Review Article

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Sustainable Developmental Approaches in Health Highlighting Ethnomedicinal & Non-Communicable Diseases: Diabetes

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Abstract

Background: *Health organisations are facing problems related to the changing disease scenario (communicable to non-communicable) globally. India is also facing the widespread condition of Type 2 diabetes mellitus (T2DM) along with the world and has about 88 million diabetic cases.*

Aim: *to develop insight among scientists and researchers about how the rapidly growing situation of diabetes and other non-communicable diseases will be controlled and cured by promoting the concept of health.*

Methods: *Various researches and review papers were searched in Google Scholar and evaluated its impact on diabetes disease.*

Conclusion*: Medical care policies in biomedical sciences (for diabetes) can control hyperglycaemic conditions but are not able to cure the disease and have strong side effects too. Also, this treatment method is costly and not able to control its rising trend. Whereas ethnomedicine (ancient medical sciences) treatment methods can control and cure the disease through healthy lifestyle practices along with medicine, they are slow in action and time-consuming. To overcome the syndemic condition of diabetes and other non-communicable diseases much work is being needed. Building of the concept of sustainable development methods to cure diabetes will be achieved by combining the concepts of biomedical sciences and ethnomedicine.*

Keywords: Diabetes, Ethnomedicine, Health, Stress, Green Nano-Biotechnology, Biomedicine

1. Introduction

In the changing global scenario, the prevalence of disease conditions is shifting from communicable to non-communicable diseases [1]. According to the WHO 2030 agenda, there is a need for sustainable development methods in health to keep the world healthy and save the lives of vulnerable people [2]. Now a day's, India is experiencing an epidemic of Type 2 diabetes mellitus (T2DM) [3]. In present time, syndemic conditions of diabetes lead to synergy of epidemic conditions of the disease that co-occur in time and place, produce complex consequences on health, and have common problems as well as symptoms at the social level [1]. The IDF (International Diabetes Federation)-2019 reported that, in a world scenario, about 463 million people are patient of diabetes and by 2030, the affected person number may increase to 578 million and 700 million by 2045 [4]. Also, the atlas reported that India had 88 million diabetic cases, whereas in Jharkhand (a state in India), the cases were about 1 million [5]. Also, 1.2 million deaths occur per year due to diabetes in South East Asia, which is the 2nd highest death in the IDF region. At present, the largest numbers of diabetic individuals are reported in China, followed by India, the United States, Brazil, and the Russian Federation [6]. So, the need of the day is to understand the concept of health and to develop a cost-effective anti-hyperglycemic drug along with the ability to protect and regenerate beta cells of the pancreas.

1.1. Health

The health condition of an individual is judged by his complete physical, mental/intellectual, and social well-being and is not only about the nonexistence of disease and infirmity. The physical conditions include normal functioning and growth of all parts of the body; the mental conditions relate to self-satisfaction, adjustment, and self-control; and social well-being means the ability to adjust with society through social skills, social functioning, and acceptance of surroundings [7]. Health is influenced by several factors, but the most important ones are heredity, environment, lifestyle, socio-economic conditions, health services, and health-related systems. That is, the health

of an individual is governed by both biological sciences and behavioral/social sciences because both components are closely interwoven in the life of a human being. It is well proven that, with time, a change in any one factor may shift the prevailing disease conditions in a society.

Nowadays, due to lifestyle changes, more than 70% of global deaths are caused by non-communicable diseases instead of communicable diseases, and also according to the WHO report, over 70% of deaths in the world are due to non-communicable diseases (NCDs) [1]. These diseases destroy and kill more than 40 million people per year [8].

2. Diabetes

Diabetes mellitus is a non-communicable disease that is caused by a metabolic disorder of the endocrine system in which impaired carbohydrate, protein, and fat metabolism is caused by either a low or absent insulin secretion or a tissue resistance to insulin [9]. In the diabetic condition, fasting glucose levels (FPG) are greater than 140 mg per dL, postprandial glucose levels are >200 mg per dL, and glycated haemoglobin HbA1c is ≥6.5%. The worldwide incidence of both type 1 and type 2 diabetes mellitus is increasing, but the type 2 diabetes mellitus graph's inclination is more rapid. The rapid growth of this condition is due to a stressful and sedentary lifestyle, increasing obesity complications, and decreased physical activity levels. In susceptible individuals, initiation of the beta cell destruction begins with an increase in the oxidative stress condition and is then followed by impairment in insulin synthesis that finally leads to insulin deficiency or absence [6].

Due to misfolding of proteins in healthy beta cells, approximately 20% of newly synthesised proinsulin proteins may fail to reach their native conformation. However, under certain pathological conditions, like oxidative stress or infection, the misfolding of proinsulin is increased. The misfolded proinsulin accumulation hip in the endoplasmic reticulum (ER) occurs when misfolded protein loads exceed the hereditarily determined threshold level of beta cells. This condition promotes the apoptosis of beta cells, and as a consequence, the insulin deficiency condition appears. Initially, the release of defective proinsulin from beta cells promotes insulin sensitivity (an increase in insulin synthesis, or proinsulin) and insulin resistance (a decrease in the interaction between insulin and its receptor) [10]. More than 50% of beta cells die, which promotes insulin sensitivity and insulin resistance conditions. 80% loss of beta cells causes hyperglycemic conditions, but when the loss becomes 100%, the onset of insulin-dependent diabetes occurs.

Diabetic conditions promote multifactorial disease conditions and complications that affect many organ systems. The vascular complications are maybe at the small vessels level (microvascular disease) like retinopathy, nephropathy, and neuropathy, and at the large vessel level (macrovascular disease) like cerebro-vascular disease, coronary heart disease (CHD), and peripheral arterial disease [PAD]. The disease is directly related to microvascular complications, whereas macrovascular complications occur at a greater incidence in diabetic individuals [6]. Vascular and nonvascular complications are mainly responsible for morbidity and death. Also, diabetic persons are more susceptible to other diseases like microbial infection (e.g., viral infection—COVID-19, influenza, etc.), which are an alarming signal for the health of individuals and society too [11]. Healthy lifestyle practices, early detection of the disease, good glycemic control, and efforts related to the minimization of secondary risks or complications are helpful in controlling or checking many diabetes-related complications and preventing or delaying their onset.

2.1. Treatment of Diabetes

Any treatment that can improve blood glucose control, reduce the toxic effect of glucose on beta cells, and increase endogenous insulin secretion can be considered for diabetes treatment. This can be achieved by 1) promoting a healthy lifestyle 2) reducing or eliminating the microvascular and macrovascular problems 3) through regeneration of beta cells and protecting beta cells from death [6].

The Thirteenth General Work Programme (2019–2023) of the WHO puts strong emphasis on the sustainable development of health goals (SDGs) and investment in universal health coverage to control the syndemic condition of noncommunicable diseases and promote mental health and well-being. For the treatment of diabetes, WHO places an emphasis on the use of biomedicines and antidiabetic drugs, community education, and awareness operations to promote healthier lifestyle practices, immunize against viruses (e.g., COVID-19), which protect against the diseases, and improve the treatment of diabetes [12].

2.2. Challenges with Existing Antidiabetic Medicines (Herbal and Synthetic)

Health care is an interdisciplinary and multi-sectoral subject, whereas medical care is only a part of health care and comes into the picture when disease prevails [13]. Many synthetic and herbal medicines are available for diabetes, but they cannot completely cure the disease or control its occurrence. So, to cure diabetes and related complications, there is a requirement for proper studies of health factors, acceptance of healthy lifestyle practices, and the formulation of a suitable composition for an antidiabetic drug. Hence, we need improved treatment methods related to diabetes that must have the ability to control glucose toxicity, have an antihyperglycemic effect, reduce the oxidative stress of cells, and protect and regenerate beta cells. Instead of using different diabetes treatment methods in isolation, if we combine the science of biomedicine and ethnomedicine, it can improve our health care practices and take care of diseases in a wholesome way.

2.3. Biomedicines and Diabetes

The concept of biomedicine is based on Western medical science, and this science describes "disease" based on physicians' and biologists' studies. The sciences see disease as a complex or multifaceted set of facts based on structural, chemical, and physiology aspects of an organism [14]. For example, in diabetes, hyperglycemia is caused by an insulin deficiency. According to this science, a diabetic person requires lifetime

antidiabetic drugs to reduce glucose toxicity, and it is the only diabetes treatment. Also, it includes screening, improved methods of diagnosis, identification of risk factors, etc. [13]. The modern antidiabetic drug has some limitations, and modern medicine has also been creating new ones in solving the problem of hyperglycemia [14]. For example, conventional synthetic medicines like metformin, glibenclamide, etc. are target specific and have a strong antihyperglycemic effect, but they are not able to control secondary complications like atherosclerosis, ketosis, etc. related to the disease, and at the same time, they have strong side effects like hypersensitivity, hypoglycemia, nausea, vomiting, flatulence, diarrhoea or constipation, headache, etc. [15]. Also, the allopathic treatment is costly and burdens the poor diabetic population. It is reported that about 50% of patient income is consumed in purchasing medicines, diagnostic tests, and medical equipment. In India, the average expenditure on diabetes treatment during hospitalization is about Rs 5,300, and it increases about 70% more in the case of a long history of diabetes (≥5 years) as compared to those with a recent history of diabetes [3]. The present-day need is to deliver quality health care at all levels that is acceptable, accessible, economical, as well as feasible for everyone.

2.4. Ethnomedicines and Diabetes

Ethnomedicine is the study of ancient and traditional medical knowledge as well as practises to promote health and cure diseases. This science embraces theoretical and practical aspects of social and biological sciences to deal with diseases (communicable and non-communicable), illness, and the health of individuals [14]. Here cultural and experience-based interpretations of health, disease, and illness concepts are used for healthcare processes and healing practises [16]. The practise of ethnomedicine for the treatment of hyperglycemia suggests the use of medicinal plants, herbomineral preparations, and bio-fabricated green nanoparticles as primary health care sources, along with other practises like changing food habits, changing lifestyles, meditation, etc.

3. Ethnobotany

Many indigenous Indian medicinal plants are useful in the successful management of hyperglycemia. The most authentic medical treatise, Sushruta Samhita (Ayurvedic literature), describes 760 species of antihyperglycemic plants, while Charaka Samhita describes 500 species (see Table 1). Antihyperglycemic herbal medicines have no side effects and are able to control hyperglycemia effectively, but in comparison to biomedicine, they are less effective because they have poor solubility and lower permeability in the gastrointestinal system [17]. Due to poor absorption, herbal medicine is required in high doses to produce the same level of antihyperglycemic effect as synthetic biomedicine.

S.No	Medicinal plants	Plant part	Activity	Reference
1	*Semecarpusanacardium*	Nut	Anti-hypeglycemic effect	[18]
2	*Chaenomelessinensis*	Fruits	Anti-hyperglycemic effect	[19]
3	*Psidiumguajava*	Fruits	Anti-hyperglycemic effect	[20]
4	*Solanum torvum*	Fruits	Antidiabetic effect	[21]
5	*Vacciniumarctostaphylos`*	Fruits	Antidiabetic effect	[22]
6	*Setariaitalica*	Seed	Antidiabetic effect	[23]
7	*Brassssicajuncea*	Seed	Anti-hyperglycemic effect	[24]
8	*Alangiumlamarckii*	Leaves	Anti-hyperglycemic effect	[25]
9	*Axonopuscompressus*	Leaves	Anti-hyperglycemic effect	[26]
10	*Catharanthusroseus*	Leaves	Antidiabetic effect	[27]
11	*Centauriumerythrea*	Leaves	Antidiabetic effect	[28]
12	*Cocos nucifera*	Leaves	Antidiabetic effect	[29]
13	*Lithocarpuspolystachyus*	Leaves	Anti-hyperglycemic effect	[30]
14	*Opuntiastreptacantha*	Leaves	Anti-hyperglycemic effect	[31]
15	*Cassia auriculata*	Leaves	Anti-hyperglycemic effect	[32]
16	*Vitexnegundo*	Leaves	Anti-hyperglycemic effect	[33]
17	*Symplocoscochinchinensis*	Leaves	Anti-hyperglycemic effect	[34]
18	*Solanum xanthocarpum*	Leaves	Antidiabetic effect	[35]
19	*Albiziaodoratissima*	Bark	Antidiabetic effect	[36]
20	*Berberis vulgaris*	Root	Antidiabetic effect	[37]
21	*Caesalpiniadigyna*	Root	Anti-hyperglycemic effect	[38]
22	*Ophiopogonjaponicus*	Root	Anti-hyperglycemic effect	[39]
23	*Marrubium vulgare*	Aerial part	Antidiabetic effect	[40]

24	*Ocimum sanctum*	Aerial part	Antidiabetic effect	[41]
25	*Viscumschimperi*	Aerial part	Antidiabetic effect	[42]
26	*Enicostemmalittorale*	Whole plant	Antidiabetic effect	[43]
27	*Hybanthusenneaspermus*	Whole plant	Anti-hyperglycemic effect	[44]
28	*Lippanodiflora*	Whole plant	Antidiabetic effect	[45]
29	*Prosopisglandulosa*	Whole plant	Anti-hyperglycemic effect	[46]
30	*Zygophyllum album*	Whole plant	Antidiabetic effect	[47]

Table 1: List of Some Medicinal Plants Having Antihyperglycemic/Antidiabetic Activity

3.1. Herbomineral (Bio-Fabricated Green Nanoparticles) Preparation of Ayurveda

Herbomineral preparations of Ayurveda have gained tremendous attention in the present time under the name "green nanotechnology." Since ancient times, the importance of metals in human physiology has been well established because they are directly or indirectly related to enzymes or their activities. Modern nanomedicine and ayurvedic-bhasma are using nano-metal based compositions to treat a common set of diseases like: zinc is used to treat diabetes, arthritis, and tuberculosis; iron for anemia, diabetes, and rheumatism; silver for muscle wasting, nerve disorders, and brain disease; calcium for acidity, tuberculosis, asthma, cough, and impotency; copper for cirrhosis, acidity, flatulence, and tuberculosis; and gold for rheumatoid arthritis [48]. The bio-fabricated antidiabetic nanoparticles (see Table-2) are non-toxic, more stable, and biocompatible, and they are selectively delivered to specific sites in the body via systemic administration [49].

S.No	**Bio fabricated Nanoparticles (NPs)**			
1	**AgNPs**	**ZnONPs**	**AuNPs**	**Other metallic nanoparticles**
2	*Allium cepa*	*Andrographispaniculata*	*Cassia auriculate* (Flowers),	Selenium - *Catathelasmaventricosum* polysaccharides (CVPs),
3	*Argyreia nervosa* (Leaves)	*Azadirachtaindica* (Leaves)	*Cassia fistula* (Stem bark)	Copper-*Gnidiaglauca* (Leaves)
4	*Avicenniaofficinali*	Costusigneus (Leaves)	*Coumestanwedelolactone*	gold-silver conjugates *Ocimumbasilicum* (Flower)
5	*Callophylumtomentosum* (Leaves)	*Heriteriafomes* (HF)	Escin compound (a plant derivative)	*Au-Ag conjugates Ocimumbasilicum* (Leaves)
6	*Cantellaasiatica* (leaves)	*Sonneratiaapetala* (SA) (Leaves)	*Fritillariacirrhosa, Gymnema*	Copper -*Plumbagozeylanica*(Leaves)
7	Cladosporium fungi	*Hibiscus rosa-sinensis(Leaves)*	*sylvestre* (Leaves)	Chitosan- *Stevia rebaudiana* (Leaves)
8	*Clausenaanisata* (Roots)	*Momordicacharantia*	*Gymneasylvestre*	Pd-rGO (palladiumgraphene oxide) conjugates -*Zanthoxylumarmatum*(Fruits)
9	*Colpomeniasinuosa* (Marine algae)	*Moringaoleifera* (Leaves)	*Leucosideasericea*	
10	*Costuspictus* (Leaves)	Murrayakoenigii (Leaves)	*Marsileaquadrifolia*	
11	*Cympogon citrates* (lemongrass)	*Silybummarianum* (Seeds)	*Saracaasoca,*	
12	*Enhalusacaroids* (Leaves)	*Tamarindusindica* (Leaves)	*Sargassumswartzii*	
13	*Eysenhardtiapolystachya* (Bark)	*Urticadioica* (leaves)		
14	*Gracillaria edulis*	*Vacciniumarctostaphylos* (Flower)		
15	*Heriteriafomes*	*Vacciniumarctostaphylos* (leaves)		

Table 2: Bio-Fabricated Green Nanoparticles Examples having an Antidiabetic Activity [50, 51]

3.2. Change in Food and Lifestyle Practices

3.2.1. Food/Nutrition

One of the important reasons for the increasing trend of type 2 diabetes mellitus is obesity. The American Diabetes Association (ADA) has recommended *Medical Nutrition Therapy* (MNT). According to MNT, the optimum coordination of caloric consumption with other aspects of diabetes therapy (e.g., insulin, antidiabetic drugs, workouts, and a decrease in weight) should be taken care of for the treatment of the disease. MNT refers to three levels of prevention measures: primary measures promoting weight reduction to check or delay the beginning of diabetes mellitus (in obese or pre-diabetic individuals); secondary measures related to improvement of glycemic control to prevent or delay hyperglycemia-related complications; and tertiary measures related to management of diabetes-related difficulties (cardiovascular disease, nephropathy) in diabetic individuals. Although the recommendations for all three types of MNT overlap with each other to achieve sustainable health [6].

3.2.2. Physical Activity /Exercise and Yoga

Exercise and yoga provide good health and have multiple benefits in diabetic patients, like lowering blood plasma glucose and stimulating insulin sensitivity; reducing cardiovascular risk and blood pressure; helping to sustain muscle mass; and decreasing obesity and overweight. In the resting state, skeletal muscle is one of the key sites for metabolic fuel (e.g., glucose) intake, and the greater than before muscle activity during forceful, aerobic exercise significantly increases glucose needs. The American Diabetes Association (ADA) recommends 20–30 min/day moderate aerobic physical activity for diabetic patients. Due to the absence of normal glucose regulatory mechanisms, vigorous exercise must be avoided by the diabetic person [6].

3.2.3. Stress, Hormonal Equilibrium, and Meditation Process

According to the WHO's 2018 report, stress-related disorders are increasing with time/in modern society, and about 300 million people are suffering alone from depression [52, 53]. The World Health Organization has predicted chronic stress is the 6th major cause of death in the world [54-56].

Stress is the emotional and brain's response, which is based on the thoughts and perceptions of an individual with respect to a tough condition. Chronic stress is a condition where gradually the emotional, mental, and physical equilibrium of the body is disturbed (see figure 1). During stress, the key hormones epinephrine and norepinephrine (stress hormones) cause stimulation or suppression of other hormones and regulate bio-chemical expressions and metabolic processes. Continuous and long-term expression of stress hormones promotes the overproduction of reactive oxygen species (ROS) and promotes endocrine-related diseases by glandular destruction, mutations, etc. [6]. Example-

- Type 1 diabetes mellitus is an insulin-hormone deficiency state, and it can be recognised by the glandular destruction of beta cells due to infection, autoimmunity, inflammation, tumour infiltration, infarction, and hemorrhage.
- Type 2 diabetes mellitus is acquired form of disease. It arises when body does not use insulin properly or development of functional hormone resistance condition due to defects in insulin receptors of the membrane, nuclear receptors, or receptors of signalling pathways.

It was reported that a key factor to induce the pathobiology of hyperglycemia is the overproduction of superoxide by the mitochondrial electron transport chain of the defective cell (i.e., not being able to regulate glucose level) [57]. In general, hyperglycemic severity increased along with stressful conditions due to reactive oxygen species generation [58]. It is well proven that at the molecular level, stressed conditions disturb the biochemistry, physiology, and metabolic processes of cells and tissues throughout the body by influencing different hormones and molecular signals.

According to review articles by Onyishi et al., spiritual beliefs and faith-based intervention are helpful in the reduction of stress, promote mental and physical health, and also have positive relationships and high efficacy in the management of diabetes (see figure 2) because emotional and mental conditions of the body are regulated by thought and perception (positive or negative interpretation of any situation) [59].

If we look at disease history, before and during the 1970s, the prevalence of non-communicable diseases was lower. It may be due to the fact that Indian people were more prone to study and understand the Shastra and the Veda (the ancient Indian knowledge treasury of ‘Gyan’ and ‘Vigyan’) principles of life and relaxing mental and emotional faculties just by maintaining the equilibrium of thoughts in the long run. The literature helps and promotes stable emotional and strong mental health, as well as good social relation building, by teaching us about self-satisfaction, self-control, adjusting to society, social functioning, and acceptance of our surroundings and our adjustment to them. Also, the Shastra and the Vedic visions are blessed with well-proven, scientifically farsighted philosophies of life and living styles, but there is a need to understand them. The principles of the art of living from this literature help us initially in the regulation of equilibrium of thoughts, emotional and mental status of the body, and in the long run, they help in overcoming chronic stresses, equilibrating epinephrine and norepinephrine hormone levels, and oxidative stress of the body.

For example, according to "the Karmayoga lesson" of the Shreemad Bhagawat Geeta, our whole body system is strongly regulated and coordinated by thought processes [60]. Body, Indriya (the sense organ), Mann (emotion), and Buddhi (the brain)—all of them are regulated in very close coordination. The brain (wisdom) controls Mann (like-dislike, pleasure-pain), and Mann controls Indriya, and all of them in combination control the body and karma/working activity of an individual at all levels. They can control working behaviour from the micro-level (cells) to the macro-level (the whole body) just by influencing different hormones and molecular signals in the body (see figure 3). But during stressed conditions or the absence of farsighted vision, Mann (emotion) becomes powerful and controls the brain, which promotes an unbalanced condition in Indriya activity and the karma of the whole body system. Chronic stress promotes

pathological conditions inside the body due to overproduction of stress hormones and disturbs the health of individuals on all levels, including emotional, mental, physical, and at a broader level, social well-being.

At the initial level, the meditation of thoughts (spiritual beliefs and faith-based intervention) might reduce stress hormone overproduction just by controlling Mann by brain. Also, it can maintain a sustainable equilibrium of thoughts, strengthening mental health and providing internal satisfaction. At the micro-level, the spiritual beliefs and the Shastra-based meditations may control the brain's response and maintain the equilibrium of stress hormones. In the long run, it may help reduce the oxidative stress of cells, reduce ROS formation, and also, maintain the homeostatic conditions of the body in a sustainable way. This area of science is still unexplored, and it will open a new area of investigation for researchers and health workers.

So, ethnomedicine is one of the most cost-effective ways to deal with the global challenges of diabetes and other non-communicable diseases (like cancer, heart diseases, etc.) by promoting components of health in a sustainable manner. At the initial level, this multi-disciplinary structure may be preventing the commencement of the disease through changes in food habits, lifestyle practices, and meditation, and in the case of a diabetic, by providing medical treatment through plant extracts, herbomineral preparations, along with food habits and others, which can help and improve glycemic control while delaying diabetes-related complications and protecting beta cells from destruction. Knowledge of these treasuries is available for everyone at an affordable cost. This can be used by all people, rich and poor, without any side effects.

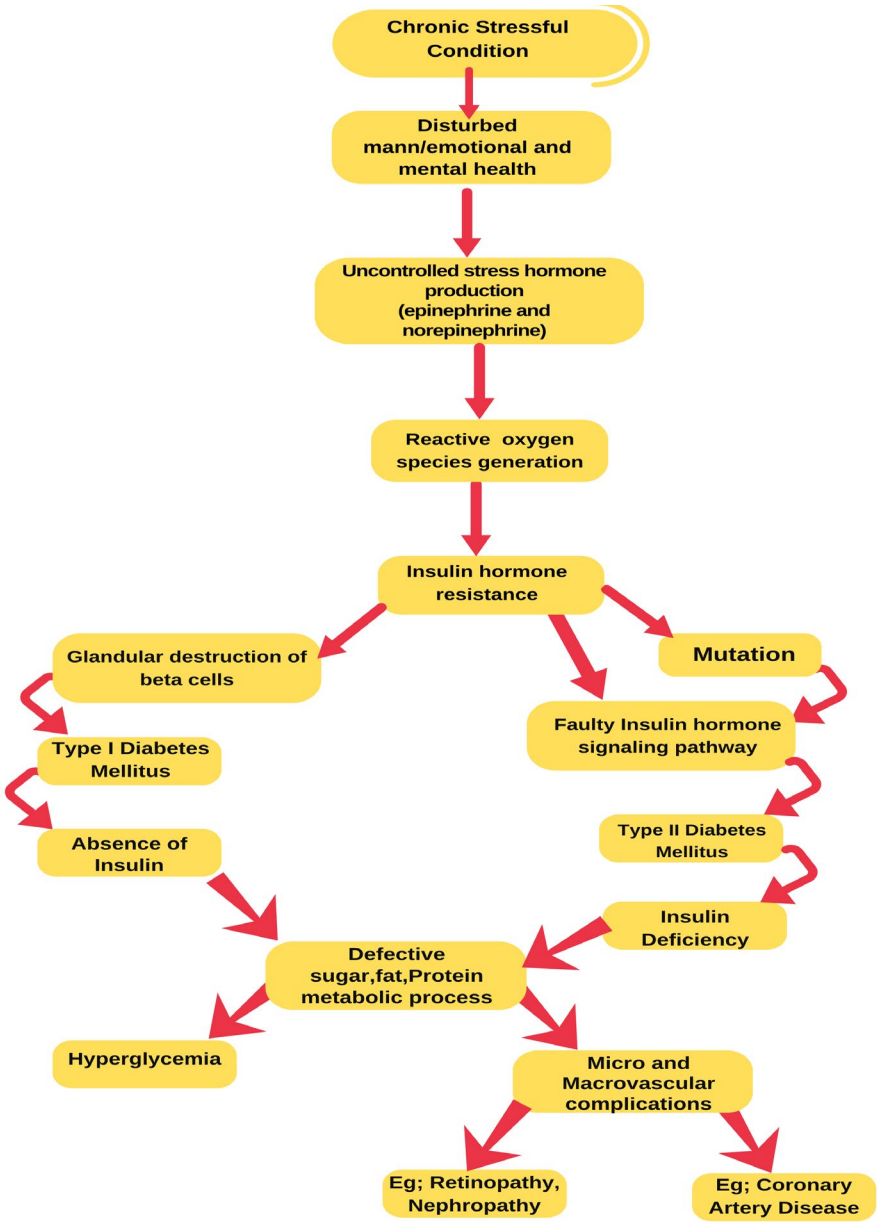

Figure 1: Represents the Relationship Between Chronic Stress, Insulin Synthesis, and its Complications

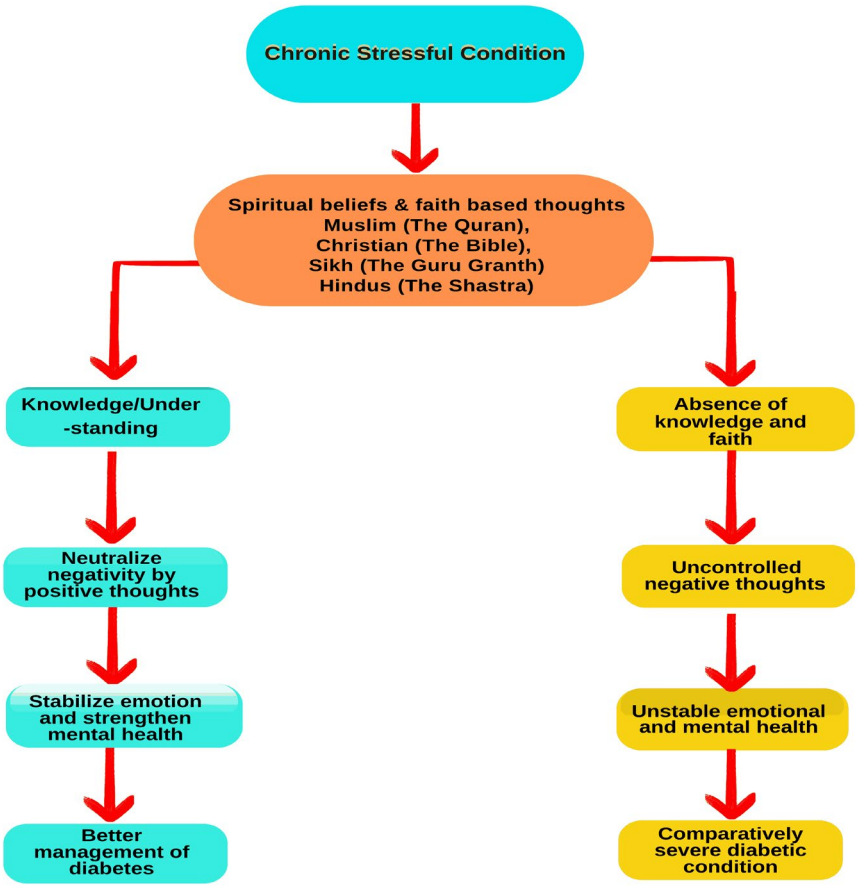

Figure 2: Represents the Relation Among Stress, Spiritual Faith (Positive Thoughts), and Diabetes Management

Figure 3: Represents Relations Among the Sciences of the Veda and the Shastra, the Health System (at the Micro- and Macro-Levels), and Disease

4. Conclusion

To overcome the global emergency of diabetes and its complications, there is a need to look towards health and factors regulating health instead of only medical care. By combining biomedicine and ethnomedicine methods of treatment, the scientific world may be able to provide a worthwhile health care system at every level and in sustainable way. In the long run, the combined treatment system (biomedicines and ethnomedicine) will control and cure the prevalence of diabetes and other non-communicable diseases (cancer, coronary artery disease, stress-related disorders, etc.). At the same time, this biomedicine-ethnomedicine-based medicinal system will become affordable, feasible, acceptable, and accessible to all, and in the future, it will also open new areas of research too.

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