EPIDEMIOLOGY OF OBESITY AND ANTI-OBESITY THERAPEUTIC MEDICINAL PLANTS AND AROMATIC PLANTS IN THE WORLD WITH REFERENCE TO THEIR PATHOPHYSIOLOGY AND ACTION MECHANISM

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Abstract

Pharmacological intervention is seen as an approach for treating obesity, which is thought to have a substantial effect on medical conditions and produces multiple chronic conditions and difficulties. For something like a long time, it was thought being overweight was such a consuming disorder which might be treated with counselling and relatively brief medication therapy. The majority of biochemical lean mass medicines have side effects, which makes it more difficult for regulatory bodies to approve them. This article gives an insight into the latest anti-obesity medications and natural ingredients to anti-obesity characteristics in addition to their effectiveness mechanisms, which also include reducing lipid accumulation, vastly increased metabolic activity, reducing energy intake (thermogenesis), suppressing hunger, changing the configuration of the intestinal micro flora, and growing fecal fat detoxification.

Key words: Obesity, Therapeutic potential, Herbal plants, Obesity pathophysiology

1: INTRODUCTION:

Obesity is an epidemic that affects people all over the world and is characterized by excessive body fat that results from severe energy imbalance. However, obesity increases the risk of developing a number of chronic conditions, including type 2 diabetes (T2D), cerebrovascular events, hyperlipidemia, cardiovascular diseases (CVD) and obstructive sleep apnea. Meal intake is regarded to be the primary factor in hypothalamus and gut's control of hormone peptides that affect hunger. In addition to increasing fatty acid oxidation inside muscles and lowering anorexigenic hormones like cholecystokinin, palatable foods also cause hyperplasia and excessive fat buildup (CCK) (Shang *et al.* 2021).

Moderate exercise is one of the best strategies, along with anti-obesity medicine to combat the complications of obesity, according to the national heart, lung and blood institute recommendation of "Pharmacological Management of Obesity". Researchers have recently concentrated on the medicinal potential of natural items for treating obesity with minimal side effects. This study focused on recent research on herbal treatments for obesity that was produced by numerous researchers throughout the world. In this study, recent trends in pathogenesis, epidemiology and plant biology are briefly discussed, along with the photochemical components of the plants and their mechanism of action. As a result, the country- specific research conducted between 2000 and 2018 has also discussed (Rahman *et al.* 2022).

The WHO set a goal to stop obesity prevalence at a level that would not increase further, citing the importance of reducing the burden that obesity has on society and health. The "Global Action Plan for the Prevention and Control of non-communicable diseases 2013-2020" included it as one of its primary goals in 2010.The political statement of the high level UN General Assembly conference on the prevention and control of NCDs in September 2011 emphasized the significance of lowering unhealthy eating and physical inactivity. Dietary carbohydrates with "High Glycemic Index" are those whose monosaccharide content makes up the majority of units. Polymeric carbohydrates are reported to have a "low glycemic index" and are digested more gradually (Hasanpour *et al.* 2020).

The incremental area under the blood glucose curve after consuming a test item, represented as a percentage of the corresponding area after an equivalent load of a reference carbohydrate, such as glucose or white(wheat) bread, is known as the glycemic index(GI). Vegetables, plain yoghurt and protein-rich spaghetti are examples of low-GI foods. White bread, dates and baked potatoes are few examples of high-GI food items. High-GI foods cause a significant, quick rise in blood sugar levels, which is followed by a swift rise in insulin levels. Insulin encourage the uptake of blood glucose into liver and skeletal muscle cells, where it is stored as glycogen. Moreover, insulin promotes the production of fatty acid, which may lead to lipid buildup (Kumar *et al.* 2022).

A reduction in insulin sensitivity is linked to fat buildup in skeletal muscle and the liver. Type 2 diabetes and heart diseases risk are both increased by insulin resistance. In people with impaired glucose tolerance, postprandial hyperglycemia and insulin resistance are believed to be a key factors in the onset and progression of cardiovascular diseases. A high-GI diet and prevalence of type 2 diabetes are correlated, according to three significant epidemiological research on female participants. As was previously stated regarding GI, the kind of carbohydrates in a diet, with their different glycemic characteristics, can affect how quickly sugars are absorbed into a body. Including resistant starches into a meal is one way to lower the GI. Resistance starches function like dietary fiber because they withstand digestion in the small intestine and move into the large intestine (Saad *et al.* 2022).

Improved methods should be taken into consideration to lower the prevalence of obesity and enhance quality of life. To improve patient outcomes, doctors and other health care providers should advise patients to make changes to their everyday routines. Obesity is typically brought on by the diet and is caused by an excessive intake of calorie-rich foods, a lack of exercise and a decreased in energy consumption. Either the number of fat cells or their size grow as a result of imbalance between energy consumption and use. Weight loss has been successfully treated with complementary and alternative medicine (CAM), which induces dietary changes and herbal supplements .World Health Organization (WHO) advised Asian nations to lower BMI cut-off numbers in 2002 (Ansari *et al.* 2021).

Herbs are being used to isolate numerous therapeutically beneficial chemicals that are used to treat variety of ailments. There are numerous typical herbs and spices that are consumed in daily life that could be beneficial in preventing weight gain. Green tea, Camellia sinensis, Black Chinese tea and Nigella sativa all demonstrated positive anti-obesity properties. It is advised that the dosage of medicinal herbs be established for efficient treatment and any potential negative effects. 53 medicinal herbs were examined in a study for potential anti-obesity properties (Ansari *et al.* 2021).

Black tea, licorice, cheery, garlic powder Rhubarb stalk have all been shown to significantly lower total cholesterol and LDL cholesterol levels. In order to examine the benefits of processed tomato vinegar beverage TVB against obesity and insulin resistance, a research was carried out. The results revealed a decrease in insulin resistance and visceral obesity. Besides assisting in weight loss, tomatoes also lower the risk of developing chronic inflammatory disorder (Nyakudya *et al.* 2020).

2: OBESITY AND CLINICAL RISKINESS RELATIONSHIP:

Obesity, as long as carrying a well-being threat/hazard itself, has evaluated the prevalence of significant obesity affiliated/linked co-morbidities and also raises the threat for evolving a large scale diversity of other disorders like gallbladder disease high blood pressure, osteoarthritis, coronary heart disease, diabetes mellitus (Type-2) and high blood cholesterol level. Type 2 diabetes mellitus prevalence raised/magnified in women, men and overweight patients. Furthermore, the prevalence of high blood pressure and type 2 diabetes mellitus raised with raising weight class in both men and women. Some principal diseases and their clinical association with obesity has been mentioned in following in detail (Tan *et al.* 2022).

Rank of countries by Obese population in 2017

COUNTRIES	Obese population	Obesity percentage
Nigeria	14,185,907	4%
United State of America	73,872,022	23%
Iran	14,311,564	4%
China	65,706,627	20%
Mexico	24,520,821	8%
Turkey	16,092,644	5%
India	44,332,755	14%
Russian Federation	23,444,354	7%
Egypt	19,047,097	6%
Brazil	28,279,032	9%

2.1) Obesity and diabetes mellitus:

Hyperlipidemia, diabetes mellitus (Type-2) and obesity usually coexist and linked with substantially increased mortality and morbidity. A substantial increase in total in-take of refined fructose and carbohydrates has paralleled current raise in the level of diabetes and obesity. Mainly liver concerns with sugar's metabolism especially fructose, so the accumulation and enhanced level of hepatic triglycerides is the result of high flux of fructose i.e. pro-inflammatory cytokine expression increases. Fat cells particularly those deposited hormones and some special substances that fire inflammation (Unuofin *et al.* 2020).

Even though inflammation is a worthy section/component of healing action and also a fundamental constituent of immune system, a wide class of health problems are associated with incompatible inflammation. The metabolism of carbohydrates and fats modified due to inflammation and the body becomes less receptive/ susceptible to insulin, leading to high level of blood sugar and ultimately, to several complications especially diabetes. In the Nurses' Health Study, the chance/danger of evolving diabetes mellitus was 93 time greater within women who had a BMI of 35, in contrast with women with BMI below 22. Diabetes risk also increased due to gain in weight during childhood, even within women who had a body mass index in normal healthy range (Unuofin *et al.* 2020).

A comparable connection found in men by the Health Professionals Follow-Up Study. More researchers carried out a systematic review on diseases associated with weight of 89 studies and later did a Meta-analysis or statistical summary of the data. The 18 studied weight linked diseases, the top of risk list disease was diabetes mellitus paralleled with women and men in normal range of weight (BMI below 25). Women with body mass index higher than 30 had a 12-times higher risk and men with MBI higher than 30 had 7-times greater risk of evolving diabetes mellitus (Benchoula *et al.* 2022).

2.2) Obesity and Respiratory/lung Function diseases:

Overflow of weight impairs/damage the functions of respiratory system via metabolic and mechanical pathways. The strength and flexibility of chest wall and respiratory muscles can be diminished due to visceral fat accumulation in the same case the expansion of lungs may also be reduced due to abdominal fats accumulation. The obesity accompanied by low-grade inflammatory state is the result of production of cytokines which also block/restrict the functions of lungs. The principal respiratory diseases associated with obesity are obstructive sleep apnea and asthma (Bahramsoltani *et al.* 2021).

A prospective seven studies meta-analysis that comprised/enclosed 333,000 issue and theme, obesity was predicted to raise the chance/prevalence of evolving asthma in both women and men by 50%. The principal contributor to obstructive sleep apnea is obesity, approximately influence the 1:5 in adults. This situation is linked/connected with cardiovascular diseases, hypertension, accidents, premature mortality and daytime sleepiness. Approximately 50-70% of patients of/with OSA are obese. Clinical trials recommend that moderate loss in weight can be supportive when handling OSA (Saad. 2022).

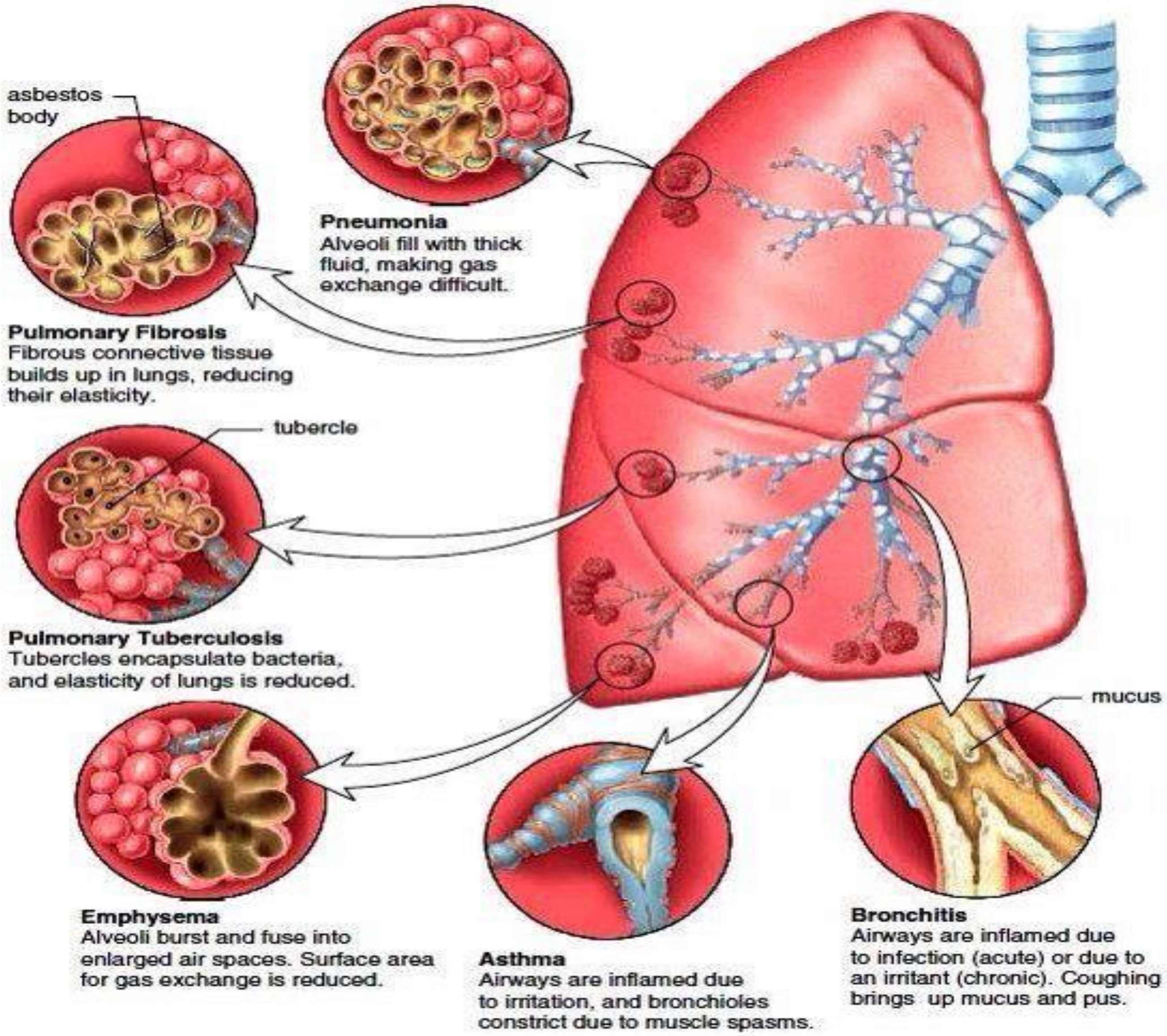

Figure: Obesity and some diseases associated with respiratory system

2.3) Obesity and Inflammation:

Obesity, diabetes mellitus and cardiovascular diseases etc. are associated in that they are interlinked with inflammation i.e. chronic down level inflammation. A principal correspondent/participant to inflammation is obesity i.e. adipose tissues accumulation. Advance studies have evolved/discovered the adipocytes capability/proficiency to regulate the inflammatory reaction and also their biologically dynamic nature. In a study. Adipose tissues of mammals are characterized as brown adipose tissues and white adipose tissues. Metabolically both forms are similar but the difference is that brown adipose tissues dissipate energy while white adipose tissues accumulate/store-up energy. WAT are composed of visceral adipose tissues and subcutaneous tissue and play a vital role in pathophysiological actions/operations leading to inflammatory disorders development and advancements. VAT supplies and surrounds internal organs whereas subcutaneous adipose tissues accumulate body residues and energy reserves in lower and upper parts of body (Kumar *et al.* 2021).

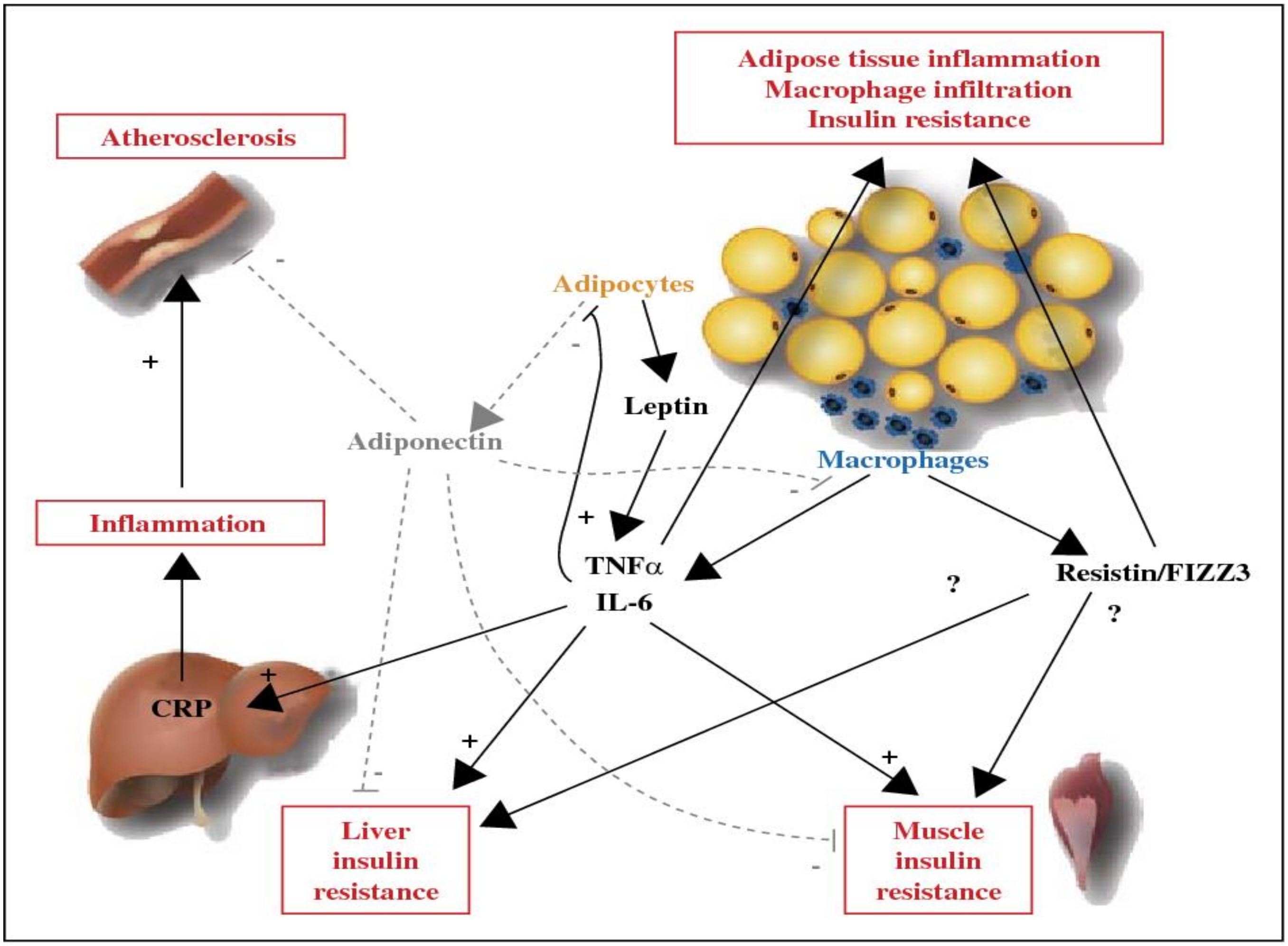

Figure: Obesity and all types of inflammations which are causative agents of complex and lethal diseases for a long time which even leads to death

Mature adipocytes are principal component of adipose tissues and also a smaller cells group i.e. macrophages, fibroblasts and pre-adipocytes. Multifunctional adipocyte cells comprises in anti-inflammatory and inflammatory factors secretions, lipid storage and lipid synthesis. Primarily, adipose tissues produce anti-inflammatory factors under normal conditions, but in hypertrophy (lipid accumulation) within adipose tissues the macrophages, pre-adipocytes and adipocytes can produce a diversity/range of hormones and inflammatory cytokines like monocyte chemotactic protein-1, interleukin-6, nitric oxide synthase, resistin and C-reactive protein. A hormone leptin (pro-inflammatory) secreted by enlarged adipocytes decreases adiponectin secretion (anti-inflammatory characteristics hormone). Monocyte chemotactic protein-1, interleukin-10, interleukin-6, interleukin-1 beta and tumor necrosis factor alpha are principal inflammation causing chemokine's and cytokines. Visceral adipose tissues has a higher rate interleukin-6 expression and also increase the rate of lipolysis (fatty acid breakdown). By increasing adiposity, expression and activation of inflammatory cytokines like TNF-, IL-6 and MCP-1 also increases i.e. monocytes are transported from blood to adipose issues where they discriminated/distinguished into inflammatory macrophages. There is a study to support that by hypoxia, macrophages may be fascinated/drawn to high class of necrotic tissues in developing and extending adipocytes (Kumar *et al.* 2021).

2.4) Obesity and Stroke:

Coronary disease and Ischemic stroke (clot caused) share the similar/indistinguishable disease risk factors and processes. A prospective 25 studies meta-analysis with 2.3 million contestants revealed a graded and direct affiliation/relationship between stroke risk and obesity (excess weight). 22% risk of ischemic stroke increased by overweight. In there was no a valuable association between hemorrhagic stroke and obesity or overweight. A statistically association analysis in diabetes, cholesterol and blood pressure showing that these parameters interfere/facilitate the impact of obesity on stroke. 26 observational studies meta-analysis included 390,000 ethnic groups, some racial, women and men, obesity was principally affiliated with death from cardiovascular and CAD diseases. Women with normal range BMI (18.5-24.9) had less rate of disease compared with women who had BMI greater than 30 i.e. 62% dying early disease. Men with BMI greater than 30 had comparable raised risk (Arozal *et al.* 2020).

2.5) Obesity and coronary arteries diseases:

Several surveys have revealed a direct affiliation/relation between coronary artery diseases and body weight. A prospective meta-analysis of 21 studies was conducted by CAD teamwork researchers in which 300,000 participants were followed an average of 16y. In analysis the participants had 32% developing risk of CAD who were overweight as compare to normal weight range participants while 81% higher risk was noticed in participants who were obese. Cholesterol levels and blood pressure adjustment decreased the risk evaluations i.e. remarkably significant for obesity. The investigators estimated that the effect of excess weight on blood pressure and blood cholesterol accounts for only about half of the obesity-related increased risk of coronary heart disease (Bouyahya *et al.* 2021).

2.6) Obesity and cancer:

In 2007 a review data was released by an authority board assembled by American Institute for Cancer Research and World Cancer Research Fund, concluded that there was a potent affiliation/relation between obesity and cancers of gallbladder, kidney, endometrium, breast, rectum, colon, pancreas and esophagus. During adulthood weight gain and abdominal obesity were affiliated/associated with many cancers. Later on, a meta-analysis and systematic review conformed that a direct relationship is present in obesity and cancers of pancreas, ovary, kidney, esophagus, endometrium, rectum, colon and breast (Ahmed *et al.* 2022).

2.7) Obesity and cardiovascular diseases:

An association in epidemic obesity and other metabolic disorders like cancer, cardiovascular diseases and insulin resistance has developed/built an important focus of scientific analysis and a good objective of therapeutic interventions. Nevertheless, in obese mice endoplasmic reticulum stress exact physiology is not known/unexplored, it result from diverse/several physiological circumstances such as reduced/declined revascularization of adipose tissues, for insulin resistance setting of low glucose, major requirements for synthesis of protein and overcharge of nutrients. Weight of body is directly affiliated with diverse risk factors of cardiovascular diseases. Inflammation, blood sugar, triglycerides, cholesterol, low density lipoprotein and blood pressure levels increases with increase of body mass index. So, the chance, change and rate of cardiovascular diseases, stroke and coronary heart diseases also increased proportionally (Poddar *et al.* 2020).

2.8) Obesity, cognitive functions and memory:

Population's scourges diseases are dementia and Alzheimer's i.e. 7.5 million people affect in US. Over age of 65, Alzheimer's disease lifetime risk is 9.1% in men and 17.2% in women. For dementia and Alzheimer's disease modifiable and potential risk factor id body weight. 10 cohort studies prospective and meta-analysis that enclosed 42,000 participants followed 3-36 y revealed a U-shaped connection in Alzheimer's disease and body mass index. More advance meta-analysis revealed an analogous, strong and stable affiliation between Alzheimer's disease and obesity (Saad *et al.* 2021).

2.9) Obesity and Mortality:

Obesity is a universal health problem and affiliated with high mortality and morbidity, bring out the adverse impact on manifold aspects of health i.e. increases the range and rate of premature mortality. Globally, in high mortality leading top five diseases obesity is also involved. Nevertheless, pinning down the obesity share to premature mortality has been with current methodological issues and difficulties and controversy (Shende *et al.* 2021).

3) PATHOGENESIS OF OBESITY

Out of 7.5 billion people of the world's population, 0.774 billion people were ascertained to be obese. From these 0.774 billion people, 650 million were obese and 1.9 million were overweight. According to 2016 survey, 41 million children below 5 years and 340 million children above 5 years were found obese and overweight. Generally more than 50% of obese patients have filled the China, USA, and India. The fundamental pathophysiology of obesity include either up or down regulation of hunger by controlling biological process, physical activity etc. Dysregulation causes an overflow of adipocytes to form, which raises the release of cytokines, which leads to the development of vascular complications. Hyperlipidemia, circulatory irregularities and atherosclerosis are linked to these problems. Bowel cancer, gallstones, liver disorders and other serious pathological illness are brought on by obesity in conjunction with atherosclerosis. Hence controlling obesity is essential for avoiding and treating these comorbidities. Either decreasing appetite or boosting calorie expenditure can be use to treat obesity. Regulation of hormones and receptors that express hunger and satiety signals can influence appetite .Moreover, an increase in physical activity prevent the formation of white adipocytes (Przeor. 2022).

These techniques will aid in preventing obesity and reducing its negative effects. Adipocyte buildup throughout the body and atherosclerosis are brought on by an excessive blood level of fatty acids and triglycerides. Increase in oxidative stress, hypertriglyceridemia, diabetes and several metabolic disorders were the result of this. Hence, decreasing level of stored and circulating fat is essential for managing obesity. Hence, decreasing oxidative stress, a major cause of many medical illness, may be useful in reversing the beneficial effects of obesity and other issues. The adipocytes also trigger the release of adipokines, which contain the three molecules Lectin, Adiponectin and Visfatin (PBEF) (Jamal *et al.* 2022).

Adiponectin may activate cytotoxic autophagy in female-specific cancer of breast, colon, prostate and ovaries. Consequently, adiponectin suppression can reduce the risk of obesity related carcinogenesis. These three hormones trigger the release of insulin, which helps to control body fat and maintain blood glucose level. Hence, any dysregulation of the physiological order results in imbalance and obesity. This show how important insulin is for managing fat and how it relates to diabetes. Consequently, dopamine controls the release of each hormone via the gastrointestinal system, pancreas and adipose tissue. When these hormones are dysregulated, obesity may result. These hormones maintain hunger, satiety and body fat. Thus, these parameters and their roles are vital in development of new anti-obesity drugs (Hosseini *et al.* 2021).

3.1) Medicinal Plants distribution for obesity treatment:

Different plants have been distributed in different areas of difernt countries. These plants have beneficial impact against obesity.

Table 3.1: Obesity treatment plants and their geographical distribution

Family	Species	Geographical distribution	Reference
Asteraceae	*Taraxacum officinale* F.H.Wigg	Panama, Guatemala, China, Kazakhstan, Argentina, Madagascar, United Sates, Chile, South Africa.	(Guru *et al.* 2021)
	Hieracium pilosella L.	United States, Canada, China	(Hosseini *et al.* 2021)
	Cichorium intybus L.	Venezuela, Panama, Madagascar, Guatemala, Canada, Mexico, China, United States, Chile, El Salvador	(Negi *et al.* 2021)
	Baccharis trimera	Paraguay, Bolivia, Argentina, Brazil	(Marrelli. 2021)
	Artemisia princeps Pamp.	Japan, North Korea, China, South Korea.	(Guru *et al.* 2021)
	Tanacetum vulgare L.	Japan, United States, Ecuador, South Korea, China, Kazakhstan, Brazil, Argentina, Chile, Guatemala, Costa Rica, North Korea, Bolivia, El Salvador.	(Shabab *et al.* 2021)
	Cynara scolymus L.	United States, Colombia, Ecuador.	
	Bidens Bipinnata L.	Venezuela, Nepal, Laos, Ecuador, China, Brazil, Thailand, Madagascar, United States, Cambodia, North Korea.	(Diab *et al.* 2022)
	Baccharis articulata	Argentina.	(Bayliak *et al.* 2021)
	Achyrocline satureioides	Venezuela, Peru, Guiana, Colombia, Bolivia, Argentina, Uruguay, Paraguay, Ecuador,	(Marrelli *et al.* 2020)
Sapindaceae	*Paullinia sorbilis* Mart	NI	(Tripathy *et al.* 2021)
Salicacae	*Salix matsudana* Koidz.	Bolivia, China	
	Caseria sylyestris	Suriname, Puerto, Paraguay, Nicaragua, Jamaica, Virgin Island, Honduras,	(Bayliak *et al.* 2021)

		French Guiana, Suriname, El Salvador, Puerto Rico, Panama, Mexico, Haiti, Guiana, Nicaragua, United States, Cuba, Costa Rica, Brazil, Argentina, Colobia, Belize.	
	Populus balsamefera L	Bolivia, United states, Canada	(Ignat *et al.* 2021)
Theaceae	*Camellia thea* Link	Laos	
Polygonacea	*Persicaria hydropiper* L	Thailand, Russia, Mongolia, United States, China, Burma, Australia, South Korea, Sri Lanka, Nepal, Japan, Buthan, Canada.	
Rosaceae	*Rubus coreanus* Miq	Japan, Korea, China	(Bayliak *et al.* 2021)
Rutaceae	*Fortunlla japonica*	Honduras	(Gadde *et al.* 2018)
	Citrus decumana Murr	China	
	Citrus aurantium L	Venezuela, Paraguay, Mexico, India, Guatemala, EI Salvador, Cuba, Colombia, Bolivia, Argentina, Peru, Panama, Madagascar, Honduras, United States, Ecuador, Costa Rica, Brazil, Bolivia.	
Rutaceae	*Aegle marmelos* L	Vietnam, Laos, Honduras, Cambodia, Buthan, Suriname, India, China.	
Piperaceae	*Piper mikanianum* (Kunth) steud	Argentina, Brazil, Paraguay	(Bayliak *et al.* 2021)
	Piper nigrum L	Venezuela, Peru, Honduras, Ecuador, Colombia, Brazil, Sri Lanka, India, French Guiana, Costa Rica, Brazil,	

		Belize.	
Poaceae	*Cymbopogon citratus*	French Guiana, Gabon, United States, Ecuador, Costa Rica, China, Brazil, Belize, Australia, Guiana, Guatemala, Philippines, EI Salvador, Cuba, Colombia, Chile, Bolivia, Barbados, Argentina, China.	(Khanna *et al.* 2021)
	Coix lacryma-jobi L	Nicaragua, Mexico, Laos, Jamaica, Honduras, Guiana, Guatemala, Philippines, United States, Ecuador, Costa Rica, China, Burma, Brazil, Belize, Australia, South Africa, Nepal, Madagascar, Japan, India, Guiana, Gabon, Ethiopia, EI Salvador, Cuba, Chile, Brazil, Belize.	
Plantaginaceae	*Plantago ovate* Forsk	NI	(Bayliak *et al.* 2021)
Nelumbonaceae	*Nelumbo nucifera* Gaertn.	Suriname, Russia, Nepal, India, Philippines, North Korea, Burma, Brazil, Sri Lanka, Pakistan, Japan, Guiana, United States, China, Buthan.	
Myrtaceae	*Campomanesia xanthocarpa* Mart	Uruguay, Brazil, Argentina, Paraguay, Bolivia.	
Paeoniaceae	*Paeonia suffruticosa* Andrews	China	
Malvaceae	*Hibiscus sabdariffa* L	NI	
Myristicaceae	*Myristica fragrans* Houtt	Taiwan, Malaysia, India, Guatemala, China, Panama, Madagascar, Honduras, EI Salvador.	(Bayliak *et al.* 2021)
Moraceae	*Morus bombycis* Koidz.	Ni	(Zhang *et al.* 2018)

Melastoataceae	*Leandra australis*	Brazil	
Moringaceae	*Moringa oleifera* Lam	Venezuela, Pakistan, Nicaragua, Malaysia, India, French Guiana, Gabon, Costa Rica, China, Bolivia, Paraguay, Panama, Mexico, Madagascar, Honduras, Guiana, EI Salvador, Colombia, Brazil, Belize.	(Kumar *et al.* 2021)
Irdaceae	*Sisyrinchium vaginatum*	Venezuela, Suriname, Ecuador, Bolivia, Uruguay, Guiana, Brazil, Argentina.	
Lythraceae	*Cuphea carthagenesis*	Taiwan, Peru, Panama, Mexico, French Guiana, Guatemala, Unite States, Costa Rica, Brazil, Argentina, Suriname, Paraguay, Nicaragua, Honduras, Guiana, EI Salvador, Ecuador, Colombia, Bolivia.	(Bayliak *et al.* 2021)
	Dioscorea speciosa L	Vietnam, Panama, Mexico, India, Guiana, Philippines, EI Salvador, Colombia, Belize, Sri Lanka, Nicaragua, Malaysia, Honduras, Guatemala, United States, Costa Rica, China, Australia.	(Guru *et al.* 2021)
Lamiaceae	*Orthosiphon stamineus* Benth	Ni	
Lauraceae	*Cinnamomum cassia* L	Vietnam, Taiwan, Laos, India, Thailand, Malaysia, Indonesia, China.	
Lardizabalaceae	*Akebia guinata* (Houtt) Decne	Japan, South Korea, United States, China.	
Linaceae	*Linum usitatissimum* L	Uruguay, Peru, Mexico, Honduras, Ecuador, Colombia, Canada, Argentina, United States, Nicaragua, Madagascar, Guatemala, Costa Rica, Chile, Bolivia,	(Bayliak *et al.* 2021)
Fabaceae	*Senna corymbosa*	Uruguay, Brazil, United States, Argentina.	
	Phaseoulus vulgaris L.	Honduras, Guatemala, Ecuador, Costa Rica, China, Burma, Belize, Guiana,	

		Ecuador, Colombia, Canada, Bolivia, Argentina.	
	Acacia mearnii De Wild	Uganda, Taiwan, Sri Lanka, Portugal, India, United States, Ecuador, Brazil, Australia, Ruanda, Pakistan, Jamaica, Ethiopia, China, Bolivia, South Africa.	(Kumar *et al.* 2022)
	Senna alexandrina Mill	Dominance Republic, India, Brazil, Mexico, Ecuador.	
	Cassia nomame Kitag	China	
	Abarema cochliacarpos	Brazil	
Geraniaceae	*Geranium nepalense* Sweet.	Vietnam, Sri Lanka, Laos, India, China, Brazil, Thailand, Pakistan, Mongolia, United States, Burma, Afghanistan.	(Arozal *et al.* 2020)
Fucaceae	*Fucus vesiculosus* L	NI	
Equisetaceae	*Equisetum giganteum* L	Panama, Jamaica, Haiti, EI Salvador, Cuba, Nicaragua, Honduras, Guatemala, Ecuador, Costa Rica.	
Erythroxylaceae	*Erythroxylum argentinum*	Brazil, Argentina, Bolivia.	
Cyperaceae	*Cyperus rotundus* L	Japan, Honduras, Guiana, Gabon, United States, Ecuador, South Korea, Colombia, Chile, Burma, Brazil, Belize, Argentina, India, French Guiana, Guatemala, Philippines, EI Salvador, Costa Rica, North Korea, China, Kazakhstan, Buthan, Bolivia, Australia, Afghanistan.	(Hosseini *et al.* 2021)
Euhorbiaceae	*Croton gnaphalii* Baill	Brazil	
Curtisiaceae	*Curtisis dentata*	South Africa	

Dioscoreaceae	*Dioscorea nipponica* Makino	Russia, North Korea, Japan, Chile.	(Ignat *et al.* 2021)
Cucurbitaceae	*Cucurbita moschata* Duchesne	Venezuela, Panama, Honduras, Guiana, United States, Colombia, Bolivia, Suriname, Mexico, French Guiana, Ecuador, Costa Rica, Brazil.	
Costaceae	*Costus spicatus*	Dominance Republic, Honduras, Bolivia, Mexico.	
Clusiaceae	*Garcinia cambogia* Desr	NI	(Guru *et al.* 2021)
Celastraceae	*Salacia reticulate* Wight	NI	
	Tripterygium wilfordi Hook. f	Japan, China, Burma, South Korea.	(Jamal *et al.* 2022)
Combretaceae	*Terminalia bellirica* (Gaertn) Roxb	Vietnam, Sri Lanka, Laos, Honduras, Cambodia, Buthan, Thailand, Nepal, India, China, Burma, Bangladesh.	
Caricaceae	*Carica papaya* L	Paraguay, Nicaragua, Madagascar, Virgin Island, Honduras, French Guiana, Guatemala, United States, Ecuador, Costa Rica, Brazil, Belize, Argentina, Panama, Mexico, Jamaica, Cayman Island, Haiti, Guiana, Gabon, EI Salvador, Cuba, Colombia, Bolivia, Bahamas.	
Araceae	*Amorphophallus konja* K. Koch	China	(Unuofin *et al.* 2020)
Apocynaceae	*Hunteria umbellate* (K.Schum)	Gabon	
	Hoodia gordonii	South Africa	

	Gymnema sylyestre R. Br	Madagascar and South Africa	(Zhang *et al.* 2018)
Annonaceae	*Rollinia sylyatica* Mart.	Brazil	
	Annona Montana Macfad	Suriname, Panama, French Guiana, United States, Costa Rica, Brazil, Peru, Honduras, Guiana, Ecuador, China, Bolivia.	(Shabab *et al.* 2021)
Araliaceae	*Panax japonicas*	Thailand, Japan, China, Burma, Nepal, India, South Korea, Buthan.	
Aquifoliaceae	*Ilex paraguariensis*	Uruguay, Peru, Colombia, Bolivia, Paraguay, Ecuador, Brazil, Argentina.	(Tripathy *et al.* 2021)
Apiaceae	*Foeniculum vulgare* Mill	Peru, Honduras, United States, Ecuador, Colombia, Chile, Canada, Bolivia, South Africa, Mexico, Guatemala, EI Salvador, Costa Rica, China, Brazil, Belize.	
Asteraceae	*Taraxacum officinale* F.H. Wigg	Panama, Guatemala, China, Kazakhstan, Argentina, Madagascar, United States, Chile, Canada, South Africa.	
	Hieracium officinale F.H. Wigg	United States, Canada, Chile.	
	Cichorium pilosella L.	Venezuela, Mexico, Honduras, United States, China, Canada, Panama, Madagascar, Guatemala, EI Salvador, Chile.	(Unuofin *et al.* 2020)
	Baccharis trimera	Uruguay, Brazil, Argentina, Paraguay, Bolivia.	
	Artemisia princeps Pamp	Japan, North Korea, China, South Korea.	

	Tanacetum vulgare L	Russia, Mongolia, Japan, United States, Ecuador, South Korea, Colombia, Chile, Canada, Bolivia, Peru, Mexico, Guatemala, EI Salvador, Costa Rica, North Korea, China, Kazakhstan, Brazil, Argentina.	
	Cynara scolymus L	United States, Colombia, Ecuador,	
	Bidens bipinnata L	Venezuela, Nepal, Laos, Ecuador, China, Brazil, Thailand, Madagascar, United States, North Korea, Cambodia.	
	Baccharis articulata (Lam) Pers.	Argentina.	(Negi *et al.* 2021)
	Achyrocline satureioides (Lam) DC.	Venezuela, Peru, Guiana, Colombia, Bolivia, Uruguay, Paraguay, Ecuador, Brazil, Argentina.	

3.2) Natural resources and their anti-obesity products:

The developing and expanding hazards of obesity to worldwide has promoted and urged researchers and scientists to find/search effectual anti-obesity ingredients. Innumerable substances from natural resources have been studied and explored in addition with their ingredients (Tong *et al.* 2022). The source of these natural materials are mostly plants in particular herbs, grains, vegetables and fruits. These materials biological advantages are primarily provided/assisted by the inclusions/existence of unsaturated fatty acids, fibers and phytochemicals. A number of natural resources in addition with ingredients and their anti-obesity effects are outlined.

In the supermarket the available anti-obesity products can be categorized into three groups: herbal ingredients, food ingredients and other functional supplements. In functional supplement industry the highest common segment is consumption level of developing functional products in daily life of people. To consumers products made from beverage drinks (tea leaves), vegetables, grains (soybean) and fruits (berries and citrus) are comparatively adequate and secure. Contemporary, medical practitioners of china utilize herbal remedies/products which are different herbs mixtures for instance mulberry leaf and turmeric, to deal/handle obese patients (Tong *et al.* 2022).

Table 3.2: Summary of ingredients and natural materials.

Natural material	Scientific name	Bioactive ingredients	Reference
White mulberry	*Morus alba*	1-deoxynojirimycin, Rutin and resveratrol anthocyanin	(Bautista *et al.* 2019)
Coptis root	*Rhizoma coptidis*	Berberine	
Black wattle	*Acacia mollissima)*	Fisetinidol and Robinetinidol	
Lotus leaf	*Nelumbo nucifera*	Taurine, steroids, triterpnoids, alkaloids, glycosides, polyphenols and flavonoids.	
Coffee	*Coffea Arabica*	Quinic acids and caffeoyl	(Vyas *et al.* 2019)
Blue berry	*Vaccinium ashei*	Anthocyanin	
Shiikuwasa	*Citrus depressa*	Flavonoids	
Soya bean	*Glycine max*	Isolated protein	
Turmeric	*Curcuma longa*	Curcumin	
Ginger	*Zingiber officinale*	Shogoal, gingerol and paradol	(Tong *et al.* 2022)
Chili pepper	*Capsicum annuum*	Capsaicin	
Green tea	*Camellia sinensis*	Catechins, Polysaccharides and caffeine	
Mull berry	*Morus australis*	Anthocyanin	

Currently, therapy by herbal products are not common in Asia, but also more popular in Western world. That's why/for this reason, why herbal products could be additional group/grade of anti-obesity products. Calcium phosphate and probiotic are other materials that have also been tested/confirmed to reduce the impact of obesity. Fruits potential health advantages and benefits have been examined by previous surveys i.e. anti-obesity, anti-cancer and anti-inflammatory effects. For exploitation and exploration of in anti-obesity new products citrus fruit is more valuable and major category in general/typically/usually. In citrus fruit pulp and peel alkaloids, flavonoids and triterpnoids are major phytochemical ingredients.

Different studies have shown the citrus fruit extracts anti-obesity impact that facilitate/ relieve in lower the weight of white adipose tissues and body weight gain. Adipocytes key produced hormone is Leptin, functioning in energy expenditure and food intake regulation, was found to be diminished/shortened by citrus fruit intake. This hormonal operational change is suitable/advantageous for citrus-based products (anti-obesity) (Koliaki *et al.* 2019).

Flavanone glycoside and methoxylated flavones are citrus fruit significant bioactive compounds accomplished/proficient of varying/modifying leptin levels in plasma membrane. In functional food market leaves of green tea and its derived products are also common and popular as anti-obesity agents. Green tea bioactive ingredient component is polyphenols that include flavan-3-ols, flavonols (catechins) and flavones i.e. 35% of dry weight. Various clinical trials have shown/displayed catechins valuable ad health full effects like reduced fatty acids absorption, decreased body weight and decreased levels of serum leptin.

Caffeine is another popular tea leaves bioactive ingredient, which influences the activity of somatic nervous system and increase oxidation of fats and energy expenditure. In addition to green tea, additional herbal tea ingredients like honey bush, mate tea and rooibos have also been examined for functions and contributions in lipid metabolism and obesity prevention. It is a tough target to embellish/elaborate all natural products and their anti-obesity effects in one study so, in determination of higher potential ingredients and constituents in materials scientists are affectionate and devoted. In the industry and world of reported analysis in reference to functional supplement, there looks to be an affirmative and prospective bias (Tufail *et al.* 2021).

4) NATURAL ANTI-OBESITY PRODUCTS AND THEIR FUNCTIONAL INGREDIENTS:

4.1) Dietary fiber:

Cellulose, pectin, soluble dietary fiber and gum are principle dietary fibers, present in various anti-obesity products. Dietary fibers anti-obesity role was summarized by Heaton in 1970. He explained that dietary fiber could serve as physiological barrier to reduce intake of energy via three mechanisms: 1) inhibiting absorption of food in small intestine 2) removal of extra/additional nutrients in food by dietary fiber 3) Reducing appetite. Moreover, current surveys have displayed/demonstrated that ferment ability and viscosity are two principle physiochemical attributes that are thoroughly connected to the dietary fiber valuable physiological effects. In small intestine viscosity is the principle supporter to physiological effects. Delay/put off in absorption of nutrients and gastric emptying is the result of rise level of viscosity. For colon micribiota, a fermentable substrate could also be a dietary fiber i.e. production and increase of fatty acids due to increase in microbial mass. It has been demonstrated by various prospective studies that fiber-rich diet consumption for long period has a negative relation with gain of body weight (Aleksandrova *et al.* 2018).

4.2) Dietary calcium:

For support and maintenance of calcium level in blood, chronic disorders risks modulation and skeletal integrity, dietary fiber is a principle/key factor. By number of authors it has been reported that high calcium intake may rise the expenditure of energy and excretion of fecal fats. Bile acids binding and calcium-fatty acids formation are two important factors which are involved in fecal fat extraction mechanism. Some other analysis has demonstrated/displayed that adipocyte metabolism regulation factor is intracellular calcium. It is assumed that dietary calcium high dose could regulate level of circulating calcitriol (Hasanpour *et al.* 2020).

4.3) Protein:

Soy protein, whey and casein are principle protein supplements and have excellent anti-obesity effects for a long time. Daily diet with high protein level could promote/facilitate people to lose body weight. Protein contain more energy vale than carbohydrates, and also linked with higher diet-prompted thermogenesis. Few studies have displayed that consumption of high protein may induce higher level of peptide tyrosine-tyrosine i.e. in rodents and humans a principle food intake inhibitor. Protein high level thermogenesis may be described by the deficiency of storage space in the body and for synthesis of protein high cost of ATPs. It should be notable that any supplements of protein anti-obesity impact could be employed/utilized in a good/proficient way as long as/when being destroyed/exhausted with satisfactory/sufficient exercise (Vrints *et al.* 2021).

4.4) Poly-unsaturated fatty acids:

Poly-unsaturated fatty acids anti-obesity impact might be elaborated/described by their functioning, production and performance i.e. a balance in neuroendocrine system, adipocytes status, lipid metabolism and energy consumption and intake of energy. It has been explained that poly-unsaturated fatty acids could diminish/decrease action of principle enzymes which are important for synthesis of lipids i.e. stearoyl-CoA desaturase and fatty acid synthase. In spite of significant researches/surveys on PUFAs anti-obesity impact, exact molecular mechanism of PUFAs largely and clearly is unknown (van Andel *et al.* 2018).

4.5) Probiotics:

Few studies have demonstrated that obesity and type 2 diabetes development key factors are gut microbes. Gram negative bacteria such as *Enterobacter cloaca* and *Escherichia coli* cell wall composed of lipopolysaccharides that induces high fat obesity. To lower body fat and body weight of body in obese patient's proficiency and capability of some key probiotics like *Bifidobacterium breve* B-3 and *Lactobacillus gasseri* SBT2055 have been confirmed by multiple clinical trials/studies. Proposed probiotics mechanism of action primarily includes low grade inflammation, integrity and homeostasis maintenance of intestine, lipid absorption inhibition, host metabolism and regulation of appetite.Use of probiotics or prebiotics in mixture/composite form would be a superior approach/scheme to alleviate or to prevent from problems of obesity (Koliaki *et al.* 2020).

4.6) Phyto-molecules and Phytochemicals:

Naturally significant amount/quantity of biologically active compounds are present and also have been reported in enormous studies to treat different ailments.In roots, flower, leaf, bark and stem principle secondary metabolites are present that carry out significant pharmacological responsibilities/activities in human system (Wang *et al.* 2018).

4.6.1) Phytochemicals and their potential

Now a days, much attention has been gained by plant herbal drugs than synthetic drugs with efficient work/action ability. Steroids, glycosides, Saponins, tannins, flavonoids, terpenoids, alkaloids and polyphenols are principle plants phytochemicals and play a significant role for treatment of different disorders. Phytoconstituents like catechins, ellagic acid, piperine, capsaicin, ephedrine, theophylline, caffeine, gymnemic acid, genistein, apigenin, hydroxy citric acid and gugguls sterone are more significant and productive and have been published as anti-lipidaemic, anti-obesity and also as pro health properties. Although there are bundles of anti-obesity drugs are preparing from these compounds but inadequate scientific validations and investigations have done to recommend as a therapy for obesity treatment. It means the potential of derivatives of herbs and plants is still unknown and unexplored for obesity treatment. Utilization of potentially phytochemicals and derived ingredients in a wide and innovative field in future. Although, medicinal use of plants is well known but still have not been examined and researched for their safety, extra potential and efficacy. (Koliaki *et al.* 2019)

Table 4.1: Anti-obesity plant source, phytochemicals and effects

Phyto-molecule	**Example**	**Plant Source**	**Anti-obesity Effect**	**Reference**
Phytosterol	Protodioscin	*Tribulus terrestris* and *Trapa natans*	Rises high density lipoprotein level, lowers the cholesterol triglycerides and low lipoprotein level in blood	(Fuselier *et al.* 2018)
	Sitosterol	*Bauhinia variegate, Arachis hypogaea* and *Citrullus Colocynth*	Restrict pancreatic lipase and lowers the absorption of cholesterol by decreasing the low density lipoprotein-cholesterol level	
	Diosgenin	*Dioscorea villosa* and *Trigonella foenumgraecum*	Block lipogenic gene expression and restrict the triglycerides accumulation	
Alkaloids	Halfordinol	*Aegle marmelos*	Decreases the accumulation of adipocytes	(Bovolini *et al.* 2021)
	Nicotine	*Capsicum annum* and *Nicotiana tabacum*	Nicotine lowers intake of food and increases metabolic rate	
	Caffiene	*Coffea Arabica* and *Camellia sinensis*	Responsible for thermogenic and lipolytic actions	
	P-synephrine	*Citrus unshiu* and *Citrus aurantium*	P-synephrine increases body weight, rate of metabolism and expenditure of energy	
	Capsaicin	*Capsicum annuum*	Increases rate of energy expenditure and lipid oxidation rate	
Terpenoids	Betulinic acid	*Syzygium aromaticum* and *Orthosiphon*	Increases the anti-obesity leptin effect and activity and restrict tyrosine phosphate 1B i.e. hypothalamic protein	(Bouyahya *et al.* 2021)

		aristatus		
	Punicic acid	*Trichosanthes bracteata,* Punica *granatum* and *Momordica balsamina*	Punicic acid binding up-regulate PPAR α, its related genes Cpt-1 and stearoyl-CoA desaturase-1 and also activate PPRA alpha and α and γ.	(Bovolini *et al.* 2021)
Phenols	Ferulic acid	*Asparagus officinalis* and *Hordeum vulgare*	Inhibit differentiation of adipocytes, deregulation of lipid profile and Hypolipidemic effect	
	Chlorogenic acid	*Coffea canephora* and *Glycine max*	Lowers the fats of body due to reduction in glucose absorption	
Flavonoids	Phloretin-3′,5′-di-Cglucoside	*Cyclopia subternata* and *Cyclopia falcata*	Down regulate and inhibit the expression of proliferated and activated receptors of peroxisomes and triglycerides and also restrict adipogenesis	
	Resveratrol	*Vitis vinifera, Cyanococcus* and *Arachis hypogaea*	Reduce the PPAR α transcriptional activity and also restrict the adipogenesis	(Aron-Wisnewsky *et al.* 2021)
	Quercetin	*Brassica oleracea, Allium cepa* and *Coriandrum sativum*	In preadipocytes activate and regulate AMPK signal pathway and decrease adipogenesis	
	Galangin	*Helichrysm aureonitens* and *Alpinia galangal*	Decreases the accumulation of lipid peroxidation, liver weight, serum lipids and hepatic triglycerides	
	Catechins	*Vitis vinifera, Camellia sinensis* and *Coffea*	Responsible in intestinal micelle formation and restrict α-glycosidase activity due to which absorption of carbohydrates also decreases	

5) MECHANISMS OF ANTI-OBESITY EFFECT OF NATURAL PRODUCTS

5.1) Inhibiting Digestive Enzyme Activity

5.1.1) Pancreatic Lipase Inhibitors

When there is excretory enzyme activity present. Tenants of pancreatic lipase. The majority of the consumed fat in the western diet is made up of TGS or esters of one glycerol molecule and there fatty acids.it is digested and absorbed in the gut. Pancreatic lipase, which is released from the pancreas to encourage their entanglement in the small intestine, resolves 42 Dietary that cannot be absorbed. Pancreatic lipase separates free fatty acids into mono acyl glycerol after they have been joined with bile acids, cholesterol, and lyso phosphatidic acid (LPA) to create micelles by 43 TCS. Enterocytes, which eventually create material that TCs store in adipocyte, absorb mixed micelles (figure 1) (Rahman *et al.* 2018).

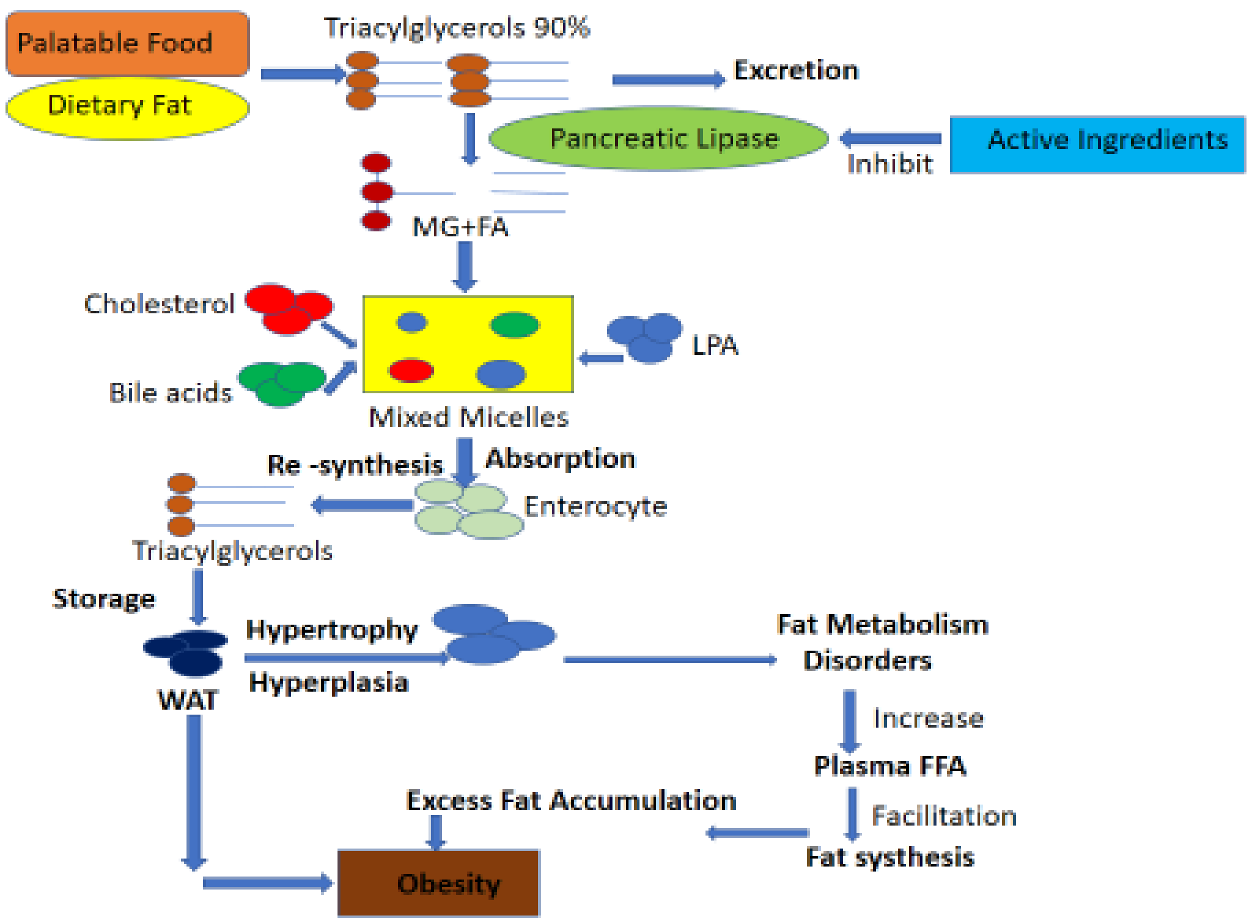

Figure 1: also depicts the procedure of combating the active capability for impeding pancreatic lipase.

Even such, consumption of packaged carbohydrate and swallowing lipids is reduced when a pancreatic lipase is habitable for lipid breakdown. Certain natural by-products may prevent pancreatic lipase 44 because it can improve diabetes 45 and reduce fat absorption, making them a possible option for weight loss therapy. Even such, consumption of packaged carbohydrates and swallowing lipids is reduced when a pancreatic lipase is habitable for lipids breakdown. Certain natural by-products may prevents pancreatic lipase 44 because it can improve diabetes 45 and reduce fat absorption, making them a possible option for weight loss therapy. Orlistat is the only anti-obesity medication approved by the FDA for long term clinical use as a pancreatic lipase interruption. However, orlistat's side effects are unsuitable for a large number of patients, so finding a new potent pancreatic lipase inhibitory (table 2) with the fewest harmful impediments from plants is a desirable goal (Orlando *et al.* 2019).

6) COMPETITIVE FORMATION OF WAT

Adipose tissue is a complex organ with a thorough understanding of pathophysiology. There are two categories of adipose tissue: brown (BAT) and white (WAT). For lipid homeostasis and power balancing, 86 WAT is essential because it determines the most effective power cache and triggers fat mobilisation for unrelated demands. Subdermal adipose tissue (SWT) and internal adipose tissue (VAT) extension are efficiently deposited anatomically in a disorganized manner by WAT, leading to distension and its complexity 88. With adipocyte hyperplasia or size augmentation, WAT increase (hypertrophy). The development of metabolic syndromes in obese people depends on the progression of adipose dysfunction, which is strongly linked to hypertrophy of the WAT and expresses an enhanced de nove formation (adipogenesis). 89 Hence, strict regulations for WAT developments and operation may be necessary to maintain power balance and understand the mechanisms governing. Adipogenesis might help in obesity managements, in the comparison, the extension of BAT or ''browning '' of WAT is shown to be a therapeutic capability for treating obesity and related metabolic diseases in rodents and humans. This is because it can reduce harmful effects and lipid spill initiation by dysfunctional WAT. 90 Brown adipocytes are ideally suited cells that use -adrenergic receptors to release heat from an objects energy.87 By stimulating decoupling protein-1 (UCP-1).

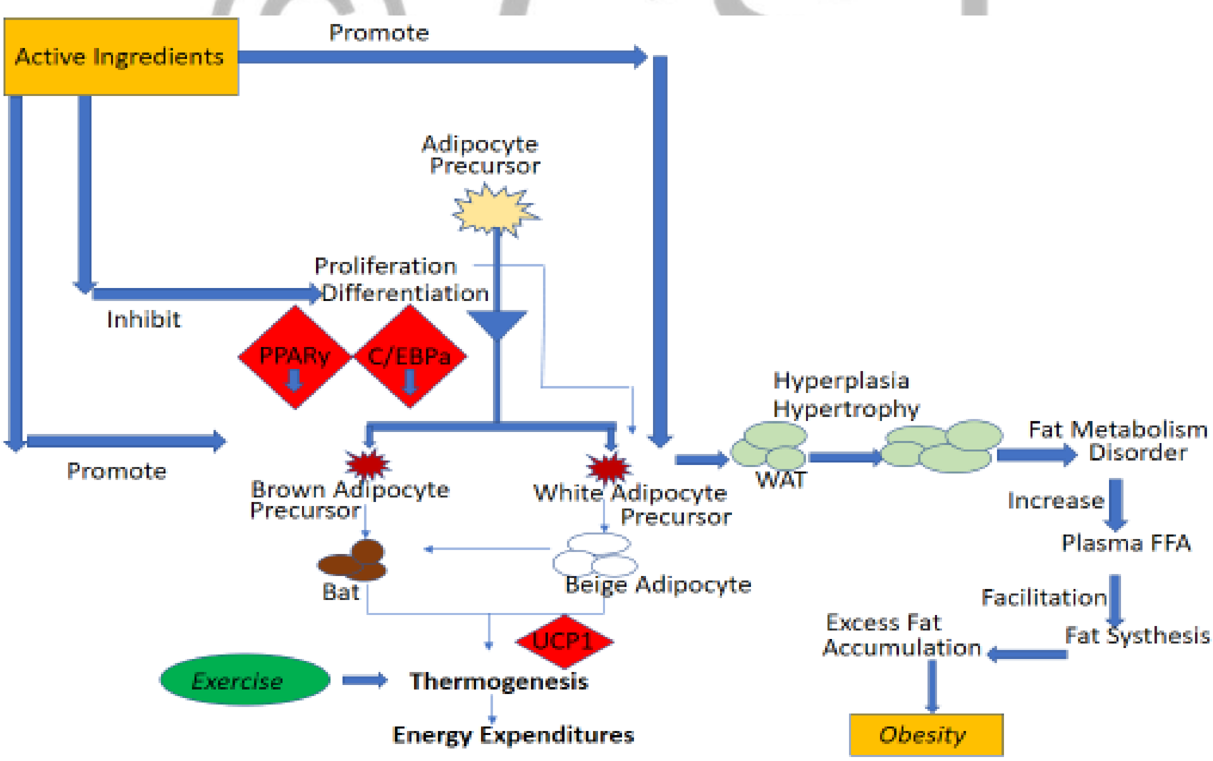

Figure2: competitive formation of wat

A mitochondria BAT-specified protein that escapes through the internal mitochondria membrane and decouples substrate oxidation from adenosine triphosphate (ATP)molecules, they also act as a frame in the appendage. The improvements of thermogenic adipocyte has been observed in WAT in the form of WAT browning. Chronic cold hazard can enhance BAT or engage in increasing BAT mess in rodents (beige adipocytes). 91 Brown adipocytes respond to CAMP catalyst with large UCPI evidence and ventilation value, which are preferably impressionable by irisin, 92 encouraging BAT enrollment mass/ activity and beige adipocytes to expand mitochondrial size. Beige adipocytes have lower primary UCPI manifestation than white adipocytes. Thermogenic effects mediated by UCPI reflection may offer a potential therapeutic plan for treating obesity. The 90 botanicals reduce the WAT structure and increase in table 3, BAT and beige Adipocyte are abbreviated, and figure 2 depicts the mode of action for preventing adipogenesis (Umbrello *et al.* 2019).

7) APPETITE REGULATION

Obesity is a result of the internal imbalance between the power of consumption and expenditure. Sibutramine and fenfluramine reduce food intake and increase satiety by acting on 5-HT/NE visual pathways and the 5-HT sensory receptor, respectively .As a result, drugs to reduce energy uptake or increase energy disbursements or both without adverse effects are currently of fascination given that energy uptake is extremely variable and energy expenses is modified primarily by physical activity 120. As a result, although due to its negative effects, it's were retreating the market.14, As a result, research is being done on natural sources of weight reduction (table 3), and figure 3 illustrates how some of the active ingredients for regulating desire work in practice (Poddar *et al.* 2020).

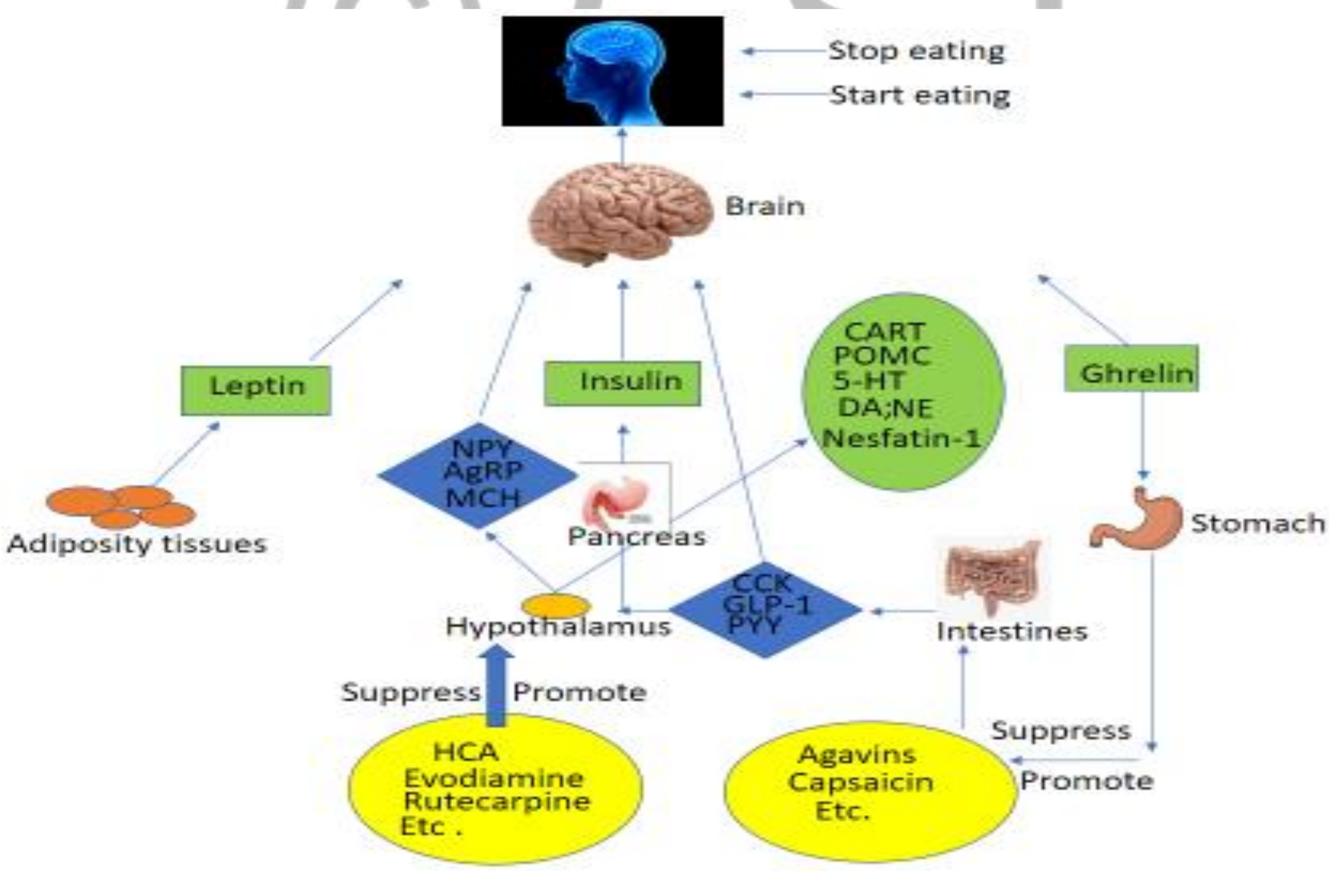

Figure 3: Appetite regulation

The brain stem and hypothalamus arched nucleus (ARC) support the control of desire by numerous suggest pathways, and this region causes to balance glucose and power. Over 40 orexigenic and anorexigenic hormones ,neuropeptides, enzymes , and several more chemicals signalize molecules and their receptors are present in the complicated essence and peripheral neuroendocrine suggest pathway, and these negatively and positively respond to want and excess.

Neuropeptide (NPY). Pro opiomelanocortin cocaine, (POCM), amphetamine-regulation transcript (CART), nesfatin-1, 5-HT (5-HTIB AND HT2C), DA, and NE are anorexigenic umpires in the hypothalamus, whereas agoutrelated peptide (AgRRO) and melanin-concentrating hormone (MCH) are orexigenic signalling molecules. Leptin, a peptide produced in adipose tissue, inhibits the expression of 121 NPY and AgRR and up-regulates it when you fast. As a result of overeating and fasting, leptin levels increase.

Leptin , in contrast, stimulates POCM and CART neurons , while fasting decrease POCM indication. Moreover, nesfatin-1, a novel anorectic peptide that manifests as starvation in the hypothalamic paraventricular nucleus and is an amino-terminal remnant of NEFA/ nucleobindin 2 (NUCB2) (Plows *et al.* 2018).

8) PLANTS UTILIZED FOR OBESITY TREATMENT:

Because they are non-invasive, pharmacological approaches are advised for the management of obesity. Sibutramine, fluoxetine, sertraline, orlistat, and topiramate are just a few of the medications that are advised. These should only be used sparingly, particularly in patients with cardiovascular disorders, as they may make the clinical situation worse.

In this context, plant species have become crucial for supplying extracts and isolated chemical compounds that are used as a starting point for the creation of treatments for obesity. To ensure solid, secure, and dependable outcomes, all the factors that identify a plant as an alternative therapy for the treatment of diseases must be thoroughly evaluated. The formulation of treatment strategies that take into account the available data requires the establishment of evidence-based public policies (Wang *et al.* 2018)

Table 8.1: Chemical composition and biological tests of medicinal plants utilized against drugs

Anti-obesity activity	Biological tests (in vivo/in vitro	species	Plant part	Process/extraction method	Chemical composition	Reference
In vitro anti-obesity Effects on 3T3-1 pre-adipocyte cells	In vitro	Akebia quinata (Houtt.) Decne	Fruit	Reflux extraction using ethanol at 70° as solvent	Phenolic compounds	(Masarone *et al.* 2018)
	In vitro	Artemisia princeps	Leaf	Reflux extraction using ethanol at	Phenolic compounds	

		Pamp		70° as solvent		
	In vitro	Cichorium intybus L.	Leaf	Extraction using hexane, ethyl acetate and methanol as the solvent	Tannins	(Šimják *et al.* 2018)
	In vitro	Lagerstroemia speciosa (L.) Pers.	Leaf	Extraction by maceration using water and methanol as solvents	Tannins	
	In vitro	Persicaria hydropiper L	Leaf	Extraction using methanol as solvent	Flavonoids	
Mediation of lipid levels based on enzymatic parameters	In vivo	Achyrocline satureioides (Lam.) DC.	Flowers	Decoction extraction using water as the solvent	Flavonoids	(Lega *et al.* 2020)
Reduced levels of triglycerides, LDL-C E VLDL-C	In vivo/in vitro	Carica papaya L	Fruit	Decoction extraction using water as the solvent	Alkaloids, saponins, tannins, anthraquinones, flavonoids (antocianidinas)	
Suppression of appetite stimulus signals in the hypothalamus	In vivo/in vitro	Carica papaya L	Leaf	Extraction by maceration using methanol as solvent	Saponins	
Suppression of lipogenic enzymatic activities	In vivo	Artemisia princeps Pamp	Leaf	Extraction by maceration using 70° ethanol as solvent	Terpenes	
Suppression of triglyceride accumulation in liver and adipose tissues	In vivo	Artemisia princeps Pamp	Leaf	Extraction by maceration using 70° ethanol as solvent	Terpenes	
Reduction of	In vivo/in	Aegle	Leaf	Accelerated	Cumarins	

triglyceride and cholesterol levels of lipid metabolism modulation	vitro	marmelos (L.) Corrêa		extraction using as solvents n-ethanol, hexane, n-butanol and dimethyl carbonate		
	In vivo/in vitro	Cucurbita moschata D.	Stalk	Extraction by maceration using water as solvent	Terpenes	(Vrints *et al.* 2021)
	n vivo	Ilex paraguariensis A. St.-Hil	Leaf	Extraction by maceration using water as solvent	Methylxanthines (theophylline), saponins, alkaloids (caffeine and theobromine)	
Increased gene expression related to energy expenditure on skeletal muscle and decreased fatty acid synthesis	In vitro	Acacia mearnsii De Wild	Stalk	Extraction using water as solvent	Flavanois (flavan-3-ol e catequins)	
Delay of intestinal absorption of fat in the diet by inhibition of pancreatic amylase and activity of the enzyme lipase	n vivo/in vitro	Achyranthes aspera L	Seeds	extraction by using 95% ethanol as the solvent	Total phenols; flavonoids; saponins	
Reduction in lipid levels and increase in HDL-C levels	In vivo	Annona Montana Macfad	Fruit	Extraction by maceration using water as solvent	Alkaloids e terpenes	

Reduction of triglyceride levels	In vivo/in vitro	Camellia the Link	Leaf	Extraction by maceration using water as solvent	Phenolic compounds	(Aron-Wisnewsky *et al.* 2021)

CONCLUSION AND FUTURE PERSPECTIVES:

The research active ingredients with anti-obesity effects, however, faces present many obstacles. More extensive study is required because the majority of such bioactive chemicals modes of action are not well understood. The range of active compounds that have to be employed both pharmacological and toxicological research investigations as well as clinical examinations of their performance is also challenging to produce. In spite of this, it is advised to combine these active chemicals because of how well they function together & in tackling the problem of issue of weight gain. Finally, but it's not, considering the majority of the herbs we examined offered as pills, no therapeutic study has been performed with them in persons.

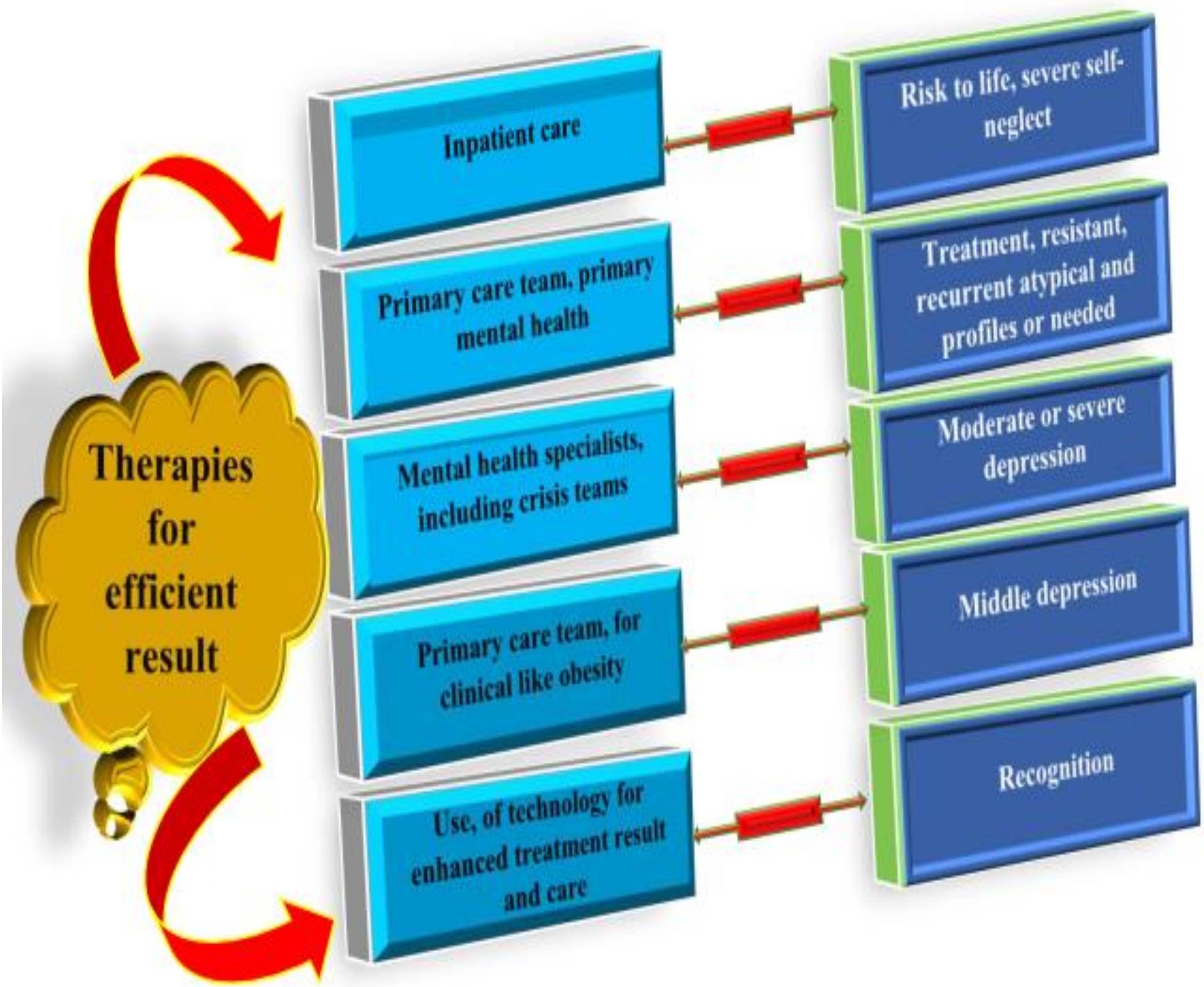

Figure: Therapies for efficient result

Because it is unclear if the bulk of dosage and active ingredient study result from animal models can be transferred to mankind, just a small number of medications reached the stage of drug trials, and none have yet been authorized. Moreover, modest levels or doses of active substances used in cell culture and animals' models should be preferred over high levels for security reasons when determining the ideal dosage. In order to evaluate the safety and efficacy of these potential anti-obesity in healthy volunteers is generally needed. Although there are therapies with some degree of success, there are still significant gaps in comprehensive and efficient care.

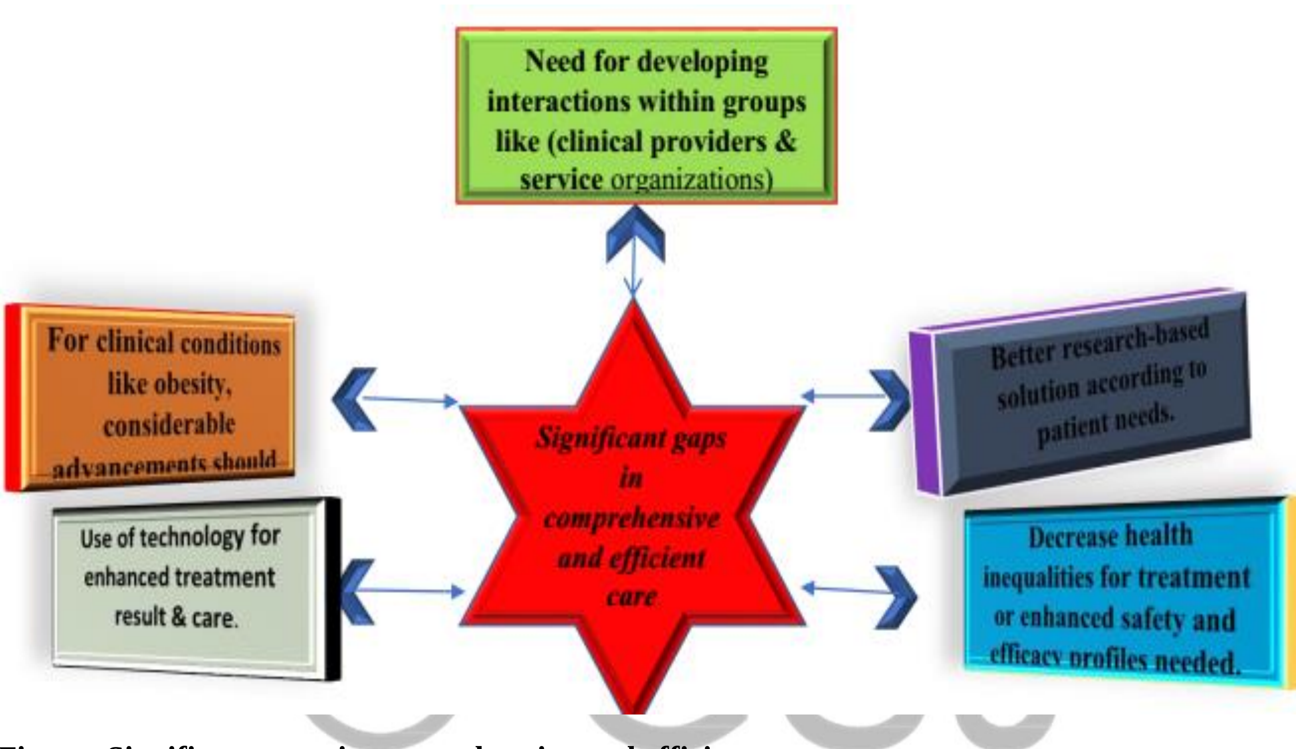

Figure: Significance gap in comprehensive and efficient care

A primary hole in the area of diabetic or gastric bypass treatment is the failure of ascertain exact degree of weight drop needed for a particular treatment improvement in terms of co morbid conditions heart disease risk, and death rates. Incidence associated fat loss [54], but particular continues to pose issue. With patients with multiple risk components in addition fatness, studies need to concentrate on the manner in which diseases cooperate. Another still immature field, equivalent to disease, would be the weight loss surgery to generating glucose cure. Certainly, the stage in the growth of this growing field to be apply synthetic medicine toward numerous studies, but specifically weight loss surgery, to estimate measurable solutions in such disease states.

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