: Prospective cohort study. *BMJ.* 2017;357:j1794. doi: 10.1136/bmj.j1794. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
10. Varlamov O. Western-style diet, sex steroids and metabolism. *Biochim. Biophys. Acta Mol. Basis Dis.* 2017;1863:1147–1155. doi: 10.1016/j.bbadis.2016.05.025. [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
11. Danielewicz A., Przybyłowicz K.E., Przybyłowicz M. Dietary patterns and poor semen quality risk in men: A cross-sectional study. *Nutrients.* 2018;10:1162. doi: 10.3390/nu10091162. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
12. Nassan F.L., Chavarro J.E., Tanrikut C. Diet and men's fertility: Does diet affect sperm quality? *Fertil. Steril.* 2018;110:570–577. doi: 10.1016/j.fertnstert.2018.05.025. [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
13. Jensen B. Rat testicular lipids and dietary isomeric fatty acids in essential fatty acid deficiency. *Lipids.* 1976;11:179–188. doi: 10.1007/BF02532855. [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
14. Fischbein A, Zabludovsky N, Eltes F, Grischenko V, Bartoov B. Ultramorphological sperm characteristics in the risk assessment of health effects after radiation exposure among salvage workers in Chernobyl. *Environ Health Perspect.* 1997;105:1445–1450. [[PubMed](#)] [[PubMed Central](#)] [[Google Scholar](#)]
15. Xu G, Intano GW, McCarrey JR, Walter RB, McMahan CA, Walter CA. Recovery of a low mutant frequency after ionizing radiation-induced mutagenesis during spermatogenesis. *Mutat Res.* 2008;654:150–7
16. Qiao Z.-D., Dai J.-B., Wang Z.-X. The hazardous effects of tobacco smoking on male fertility. *Asian J. Androl.* 2015;17:954–960. doi: 10.4103/1008-682X.150847. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]

17. Ashiru O., Odusanya O.O. Fertility and occupational hazards: Review of the literature. *Afr. J. Reprod. Health.* 2009;13:159–165. [[PubMed](#)] [[Google Scholar](#)]
18. Sheiner E.K., Sheiner E., Hammel R.D., Potashnik G., Carel R. Effect of Occupational Exposures on Male Fertility: Literature Review. *Ind. Health.* 2003;41:55–62. doi: 10.2486/indhealth.41.55. [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
19. Bonde J.P. Male reproductive organs are at risk from environmental hazards. *Asian J. Androl.* 2010;12:152–156. doi: 10.1038/aja.2009.83. [[PMC free article](#)] [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
20. Jensen T.K., Bonde J.P., Joffe M. The influence of occupational exposure on male reproductive function. *Occup. Med.* 2006;56:544–553. doi: 10.1093/occmed/kql116. [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]
21. Benoff S., Cooper G.W., Centola G.M., Jacob A., Hershlag A., Hurley I.R. Metal ions and human sperm mannose receptors. *Andrologia.* 2000;32:317–329. doi: 10.1046/j.1439-0272.2000.00401.x. [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]