

Climatotherapy the Need for Novel Applications in Nigeria

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Abstract

Climatotherapy is the application of climatic elements for the treatments of skin diseases and infections which are vitiligo, atopic dermatitis, eczema etc. It also employs the utilization of springs, muds and clays of medicinal values through the inhalation, exposure and immersion for the treatment of chronic skin infections. Climatotherapy originated during the roman-empire and was a ritual practice amongst the Greeks, Babylonians and the Mesopotamians. It was founded by Hippocrates over 500 BC and has remain relevant since then even with the discovery and applications of pharmaceutical medicines. Climatotherapy also functions with other similar therapies which are balneotherapy, heliotherapy, fangothrapy, hydrotherapy, crenotherapy etc. The climate and geography of an area is the major determining factor in the application of spa therapy and climatotherapy and as such the most organized climatotherapy center is the Bulgaria coast of the black sea and the most widely visited and recognized climatotherapy center is the dead sea region in the middle east. Other areas of the world blessed with such sites for therapeutic use are the west Virginia springs, hot springs of Arkansas, Bedford's springs of Pennsylvania, Safaga area of Egypt amongst others. The Nigerian environments which include her sedimentary and basements terrains are replete with potentials for climatotherapy, balneotherapy, hydrotherapy etc. from the Ikogosi, Zuwan Zafi Numan and the Yankari springs to the Niger delta formation waters and the caves and fountains that dots the entire landscape of Nigeria. These are novel areas for the application of alternative medicine using rich natural medicinal waters and lakes. This research is a review to enunciate and elucidates on the full potentials of Nigeria as a promising climatotherapy and other forms of spa therapy hub in Africa. There is a need for the utilization of these sites for climatotherapy and their documentations. Nigeria has the potentials from these sites to compete with the great dead-sea region of the middle-east and others. This review also discovered areas for empirical research on climatotherapy and spa therapy in Nigeria through collaborations and synergy between medical practitioners, dermatologists, climatologist, geologist and other experts who are interested in exploring the natural environments for alternative and sustainable therapies.

Keywords: Climatotherapy; Mineral water; Alternative medicine; Spa therapy

Introduction

Climatotherapy is a branch of applied climatology which employs the application of climatological knowledge and principles to the solution of practical problems facing mankind [1]. Climatotherapy is the use of climatic factors for therapy which includes the medical application of climatic factors for the prevention or treatment of diseases for the improvement of body functioning [2]. Climatotherapy is performed in specific climates, e. g. high-altitude climates, sea coastal climates and often times changes of climatic environment. Climatic factors for therapy are radiation (ultraviolet, light, infrared), thermal stimuli (temperature, wind, humidity, etc.) and air composition (pO₂, therapeutic aerosols, absence of pollution and allergens, etc.) [2]. Climatotherapy involves the treatment administered to patients through the modification of their exposure to the physico-chemical impacts of the atmosphere where harmful environmental conditions are non-existent for simultaneous isolation and the attainments of a natural curative environmental conditions [3]. This method is guided by the principle of the protection from unfavorable atmospheric conditions and the adaptation to natural curative environmental conditions which stimulates the protective factors and at the same time the removal of its effects. These effects depend on the

type and length of climatic exposure which is determined by the dose and the physiological and pathological conditions of the patients [3].

Climatotherapy is a potent measure for the treatment and managements of numerous skin diseases and infections ranging from atopic dermatitis, eczema and psoriasis vulgaris etc. Methods of exposure and modalities in climatotherapy are open air rest with exposure of the whole body or body parts to climatic factors and walking in conjunction with exposure to climatic factors (Terrainkur) and speleotherapy (therapy in caves), etc. Important climatotherapy centers in the world are dead-Sea, Kangal hot spring with fish, Blue lagoon, Black sea-bulgaria, La roche- possay and the Safaga area in Egypt. The spa therapy is an ambiguous word it refers to collections of therapies; Thalassotherapy, Heliotherapy, Hydrotherapy, Crenotherapy, Balneotherapy, Ichthyotherapy, Fangothrapy and Climatotherapy. While Climatotherapy exploits the curative properties of the atmosphere (such as humidity, barometric pressure, temperature, altitude, sunshine and storminess and foliage type) for mental relaxation and physical recuperation, thalassotherapy (which originated from France and Britain during the 19th century) believes in the healing powers of sea water which contains trace elements of potassium, calcium, sodium, magnesium and iodide that are absorbed through the infectious skin. This therapy is administered as showers of warmed sea water, inhalation of sea frog and the use of marine mud or algae paste as alternative treatments for medical conditions to reduce

stress, anti-aging and relaxation in the dead sea region. Balneotherapy involves the use of mud bath as therapy, fangotherapy uses medicinal clay and the combination of mud, steam and water for therapeutic use is referred to as crenotherapy, the utilization of ultraviolet rays of sunlight is known as heliotherapy and the internal and external use of water in all forms for therapy is called hydrotherapy. A typical example is the Hamman a Turkish styled steam bath of both warm, cold and hot rooms heated to 37°C and enriched with algae and oxygen to reduce tension, muscular pain, physical tonus and psychic restoration of patients [4,5].

Origin of Climatotherapy

Hippocrates the father of modern medicine is the progenitor of climatotherapy since the period 500 BC where climatotherapy was administered for the treatment of different chronic inflammatory skin disorders [6]. Climatotherapy is known and referred in different names as health resort medicine, spa therapy and kurortology due to its complexity in therapeutic applications with sea and mineral waters as principal factors and other natural and artificial environmental factors. The modalities employed especially in the dead-sea region in climatotherapy are heliotherapy (solar radiation exposure), balneology (immersion in mineral waters in pools), speleotherapy (mud therapy) and thalassotherapy (sea water bath) for the utilization of atmospheric temperature, barometric pressure, humidity and solar radiation [6].

There is vagueness as to the precise period of spa treatment but the practice gained popularity by the Greeks, Mesopotamians and the Babylonians as early as the 500 BC where it was reported by Homer a classical writer of the various social baths and hot air bath called *laconica* indulged by the Greeks. The diffusion of spa therapy as a global practice was championed by the Romans who constructed over 1352 public fountains and 962 public baths for citizens of the Roman empire especially soldiers to enable them recover after very prolonged battles called *aquae* for the treatment of gout, bladder, kidney illnesses, paralysis, bronchitis rheumatic illnesses and general strength decline. They also recommended long sea voyages due to its changes in air and climate to have some therapeutic effects for the treatment of tuberculosis, general convalescence and wound healing disturbances [3]. This continued with the use of natural springs until the twilight of the Roman empire. Afterwards it shifted to Belgium during the 14th century up to the end of the 20th century where prominent personalities advocated its use for the treatment of skin diseases and infections. These are Charles Darwin, Leonardo da Vinci, Ferdinand von Habra and Louis Duhring who specifically recommended hydration and bathing for the treatment of pemphigus, psoriasis and ichthyoids etc. At the end of the 20th century the concepts of spa treatment moved to North America where areas like the White Sulphurs of West Virginia, hot springs of Arkansas and the Bedford's springs of Pennsylvania became prominent places for the treatments of skin infections especially for both the rich and poor. This later declined after the discovery and efficiencies of modern medicine [4]. The most organized region for climatotherapy currently is Bulgaria's coast of the Black Sea but the most recognized is the Dead Sea region which has the potential for the treatments of non-dermatological and dermatological diseases such as eczema, vitiligo, psoriasis and lichen planus [6].

Climatotherapy was also developed in England by the English physician Russell R in the eighteenth century with sea side resorts at Brighton England and later the first sea side hospital in Margate southern England in 1796 by Lettsom JC which led to the spring up of sea side hospitals and pediatric hospitals on all European sea coasts.

In Germany Vogel SG (1750-1830) pioneered the application of sea side resort for therapy with the establishment of the first German sea side bath in Heiligendamm/Doberan at the sea of Baltic and the Spa Norderney Frisian North Sea island bath in 1797, others are Weak on Fohr in 1819, Helgoland in 1826, Borkum in 1850, Westerland on Sylt in 1855 and the St Peter-Ording in 1913 with the first climatotherapy treatment for tuberculosis and scrofulosis carried out in Norderney. The importance of heliotherapy came to the lime light in England pioneered by Edwards in 1824 and in 1867 by Winslow, in 1855 in Velden/Slovenia Switzerland by Arnold Rikli (1823-1906) and in 1841 by Ruedi Luzius who founded a health resort for children suffering from scrofulosis in the high mountains of Switzerland. This was further developed into a global therapy by Auguste Rolier from Leysin in the Bernese Alps and in 1894 by Mehl Maximilian who developed the Mehl heliotherapy in Germany and was regarded as the progenitor of the sun sanatorium for lupus and skin infections in Orangeburg Berlin Germany. The twentieth century witnessed a decline and a resurgence of climatotherapy due to the emergence of pharmacological therapies and since they were inadequate in medical investigation for the treatment of chronic skin and pulmonary infections a resurgence was initiated in the 1950s for the treatment of atopic eczema and bronchial asthma, in 1953 the first dermatological specialized clinic was founded by Hartung Jo followed by the Baltic sea by Linser and Karnack for atopic eczema who also administered thalassotherapy aboard ships. This ushered an inaugural symposium called the premium Dermatological Bulgaria in Sofia [3,4]. According to Harari [7] the shores of the Dead Sea region are the world famous therapeutic home for patients with numerous skin diseases ranging from Eczema, Psoriasis vulgaris etc. since 4 decades ago. Patients exit this region with optimism and confidence in the miraculous therapy after seeking relief for their chronic skin symptoms. The Dead Sea region is located less than 400 meters below sea level with rare geo climatic conditions replete with high and stable temperatures, low relative humidity and atmospheric pressure relatively higher than that of sea level. The region is also blessed with other therapeutic resources which are mostly photo-biological with the presence of a specific attenuation of the ultraviolet radiation (UV), predominant on smaller UVB wavelength below 300 nm. Others are hyper-saline terminal lake, with unique composition and concentration of salts, hot springs mineral waters highly enriched in magnesium, sludge marine black deposition at the seabed, concentration of bromine in the atmosphere and also selenium in waters make the Dead Sea a therapeutic heaven for the treatments of skin diseases.

In contemporary times spa therapy is a global practice with replete of refreshing destinations all over the world. A typical example is India where spa therapy has evolved and developed to include hydrotherapy, aromatherapy, reflexology and meditation. The Traditional Ayurveda health resorts are many especially in the southern region of India where they flourish as a cottage industry. Spa therapy is gradually assuming a commanding position in alternative medicine for the treatment and prevention of dermatological diseases which offers chemical, mechanical, immunological and thermal actions for the wellness and fitness of both body and spirits [4].

Conceptual Frameworks

Human body (Heat) energy balance

This concept is premised on the first law of thermodynamics which states that energy can neither be created nor destroyed but rather

undergoes transformation from one form to another [8]. Human beings are closely linked to the atmospheric environment via their heat budget where energy ingested and expended must be accounted for Koppe, et al. [9]. The human body energy balance is an excess of energy intake relative to expenditure which lead to body energy storage; on the other hand, a deficit of energy intake relative to expenditure will lead to loss of human body energy stores [8]. External (climatic) and internal (metabolic) heat sources influence body temperature of which ambient temperature, humidity, air movement and radiant heat from the sun contribute to climatic heat stress. Body temperature reflects a careful balance between heat production and heat loss due to the continuous heat exchange between the body and the environment [10]. The principle of the human body energy balance is guided by the formula:

$$M + Q + C + E + Res = S.$$

Where:

M is metabolic heat production (both basic metabolic rate and metabolic energy production due to activity and workload)

Q is radiation balance

C is heat exchange by convection

E is heat loss by evaporation,

Res is heat loss by respiration and S is net heat storage, i. e. changes in body heat content Havenith, 2002).

For long periods (24 hours) S can be considered equal to zero in that heat gains are equilibrated by heat losses. However, at particular moments, S could be positive or negative with Positive S indicating accumulation of heat in the body and negative S indicating a cooling of the body core [10].

Thermal comfort

Thermal comfort is defined as that condition of mind which expresses satisfaction with the thermal environment by subjective evaluation [11,12]. Thermal comfort is classified based on outdoor, semi-outdoor and indoor environments [13]. The acceptable ambient temperature of comfort is slightly higher in the summer than in the winter, which are 23-27°C and 20-25°C, respectively. Thermal comfort is not only influenced by temperature but also factors like relative humidity, air velocity, environment radiation and physical activity levels and cloths insulation [11]. Thermal comfort is calculated by the finger's Predicted Mean Vote (PMV) equation which gives the optimal thermal comfort for any activity level clothing insulation and for all combinations of the environmental variables such as air temperature, air humidity, mean radiant temperature and relative air velocity [11]. The equation depicts that, thermal comfort is attained when the rate of heat dissipation from the body by means of radiation and convection equal the rate of metabolic heat production making heat storage nonexistent [11]. Thermal comfort is maintained when the heat generated by human metabolism is allowed to dissipate, maintaining thermal equilibrium with the surroundings. Any heat gained or loss beyond this generates a sensation of discomfort [11]. Human thermal comfort is the state of mind that expresses satisfaction with the surrounding environment [12,14]. Enumerated three parameters for thermal comfort: the body's heat balance; sweat rate and mean skin temperature within comfort limits. These parameters are expressed by: body-core temperature within a very narrow range of 36.5-37.5°C, skin temperature of 30°C at the extremities and 34-35°C body stem and

head temperature [11]. Human comfort is directly connected to the state of local weather and bioclimatic conditions which may greatly depreciate or improve the human energetic potential [15]. Temperature is the most significant component to the experience of comfort in a space (Physiologic Effective and Standard Effective Temperatures [16]. Our bodies perform within an internal temperature range much narrower than external temperatures and in the process our bodies' metabolism generates heat which must dissipate into the surrounding air or surfaces [16-18].

Vulnerability

Vulnerability is the degree to which a system is susceptible to or unable to cope with the adverse effects of a not benign climatic condition [19]. Vulnerability is an ambiguous concept as it means different things to several disciplines. It has been conceptualized in different ways by scholars from different knowledge domains, and within same domain. A clear example is the natural scientists and engineers who apply the term in a descriptive manner whereas social scientists use it in the context of a specific explanatory model [20]. This variance is expressed in the following themes as: natural hazards and disaster management, ecology, public health, poverty and development, secure livelihoods and famine, sustainability science, land change, and climate impacts and adaptation. The divergent explanations as to how these knowledge domains define vulnerability are a function of their applications [21]. A decade and half ago, several authors had emphasized that vulnerability could only be used with reference to a particular vulnerable situation [22] described vulnerability as a function of a specified system to a specified hazard or range of hazards and a distinction between the present and future vulnerability. Elaborated further to describe vulnerability not only as a function of place alone but assessments of the vulnerability of specific variables of concern to specific sets of stressors. Furthermore, situated the concept of vulnerability to risk to both ecosystem and social systems which are: the threat, the region, the sector, the population group, the consequence, and the time period [21]. Differently referred to vulnerability as a climate-related assessments based on the characteristics of the vulnerable system, the type and number of stressors, their root causes, effects on the system, and the time horizon of the assessments [21]. Adopted from the IPCC Third Assessment Report of (2001) enunciated vulnerability as a degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. And not too recent Kelman, (2014) summarized the concept of vulnerability as a condition controlled by the combine forces of physical, social, economic and environmental processes which triggers and influence the susceptibility of a community to the impact of hazards.

Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. Exposure, sensitivity and adaptive capacity are the three fundamental elements that define overall vulnerability Brown, et al. [19] Prior to this Brooks, [22] enumerated the meanings of these fundamental elements inter alia as: Exposure as the nature and degree to which a system is exposed to significant climatic variations. Sensitivity as the degree to which a system is affected, either adversely or beneficially by climate-related stimuli, the effect may be direct (e. g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e. g. damages caused by an increase in the frequency of coastal flooding due to sea level rise). Adaptive capacity as the ability of a system to adjust to climate change to moderate potential damages and to take advantage of opportunities,

or to cope with the consequences. The pathway between a climatic variable and the subsequent health impact often involves multiple steps and vulnerability can manifest at any point in that pathway [19].

An understanding of the health impact pathway is a powerful tool for identifying points of vulnerability as well as opportunities for adaptation. For example, vulnerability to health effects of heat waves can stem from; differences in exposure patterns based on occupational and social variables; the sensitivity of individuals to extreme heat; the capacity of the energy sector to meet peak demand during heat waves and; differences in community and individual capacity to implement adaptation strategies [23].

The concept of vulnerability was enumerated first by [20]. They are: the analysis of vulnerability as lack of entitlements and the analysis of vulnerability to natural hazards. Prior to this period [20] Adopted from gave further clarity surrounding the ambiguity of the concepts of vulnerability by referring to it first, as exposure (conditions that make people or places vulnerable to hazard), secondly as a social condition (measure of resilience to hazards), and thirdly as the integration of potential exposures and societal resilience with a specific focus on places or regions.

Ray man model

Ray Man model was developed for urban climatic studies in applied climatology and used for calculating short wave and long wave radiation fluxes affecting the human body This model estimates radiation fluxes and effects of clouds and complex building structures making it suitable for planning purposes in different micro to regional levels. The output of this model is the calculated mean radiant temperature required in the human energy balance model for the assessment of thermal bioclimatic conditions.

Wind-chill index

Wind-Chill Index (Wind-Chill) is defined as the combined action of air-temperature ($^{\circ}\text{C}$) and wind speed (m/s) on the heat budget of the human body which increases the intensity of heat energy that the human body surface unit loses through radiation, convection and evaporation processes expressed in W/m^2 [15]. The Wind-Chill formula is used for the calculation of the wind-chill equivalent temperature, the actual temperature the human body feels at certain values of air-temperature and wind speed from when wind increases the evaporation and increases the heat exchange rates of the human skin [15].

Review of the Literature

Bagherani, et al. [24] examined the role of Dead Sea Climatotherapy in the treatment of Psoriasis Vulgaris (a common skin disorder), by daily exposures of patients to solar radiation to induce an intense modulation of the immune system under low ultraviolet exposition. Seven hundred and ninety (790) subjects were examined over half a decade period by evaluating their psoriasis area severity index score. The results concluded that exposure to ultraviolet radiation was effective in the treatment of psoriasis vulgaris. Consistent with this is Kudish, et al. [25] who also examined the efficacy of Dead Sea Ultraviolet Climatotherapy (DSC) for moderate to severe Atopic Dermatitis (AP) children from the Czech Republic treated bi-weekly at the Centre for Deutsches Medizinisches Zentrum (DMZ), Israel. Seventy-two patients aged <19 years, divided into three groups with sun exposure treatments for 28 days consecutively in

March 2014, October 2014 and March 2015 revealed good clinical results in all groups with overall improvement in SCORAD reaching $87.5 \pm 13.4\%$ and $71.3 \pm 21.3\%$ immediately after DSC with no side effects observed during the treatments with higher cumulative exposure times correlated better results and enhanced remission. In Contrast Hitomi, et al. [26] investigate the objective and subjective influence of Climatotherapy on the physical and mental capability of people domiciled at the mountainous and low land areas in the north western part of main Island Japan. Twenty-nine participants comprising of 17 males and 12 females with an average age of 65.8 for males and 66.2 for females were involved in the programme. Their height, weight, body fat and body mass index were measured, collated and compared with the National Health and Nutrition Survey (NHNS) and their findings revealed that a regular exercise habits amongst more than 24 elderly participants was the cause of a decline in systolic blood pressure (SBP) from 141 to 119 mmHg, a rise of heart rates (HR) from 72 to 101 bpm and steady rates of blood pressure (BP). Other revelations showed that age adjusted T score of negative subscales, tension-anxiety, depression, anger-hostility; fatigue and confusion were significantly lower after climatotherapy at both sites.

Furthermore Kendrova, et al. [27] examined the effects of speleotherapy (therapy in caves) on the quality of life, depression and anxiety in 128 patients of average age of 64.05 with COPD treated and spa in sanatoriums of high tatra. The patients were divided into experimental group made up of 29 patients treated with spa and speleotherapy and the control group of 99 patient treated with spa alone for 20 days in a Belianskas cave. These treatments evaluated for the quality of life (SGRQ), Spirometric test (FEV1 and FEV1/FVC) and 6-minute walk test etc., and revealed an improvement in the quality of life, anxiety and in the six-minute walk test at ($p < 0.05$) for the experimental group with the spa and speleotherapy treatments than the control. Similarly Adler-Cohen, et al. [28]. Evaluated the potency of dead-sea climatotherapy as a treatment for atopic dermatitis and also an improvement in the quality of life of forty-nine patients during the period of 2009-2010 at the Deutsches Medizinisches Zentrum medical Centre. A computer designed protocol and a graduate solar radiation exposure after a sea bath was administered and the severity of AD was evaluated using the scoring atopic dermatitis (SCORAD) index, skindex -29 for the quality of life and the Mann Whitney U and pair T tests were employed and discovered an improvement of 39 points for SCORAD and 33 points increase for skindex-29 for the quality of life of the patients. Also Harari, et al. [29]. Evaluated the short-term results on dead-sea climatotherapy for psoriasis vulgaris by determining the success rates for dead-sea climatotherapy through the comparison of patients reaching different levels of clearance for the connection between their demographics, clinical variables and the Psoriasis Area Severity Index (PASI) 75 and (PASI) 90. Seven hundred and ninety patients suffering from moderate to severe psoriasis vulgaris for a period of five years under went the dead-sea climatotherapy and divided into groups of psoriasis vulgaris area severity index 75 and 90 and the continuous variables group. The onset of the infections was found to be inversely correlated to the success rates of the diseases. PASI 75 recorded a success rate of 76.8% while PASI which correlates with skin type II infections recorded a success rate of 91%.

Prior to the studies above Hodak, et al. [30] investigated the responds of activated immunologic cells and keratinocytes in psoriatic lesions to climatotherapy at the dead-sea for twenty-seven patients suffering from chronic, stable and plaque type psoriasis for twenty-eight days using the quantitative histologic measures and the psoriasis

area severity index score. They discovered that the psoriasis area and severity index score decreased by 81.5%, complete clearance was achieved in 48% and 41% in marked improvements after four weeks of treatment. During the remission period of 3.3 months the Malpighian layer thickness reduced by 63.4%, keratinocyte hyperplasia decreased by 78%, the residual cell proliferation was restricted to the basal layer, normalization of keratin 16 expression in 90% of the patients, the T lymphocytes were eradicated from the epidermis (depletion of >90% of CD3+ and CD25+ cells) and drastically reduced from the dermis (depletion of 69.4% of CD3+ cells and 77.4% of CD25+ cells) with a reduction in HLA-DR expression by epidermal keratinocytes.

Kushelevsky, et al. [31] compared the responses of some age groups during a four-week period of climatotherapy at the dead-sea region. In one group comprising 688 patient's climatotherapy as a function of age, sex and duration of plaque clearance was investigated and revealed that age of the patients and duration of the disease had no influence on plaque clearance of the patients. In another group comprising of 502 patients over the age of 65 and over 4500 young psoriasis patients they examined the type and incidence of side effects after the administration of climatotherapy and revealed non-variance in the type and frequency of side effects between the groups as they both recorded an 8.2% in slight sun burn, 5% sun allergy, 3.4% common cold, 2% leg oedema, 0.8% herpes simplex and 1.4% diarrhea. In the final group time was used to examine the reduction in the diastolic and systolic blood pressures in 1142 hypertensive psoriatic and discovered a reduction in diastolic and systolic blood pressure between patients of the ages less than 40 and over 65. In terms of Vitiligo patients Czarnowicki, et al. [32] investigated the administration of climatotherapy for four hundred and thirty-six vitiligo patients during the period of 1997 to 2005 at the dead sea after other failed alternatives using sun exposure after a sea bath in accordance with a computer designed protocol, other attributes investigated were age at vitiligo onset, skin photo type and involvement, duration of the disease and the timing of the dead sea climatotherapy. Logistic regression was also employed and the results showed a 3.9% total repigmentation, 81.4% good repigmentation, 13.15% non repigmentation with a pink colored vitiligo spots and a non-effect of climatotherapy in 1.6% of the patients. It was also observed that the size of the affected skin area was inversely proportional to the responds of the patients, long duration on climatotherapy was important for the effective treatments of vitiligo patients in the dead-sea region.

Suitable Sites for Climatotherapy in Nigeria

Climatotherapy is the use of the natural climatic elements of specific locations for the treatment of diseases which includes conditions like altitude, atmospheric pressure, sand composition, temperature and ultraviolet rays etc. These make the climate and the geography of an area the major suitable condition for the administration and practice of climatotherapy. According to Nghargbu, et al. [33] Nigeria is replete with waters of rich balneological resource suitable for medicinal purpose in billions of cubic meters in the form of hot springs, cold springs and formation waters. They are chemically rich in chlorosodic and bicarbonate waters including fluorinated, iodinated and brominated waters and many others for the treatments of gynecological, dermatological and gastrointestinal disorders. The Nigerian sedimentary basins and basements terrain are blessed with eight hot springs of therapeutic quality; three are suitable for drinking as mineral bottled waters and are the Wikki, Ruwan Zafi Numan and Ikogosi Springs while the other five are perfect sites for clinical

balneotherapy rich in fluoride-siliceous, fluoride and chloroside isotonic waters containing calcium and magnesium ions thus making the springs a haven for bathing, drinking and inhalation therapies. These springs are Bitrus, Akiri, Ruwan Zafi, Awe, Ruwan Dumi Awe and Tangarahu springs. In comparison, the thermal spring in Akiri in the middle Benue trough has a temperature of 40°C and the Wikki spring located in the famous Yankari games reserve has a temperature of 30°C, also the delta Niger area formation waters has potentials for balneotherapy and climatotherapy as they contain iodine, bromine and both chlorosodic and thermal for external therapy [33].

Furthermore, the Niger delta formation waters are rich in medicinal water types which are minerals, alkaline, mesothermal to hyper thermal, iodinated, fluorinated, lithic, chlorosodic and borous in nature with the possibility for the treatments of ailments ranging from gynecological, dermatological, rheumatic, digestive, respiratory and blood circulation. In the middle and upper Benue trough the waters are thermally chlorosodic in nature and hold the potentials for the treatments of dermatological and gynecological ailments whose major applications pathways are the external application of clay and water to the skin in the form of tampons, immersion, inhalation and flushing [33].

Research Gaps and Conclusion

Climatotherapy is a multidisciplinary field that requires the inputs from dermatologist, medical doctors, climatologist, atmospheric physicists, medical meteorologists and statisticians etc. There is a huge gap on contemporary research in Nigeria on the studies and applications of climatic factors for therapeutic uses. The development of this discipline will open a new vista for alternative medical treatments especially for skin infections. The use of this method is devoid of side effects, environmentally friendly and highly sustainable. According to Gutenbrunner, et al. [2] medical hydrology, climatotherapy, balneology and health resort medicine are not independent discipline recognized at the international level and the reasons are the inadequate empirical scientific evidence, the lack of application of balneology and climatotherapy as a global approach and the unilateral methods employed in the field of medical hydrology, climatology, balneology and health resort medicine without a comprehensive concepts and frameworks are the bane in the development of this potential source of alternative medicine. Devoid of globally accepted terms, the limitations in the practice only in specific climes and the advocating of balneology as a wellness concepts alone without a synergy amongst scientist and specialist makes the delve into its research and eventual discoveries a speculative one. There is an urgent need for the Nigerian natural ecosystems to be explored further for its utilization as a potential alternative for medical treatments.

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