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LIQUID TISSUE RUNNING 24×7 *IN-VIVO* IS THE HEART TOUCHING HEART THROB

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ABSTRACT

Blood pressure (BP) is the pressure of circulating blood against the walls of blood vessels. Most of this pressure results from the heart pumping blood through the circulatory system. When used without qualification, the term "blood pressure" refers to the pressure in the large arteries. Blood pressure is usually expressed in terms of the systolic pressure (maximum pressure during one heartbeat) over diastolic pressure (minimum pressure between two heartbeats) in the cardiac cycle. It is measured in millimeters of mercury (mmHg) above the surrounding atmospheric pressure. Blood pressure is one of the vital signs—together with respiratory rate, heart rate, oxygen saturation, and body temperature—that healthcare professionals use in evaluating a patient's health. Normal resting blood pressure, in an adult is approximately 120 millimetres of mercury (16 kPa) systolic over 80 millimetres of mercury (11 kPa) diastolic, denoted as "120/80 mmHg". Globally, the average blood pressure, age standardized, has remained about the same since 1975 to the present, at approx. 127/79 mmHg in men and 122/77 mmHg in women, although these average data mask quite large divergent regional trends. Traditionally, blood pressure was measured non-invasively using auscultation with either an aneroid gauge, or a mercury-tube sphygmomanometer. Auscultation is still generally considered to be the gold standard of accuracy for non-invasive blood pressure readings in clinic. However, semi-automated methods have become common, largely due to concerns about potential mercury toxicity, although cost, ease of use and applicability to ambulatory blood pressure or home blood pressure measurements have also influenced this trend. Early automated alternatives to mercury-tube sphygmomanometers were often seriously inaccurate, but modern devices validated to international standards achieve an average difference between two standardized reading methods of 5 mm Hg or less, and a standard deviation of less than 8 mm Hg. Most of these semi-automated methods measure blood pressure using oscillometry. Blood pressure is influenced by cardiac output, systemic vascular resistance and arterial stiffness and varies depending on situation, emotional state, activity, and relative health/disease states. In the short term, blood pressure is regulated by baroreceptors which act via the brain to influence the nervous and the endocrine systems. Blood pressure that is too low is called hypotension, pressure that is consistently too high is called hypertension, and normal pressure is called normotension. Both hypertension and hypotension have many causes and may be of sudden onset or of long duration. Long-term hypertension is a risk factor for many diseases, including heart disease, stroke and kidney failure. Long-term hypertension is more common than long-term hypotension.

KEYWORDS: Systole, Diastole, Pulse, Hypertension, Hypotension, Cardiac output, Cardiac cycle.

Classification, normal and abnormal values

Systemic arterial pressure: The Task Force for the management of arterial hypertension of the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH) classification of office blood pressure (BP)a and definitions of hypertension grade.

Table-1: Ranges of BP.

Category	Systolic BP, mmHg	Diastolic BP, mmHg
Optimal	< 120	< 80
Normal	120–129	80–84
High normal	130–139	85–89
Grade 1 hypertension	140–159	90–99
Grade 2 hypertension	160–179	100–109

Grade 3 hypertension	≥ 180	≥ 110
Isolated systolic hypertension[b]	≥ 140	< 90
The same classification is used for all ages from 16 years. [a]BP category is defined according to seated clinic BP and by the highest level of BP, whether systolic or diastolic. [b]Isolated systolic hypertension is graded 1, 2, or 3 according to systolic BP values in the ranges indicated.		

The risk of cardiovascular disease increases progressively above 115/75 mmHg, below this level there is limited evidence. Observational studies demonstrate that people who maintain arterial pressures at the low end of these pressure ranges have much better long-term cardiovascular health. There is an ongoing medical debate over what is the optimal level of blood pressure to target when using drugs to lower blood pressure with hypertension, particularly in older people. The Table-1 shows the most recent classification (2018) of office (or clinic) blood pressure by The Task Force for the management of arterial hypertension of the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH). Similar thresholds had been adopted by the American Heart Association for adults who are 18 years and older, but in November 2017 the American Heart Association announced revised definitions for blood pressure categories that increased the number of people considered to have high blood pressure.[1]

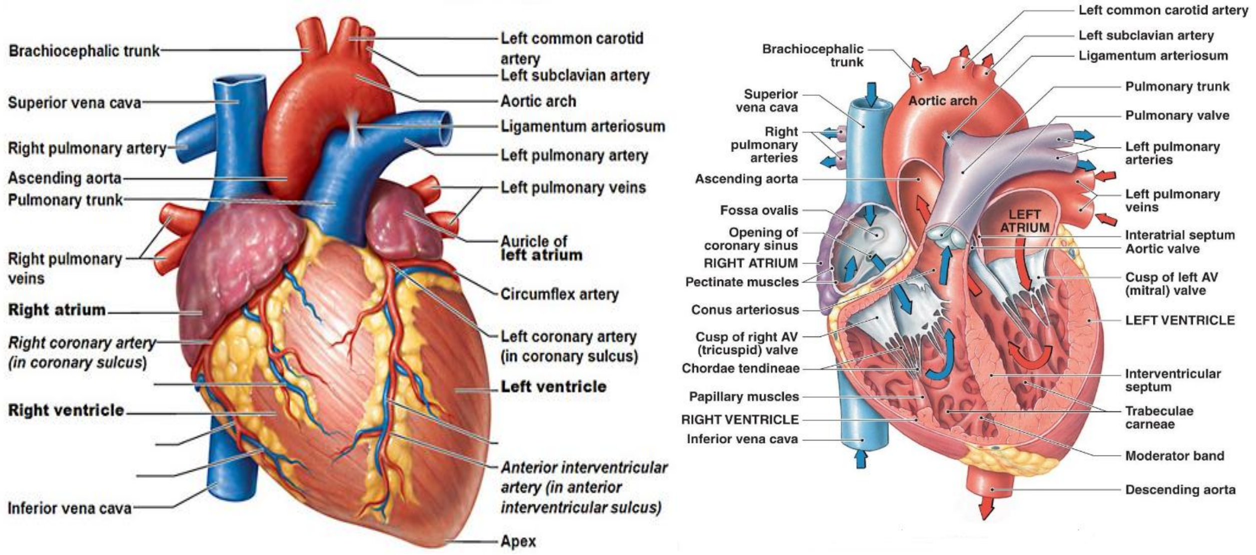


Figure-1: Human Heart.

Blood pressure fluctuates from minute to minute and normally shows a circadian rhythm over a 24-hour period, with highest readings in the early morning and evenings and lowest readings at night. Loss of the normal fall in blood pressure at night is associated with a greater future risk of cardiovascular disease and there is evidence that night-time blood pressure is a stronger predictor of cardiovascular events than day-time blood pressure. Blood pressure varies over longer time periods (months to years) and this variability predicts adverse outcomes. Blood pressure also changes in response to temperature, noise, emotional stress, consumption of food or liquid, dietary factors, physical activity, changes in posture (such as standing-up), drugs, and disease. The variability in blood pressure and the better predictive value of ambulatory blood pressure measurements has led some authorities, such as the National Institute for Health and Care Excellence (NICE) in the UK, to advocate for the use of ambulatory blood pressure as the preferred method for diagnosis of hypertension.

Figure-2: Sphygmomanometer used for measuring blood pressure.

Various other factors, such as age and sex, also influence a person's blood pressure. Differences between left and right arm blood pressure measurements tend to be small. However, occasionally there is a consistent difference greater than 10 mmHg which may need further investigation, e.g. for peripheral arterial disease or obstructive arterial disease.

There is no accepted diagnostic standard for hypotension, although pressures less than 90/60 are commonly regarded as hypotensive. In practice blood pressure is considered too low only if symptoms are present.[2]

Systemic arterial pressure and age

Fatal blood pressure: In pregnancy, it is the fatal heart and not the mother's heart that builds up the fatal blood pressure to drive blood through the fatal circulation. The blood pressure in the fatal aorta is approximately 30 mmHg at 20 weeks of gestation, and increases to approximately 45 mmHg at 40 weeks of gestation.

The average blood pressure for full-term infants:

- Systolic 65–95 mmHg
- Diastolic 30–60 mmHg

Childhood

Table-2: Rage of BP in youngsters.

Stage	Approximate age	Systolic BP, mmHg	Diastolic BP, mmHg
Infants	0 to 12 months	75–100	50–70
Toddlers and pre-schoolers	1 to 5 years	80–110	50–80
School age	6 to 12 years	85–120	50–80
Adolescents	13 to 18 years	95–140	60–90

In children, the normal ranges for blood pressure are lower than for adults and depend on height. Reference blood pressure values have been developed for children in different countries, based on the distribution of blood pressure in children of these countries.

Aging adults: In adults in most societies, systolic blood pressure tends to rise from early adulthood onward, up to at least age 70; diastolic pressure tends to begin to rise at the same time but to start to fall earlier in mid-life, approximately age 55. Mean blood pressure rises from early adulthood, plateauing in mid-life, while pulse pressure rises quite markedly after the age of 40. Consequently, in many older people, systolic blood pressure often exceeds the normal adult range, if the diastolic pressure is in the normal range this is termed isolated systolic hypertension. The rise in pulse pressure with age is attributed to increased stiffness of the arteries. An age-related rise in blood pressure is not considered healthy and is not observed in some isolated unacculturated communities.[3]

Systemic venous pressure

Table-3: Classified BP.

Site		Normal pressure range (in mmHg)
Central venous pressure		3-8
Right ventricular pressure	Systolic	15-30
	Diastolic	3-8
Pulmonary artery pressure	Systolic	15-30
	Diastolic	4-12
Pulmonary vein/Pulmonary capillary wedge pressure		2-15
Left ventricular pressure	Systolic	100-140
	Diastolic	3-12

Blood pressure generally refers to the arterial pressure in the systemic circulation. However, measurement of pressures in the venous system and the pulmonary vessels plays an important role in intensive care medicine but requires invasive measurement of pressure using a catheter.

Venous pressure is the vascular pressure in a vein or in the atria of the heart. It is much lower than arterial pressure, with common values of 5 mmHg in the right atrium and 8 mmHg in the left atrium.

Variants of venous pressure include:

- Central venous pressure, which is a good approximation of right atrial pressure, which is a major determinant of right ventricular end diastolic volume. (However, there can be exceptions in some cases.)
- The jugular venous pressure (JVP) is the indirectly observed pressure over the venous system. It can be useful in the differentiation of different forms of heart and lung disease.
- The portal venous pressure is the blood pressure in the portal vein. It is normally 5–10 mmHg

Pulmonary pressure: Normally, the pressure in the pulmonary artery is about 15 mmHg at rest. Increased blood pressure in the capillaries of the lung causes pulmonary hypertension, leading to interstitial edema if the pressure increases to above 20 mmHg, and to pulmonary edema at pressures above 25 mmHg.[4]

Mean systemic pressure: If the heart is stopped, blood pressure falls, but it does not fall to zero. The remaining pressure measured after cessation of the heart beat and redistribution of blood throughout the circulation is termed the mean systemic pressure or mean circulatory filling pressure; typically, this is of the order of ~7mm Hg.

Disorders of blood pressure: Disorders of blood pressure control include high blood pressure, low blood pressure, and blood pressure that shows excessive or maladaptive fluctuation.

High blood pressure

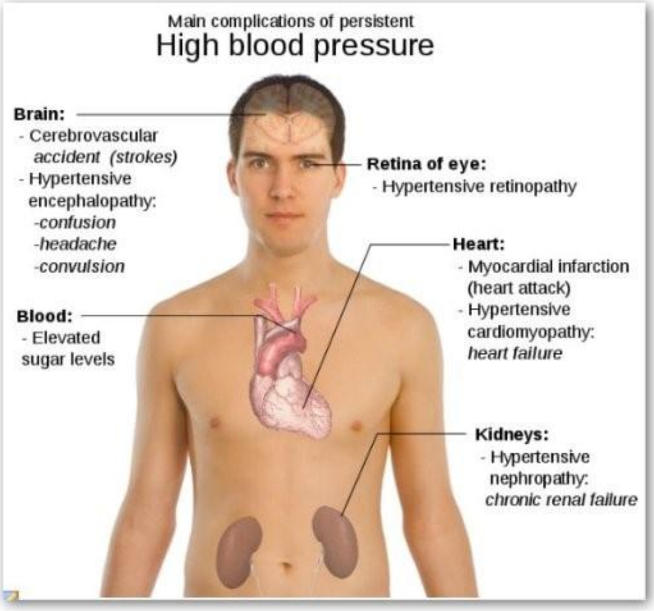


Figure-3: Overview of main complications of persistent high blood pressure.

Arterial hypertension can be an indicator of other problems and may have long-term adverse effects. Sometimes it can be an acute problem, for example hypertensive emergency. Levels of arterial pressure put mechanical stress on the arterial walls. Higher pressures increase heart workload and progression of unhealthy tissue growth (atheroma) that develops within the walls of arteries. The higher the pressure, the more stress that is present and the more atheroma tend to progress and the heart muscle tends to thicken, enlarge and become weaker over time. Persistent hypertension is one of the risk factors for strokes, heart attacks, heart failure, and arterial aneurysms, and is the leading cause of chronic kidney failure. Even moderate elevation of arterial pressure leads to shortened life expectancy. At severely high pressures, mean arterial pressures 50% or more above average, a person can expect to live no more than a few years unless appropriately treated. In the past, most attention was paid to diastolic pressure; but nowadays it is recognized that both high systolic pressure and high pulse pressure (the numerical difference between systolic and diastolic pressures) are also risk factors. In some cases, it appears that a decrease in excessive diastolic pressure can actually increase risk, due probably to the increased difference between systolic and diastolic pressures (see the article on pulse pressure). If systolic blood pressure is elevated (>140 mmHg) with a normal diastolic blood pressure (<90 mmHg), it is called "isolated systolic hypertension" and may present a health concern.[5]

For those with heart valve regurgitation, a change in its severity may be associated with a change in diastolic pressure. In a study of people with heart valve regurgitation that compared measurements two weeks apart for each person, there was an increased severity of aortic and mitral regurgitation when diastolic blood pressure increased, whereas when diastolic blood pressure decreased, there was a decreased severity.

Low blood pressure: Blood pressure that is too low is known as hypotension. This is a medical concern if it causes signs or symptoms, such as dizziness, fainting, or in extreme cases, circulatory shock.

Causes of low arterial pressure include: Sepsis, Hemorrhage – blood loss, Cardiogenic shock, Neurally mediated hypotension (or reflex syncope), Toxins including toxic doses of blood pressure medicine, Hormonal abnormalities, such as Addison's disease, Eating disorders, particularly anorexia nervosa and bulimia.

Orthostatic hypotension: A large fall in blood pressure upon standing (persistent systolic/diastolic blood pressure decrease of >20/10 mm Hg) is termed orthostatic hypotension (postural hypotension) and represents a failure of the body to compensate for the effect of gravity on the circulation. Standing results in an increased hydrostatic pressure in the blood vessels of the lower limbs. The consequent distension of the veins below the diaphragm (venous pooling) causes ~500 ml of blood to be relocated from the chest and upper body. This results in a rapid decrease in central blood volume and a reduction of ventricular preload which in turn reduces stroke volume, and mean arterial pressure. Normally this is compensated for by multiple mechanisms, including activation of the autonomic nervous system which increases heart rate, myocardial contractility and systemic arterial vasoconstriction to preserve blood pressure and elicits venous vasoconstriction to decrease venous compliance. Decreased venous compliance also results from an intrinsic myogenic increase in venous smooth muscle tone in response to the elevated pressure in the veins of the lower body. Other compensatory mechanisms include the veno-arteriolar axon reflex, the 'skeletal muscle pump' and 'respiratory pump'. Together these mechanisms normally stabilize blood pressure within a minute or less. If these compensatory mechanisms fail and arterial pressure and blood flow decrease beyond a certain point, the perfusion of the brain becomes critically compromised (i.e., the blood supply is not sufficient), causing lightheadedness, dizziness, weakness or fainting. Usually this failure of compensation is due to disease, or drugs that affect the sympathetic nervous system. A similar effect is observed following the experience of excessive gravitational forces (G-loading), such as routinely experienced by aerobatic or combat pilots 'pulling Gs' where the extreme hydrostatic pressures exceed the ability of the body's compensatory mechanisms.[6]

Variable or fluctuating blood pressure: Some fluctuation or variation in blood pressure is normal. Variations in pressure that are significantly greater than the norm are associated with increased risk of cardiovascular disease brain small vessel disease, and dementia independent of the average blood pressure level. Recent evidence from clinical trials has also linked variation in blood pressure to stroke, heart failure, and cardiac changes that may give rise to heart failure. These data have prompted discussion of whether excessive variation in blood pressure should be treated, even among normotensive older adults. Older individuals and those who had received blood pressure medications are more likely to exhibit larger fluctuations in pressure, and there is some evidence that different antihypertensive agents have different effects on blood pressure variability; whether these differences translate to benefits in outcome is uncertain.

Physiology: During each heartbeat, blood pressure varies between a maximum (systolic) and a minimum (diastolic) pressure. The blood pressure in the circulation is principally due to the pumping action of the heart. Differences in mean blood pressure drive the flow of blood around the circulation. The rate of mean blood flow depends on both blood pressure and the resistance to flow presented by the blood vessels. In the absence of hydrostatic effects (e.g. standing), mean blood pressure decreases as the circulating blood moves away from the heart through arteries and capillaries due to viscous losses of energy. Mean blood pressure drops over the whole circulation, although most of the fall occurs along the small arteries and arterioles. Pulsatility also diminishes in the smaller elements of the arterial circulation, although some transmitted pulsatility is observed in capillaries. Gravity affects blood pressure via hydrostatic forces (e.g., during standing), and valves in veins, breathing, and pumping from contraction of skeletal muscles also influence blood pressure, particularly in veins.

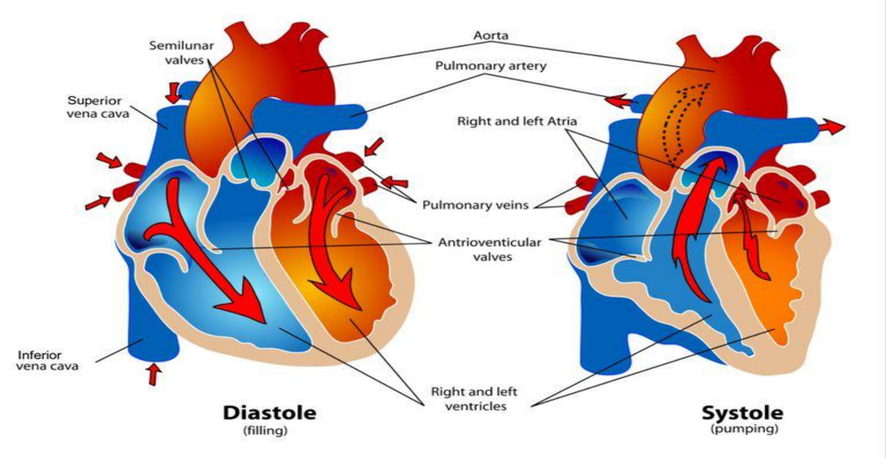


Figure-4: Cardiac systole and diastole.

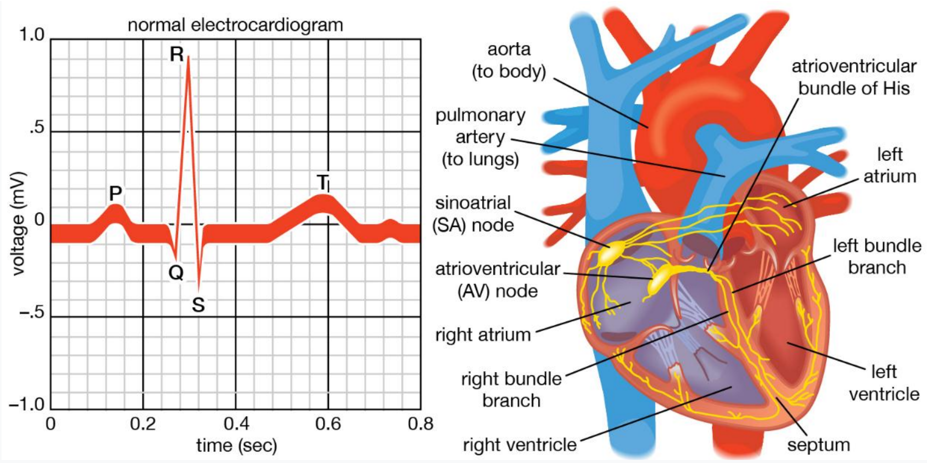


Figure-5: Cardiac cycle.

Hemodynamics: A simple view of the hemodynamics of systemic arterial pressure is based around mean arterial pressure (MAP) and pulse pressure. Most influences on blood pressure can be understood in terms of their effect on cardiac output, systemic vascular resistance, or arterial stiffness (the inverse of arterial compliance). Cardiac output is the product of stroke volume and heart rate. Stroke volume is influenced by 1) the end diastolic volume or filling pressure of the ventricle acting via the Frank Starling mechanism - this is influenced by blood volume; 2) cardiac contractility; and 3) afterload, the impedance to blood flow presented by the circulation. In the short-term, the greater the blood volume, the higher the cardiac output. This has been proposed as an explanation of the relationship between high dietary salt intake and increased blood pressure; however, responses to increased dietary sodium intake vary between individuals and are highly dependent on autonomic nervous system responses and the renin–angiotensin system, changes in plasma osmolarity may also be important. In the longer-term the relationship between volume and blood pressure is more complex.[7]

In simple terms systemic vascular resistance is mainly determined by the calibre of small arteries and arterioles. The resistance attributable to a blood vessel depends on its radius as described by the Hagen-Poiseuille's equation (resistance$\propto$1/radius^4). Hence, the smaller the radius, the higher the resistance. Other physical factors that affect resistance include: vessel length (the longer the vessel, the higher the resistance), blood viscosity (the higher the viscosity, the higher the resistance) and the number of vessels, particularly the smaller numerous, arterioles and capillaries. The presence of a severe arterial stenosis increases resistance to flow, however this increase in resistance rarely increases systemic blood pressure because its contribution to total systemic resistance is small, although it may profoundly decrease downstream flow.

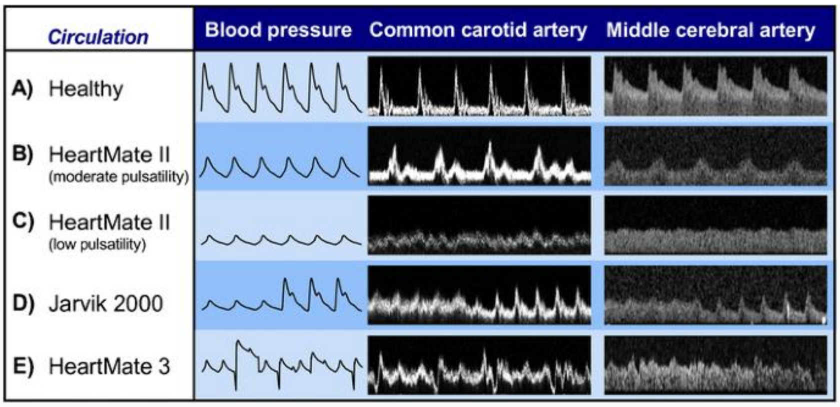


Figure-6: Schematic of pressures in the circulation.

Substances called vasoconstrictors reduce the caliber of blood vessels, thereby increasing blood pressure. Vasodilators (such as nitroglycerin) increase the caliber of blood vessels, thereby decreasing arterial pressure. In the longer term a process termed remodeling also contributes to changing the caliber of small blood vessels and influencing resistance and reactivity to vasoactive agents. Reductions in capillary density, termed capillary rarefaction, may also contribute to increased resistance in some circumstances.

In practice, each individual's autonomic nervous system and other systems regulating blood pressure, notably the kidney, respond to and regulate all these factors so that, although the above issues are important, they rarely act in isolation and the actual arterial pressure response of a given individual can vary widely in the short and long term.

Mean arterial pressure: MAP is the average of blood pressure over a cardiac cycle and is determined by the cardiac output (CO), systemic vascular resistance (SVR), and central venous pressure (CVP)).

In practice, the contribution of CVP (which is small) is generally ignored and so

MAP is often estimated from measurements of the systolic pressure, and the diastolic pressure, using the equation:
where k = 0.333 although other values for k have been advocated.[8]

Pulse pressure

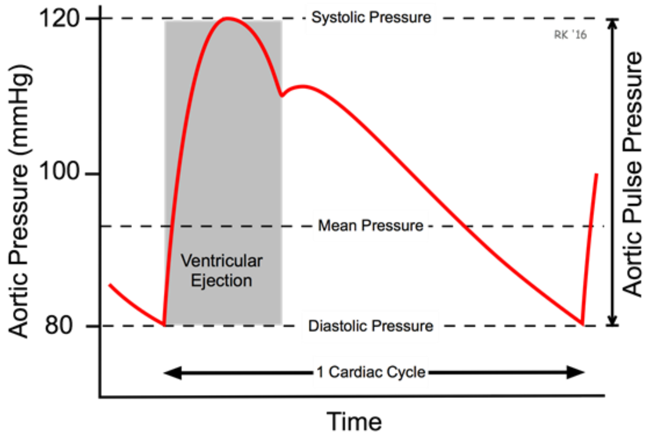


Figure-7: A schematic representation of the arterial pressure waveform over one cardiac cycle. The notch in the curve is associated with closing of the aortic valve.

The pulse pressure is the difference between the measured systolic and diastolic pressures. The pulse pressure is a consequence of the pulsatile nature of the cardiac output, i.e. the heartbeat. The magnitude of the pulse pressure is usually attributed to the interaction of the stroke volume of the heart, the compliance (ability to expand) of the arterial system—largely attributable to the aorta and large elastic arteries—and the resistance to flow in the arterial tree.

Regulation of blood pressure: The endogenous, homeostatic regulation of arterial pressure is not completely understood, but the following mechanisms of regulating arterial pressure have been well-characterized:

Baroreceptor reflex: Baroreceptors in the high-pressure receptor zones detect changes in arterial pressure. These baroreceptors send signals ultimately to the medulla of the brain stem, specifically to the rostral ventrolateral medulla (RVLM). The medulla, by way of the autonomic nervous system, adjusts the mean arterial pressure by altering both the force and speed of the heart's contractions, as well as the systemic vascular resistance. The most important arterial baroreceptors are located in the left and right carotid sinuses and in the aortic arch.

Renin–angiotensin system (RAS): This system is generally known for its long-term adjustment of arterial pressure. This system allows the kidney to compensate for loss in blood volume or drops in arterial pressure by activating an endogenous vasoconstrictor known as angiotensin II.

Aldosterone release: This steroid hormone is released from the adrenal cortex in response to angiotensin II or high serum potassium levels. Aldosterone stimulates sodium retention and potassium excretion by the kidneys. Since sodium is the main ion that determines the amount of fluid in the blood vessels by osmosis, aldosterone will increase fluid retention, and indirectly, arterial pressure. Baroreceptors in low pressure receptor zones (mainly in the venae cavae and the pulmonary veins, and in the atria) result in feedback by regulating the secretion of antidiuretic hormone (ADH/Vasopressin), renin and aldosterone. The resultant increase in blood volume results in an increased cardiac output by the Frank–Starling law of the heart, in turn increasing arterial blood pressure.

These different mechanisms are not necessarily independent of each other, as indicated by the link between the RAS and aldosterone release. When blood pressure falls many physiological cascades commence in order to return the blood pressure to a more appropriate level.

The blood pressure fall is detected by a decrease in blood flow and thus a decrease in glomerular filtration rate (GFR).

Decrease in GFR is sensed as a decrease in Na^+ levels by the macula densa.[9]

The macula densa causes an increase in Na^+ reabsorption, which causes water to follow in via osmosis and leads to an ultimate increase in plasma volume. Further, the macula densa releases adenosine which causes constriction of the afferent arterioles. At the same time, the juxtaglomerular cells sense the decrease in blood pressure and release renin.

Renin converts angiotensinogen (inactive form) to angiotensin I (active form). Angiotensin I flows in the bloodstream until it reaches the capillaries of the lungs where angiotensin converting enzyme (ACE) acts on it to convert it into angiotensin II. Angiotensin II is a vasoconstrictor that will increase blood flow to the heart and subsequently the preload, ultimately increasing the cardiac output. Angiotensin II also causes an increase in the release of aldosterone from the adrenal glands. Aldosterone further increases the Na^+ and H_2O reabsorption in the distal convoluted tubule of the nephron. Currently, the RAS is targeted pharmacologically by ACE inhibitors and angiotensin II receptor antagonists, also known as angiotensin receptor blockers (ARBs). The aldosterone system is directly targeted by spironolactone, an aldosterone antagonist. The fluid retention may be targeted by diuretics; the antihypertensive effect of diuretics is due to its effect on blood volume. Generally, the baroreceptor reflex is not targeted in hypertension because if blocked, individuals may suffer from orthostatic hypotension and fainting.

NATURAL REMEDIES

Blood pressure lower than 120/80 mm Hg is considered normal. Blood pressure that's 130/80 mm Hg or more is considered high. If your numbers are above normal but under 130/80 mm Hg, you fall into the category of elevated blood pressure. This means that you're at risk for developing high blood pressure. The good news about elevated blood pressure is that lifestyle changes can significantly reduce your numbers and lower your risk — without requiring medications.

Here are 17 effective ways to lower your blood pressure levels:

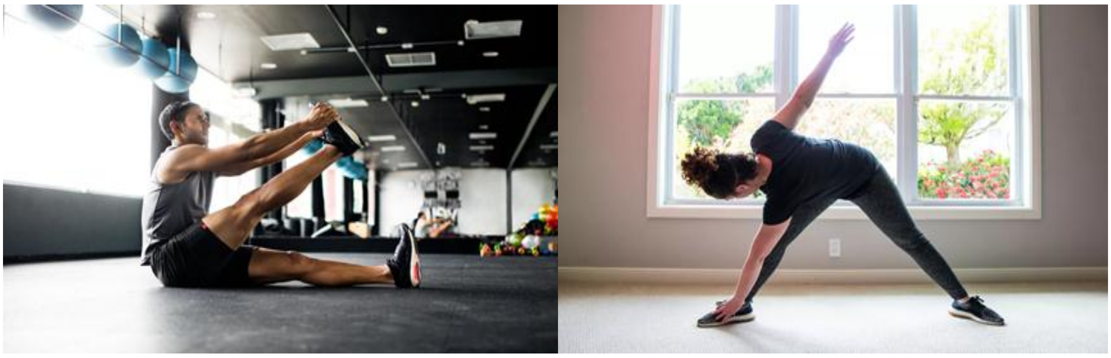


Figure-8: Daily exercise.

1. Increase activity and exercise more: In a 2013 study, sedentary older adults who participated in aerobic exercise training lowered their blood pressure by an average of 3.9 percent systolic and 4.5 percent diastolic. These results are as good as some blood pressure medications. As you regularly increase your heart and breathing rates, over time your heart gets stronger and pumps with less effort. This puts less pressure on your arteries and lowers your blood pressure.

How much activity should you strive for? A 2013 report by the American College of Cardiology (ACC) and the American Heart Association (AHA) advises moderate- to vigorous-intensity physical activity for 40-minute sessions, three to four times per week. If finding 40 minutes at a time is a challenge, there may still be benefits when the time is divided into three or four 10- to 15-minute segments throughout the day.

The American College of Sports Medicine (ACSM) makes similar recommendations.

But you don't have to run marathons. Increasing your activity level can be as simple as: using the stairs, walking instead of driving, doing household chores, gardening, going for a bike ride, playing a team sport.

Just do it regularly and work up to at least half an hour per day of moderate activity. One example of moderate activity that can have big results is tai chi. A 2017 review on the effects of tai chi and high blood pressure shows an overall average of a 15.6 mm Hg drop in systolic blood pressure and a 10.7 mm Hg drop in diastolic blood pressure, compared to people who didn't exercise at all. A 2014 review on exercise and lowering blood pressure found that there are many combinations of exercise that can lower blood pressure. Aerobic exercise, resistance training, high-intensity interval training, short bouts of exercise throughout the day, or walking 10,000 steps a day may all lower blood pressure. Ongoing studies continue to suggest that there are still benefits to even light physical activity, especially in older adults.

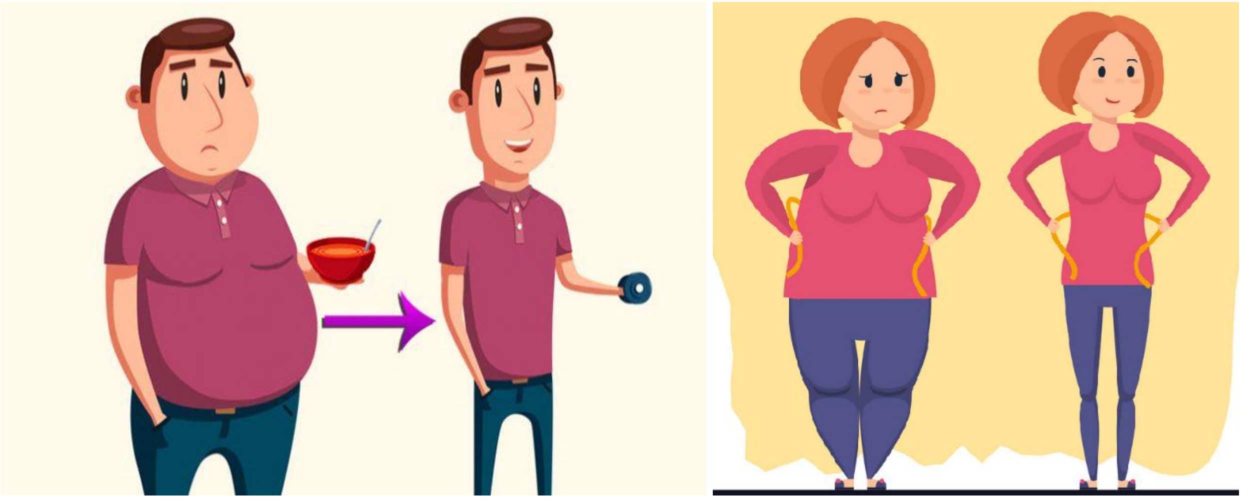


Figure-9: Loose body weight.

2. Lose weight if you're overweight: If you're overweight, losing even 5 to 10 pounds can reduce your blood pressure. Plus, you'll lower your risk for other medical problems. A 2016 review of several studies reported that weight loss diets reduced blood pressure by an average of 3.2 mm Hg diastolic and 4.5 mm Hg systolic.

Figure-10: Say No To Sugar.

3. Cut back on sugar and refined carbohydrates: Many scientific studies show that restricting sugar and refined carbohydrates can help you lose weight *and* lower your blood pressure. A 2010 study compared a low-carb diet to a low-fat diet. The low-fat diet included a diet drug. Both diets produced weight loss, but the low-carb diet was much more effective in lowering blood pressure. The low-carb diet lowered blood pressure by 4.5 mm Hg diastolic and 5.9 mm Hg systolic. The diet of low-fat plus the diet drug lowered blood pressure by only 0.4 mm Hg diastolic and 1.5 mm Hg systolic. A 2012 analysis of low-carb diets and heart disease risk found that these diets lowered blood pressure by an average of 3.10 mm Hg diastolic and 4.81 mm Hg systolic. Another side effect of a low-carb, low-sugar diet is that you feel fuller longer, because you're consuming more protein and fat.[10]

4. Eat more potassium and less sodium: Increasing your potassium intake and cutting back on salt can also lower your blood pressure.

Potassium is a double winner: It lessens the effects of salt in your system, and also eases tension in your blood vessels. However, diets rich in potassium may be harmful to individuals with kidney disease, so talk to your doctor before increasing your potassium intake.

It's easy to eat more potassium — so many foods are naturally high in potassium. Here are a few: low-fat dairy foods, such as milk and yogurt, fish, fruits, such as bananas, apricots, avocados, oranges, vegetables, such as sweet potatoes, potatoes, tomatoes, greens, and spinach.

Note that individuals respond to salt differently. Some people are salt-sensitive, meaning that a higher salt intake increases their blood pressure. Others are salt-insensitive. They can have a high salt intake and excrete it in their urine without raising their blood pressure. The National Institutes of Health (NIH) recommends reducing salt intake using the DASH (Dietary Approaches to Stop Hypertension) diet. The DASH diet emphasizes: low-sodium foods, fruits and vegetables, low-fat dairy, whole grains, fish, poultry, beans, fewer sweets and red meats.

5. Eat less processed food: Most of the extra salt in your diet comes from processed foods and foods from restaurants, not your salt shaker at home. Popular high-salt items include deli meats, canned soup, pizza, chips, and other processed snacks. Foods labelled "low-fat" are usually high in salt and sugar to compensate for the loss of fat. Fat is what gives food taste and makes you feel full. Cutting down on — or even better, cutting out — processed food will help you eat less salt, less sugar, and fewer refined carbohydrates. All of this can result in lower blood pressure.

Make it a practice to check labels. According to the U.S. Food and Drug Administration (FDA), a sodium listing of 5 percent or less on a food label is considered low, while 20 percent or more is considered high.

Figure-11: Stop Smoking.

6. Stop smoking: Stopping smoking is good for your all-around health. Smoking causes an immediate but temporary increase in your blood pressure and an increase in your heart rate. In the long term, the chemicals in tobacco can increase your blood pressure by damaging your blood vessel walls, causing inflammation, and narrowing your arteries. The hardened arteries cause higher blood pressure. The chemicals in tobacco can affect your blood vessels even if you're around second-hand smoke.

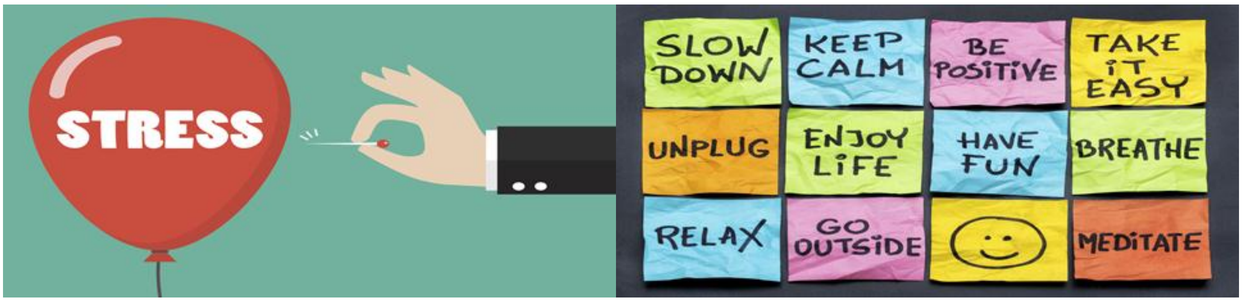


Figure-12: Reduce Stress.

7. Reduce excess stress: We live in stressful times. Workplace and family demands, national and international politics — they all contribute to stress. Finding ways to reduce your own stress is important for your health and your blood pressure. There are lots of different ways to successfully relieve stress, so find what works for you. Practice deep breathing, take a walk, read a book, or watch a comedy. Listening to music daily has also been shown to reduce systolic blood pressure. A recent 20-year study showed that regular sauna uses reduced death from heart-related events. And one small study has shown that acupuncture can lower both systolic and diastolic blood pressure.

Figure-13: Try Yoga Regularly.

8. Try meditation or yoga: Mindfulness and meditation, including transcendental meditation, have long been used — and studied — as methods to reduce stress. A 2012 study notes that one university program in Massachusetts has had more than 19,000 people participate in a meditation and mindfulness program to reduce stress. Yoga, which commonly involves breathing control, posture, and meditation techniques, can also be effective in reducing stress and blood pressure. A 2013 review on yoga and blood pressure found an average blood pressure decrease of 3.62 mm Hg diastolic and 4.17 mm Hg systolic when compared to those who didn't exercise. Studies of yoga practices that included breath control, postures, and meditation were nearly twice as effective as yoga practices that didn't include all three of these elements.[11]

Figure-14: Try Some Dark Chocolate.

9. Eat some dark chocolate: Yes, chocolate lovers: Dark chocolate has been shown to lower blood pressure. But the dark chocolate should be 60 to 70 percent cacao. A review of studies on dark chocolate has found that eating one to two squares of dark chocolate per day may help lower the risk of heart disease by lowering blood pressure and inflammation. The benefits are thought to come from the flavonoids present in chocolate with more cocoa solids. The flavonoids help dilate, or widen, your blood vessels. A 2010 study of 14,310 people found that individuals without hypertension who ate more dark chocolate had lower blood pressure overall than those who ate less dark chocolate.

10. Try these medicinal herbs: Herbal medicines have long been used in many cultures to treat a variety of ailments. Some herbs have even been shown to possibly lower blood pressure. Although, more research is needed to identify the doses and components in the herbs that are most useful. Always check with your doctor or pharmacist before taking herbal supplements. They may interfere with your prescription medications.

Here's a partial list of plants and herbs that are used by cultures throughout the world to lower blood pressure: black bean (*Castanospermum australe*), cat's claw (*Uncaria rhynchophylla*), celery juice (*Apium graveolens*), Chinese hawthorn (*Crataegus pinnatifida*), ginger root, giant dodder (*Cuscuta reflexa*), Indian plantago (blond psyllium), maritime pine bark (*Pinus pinaster*), river lily (*Crinum glaucum*), roselle (*Hibiscus sabdariffa*), sesame oil (*Sesamum indicum*), tomato extract (*Lycopersicon esculentum*), tea (*Camellia sinensis*), especially green tea and oolong tea, umbrella tree bark (*Musanga cecropioides*).

11. Make sure to get good, restful sleep: Your blood pressure typically dips down when you're sleeping. If you don't sleep well, it can affect your blood pressure. People who experience sleep deprivation, especially those who are middle-aged, have an increased risk of high blood pressure. For some people, getting a good night's sleep isn't easy. There are many ways to help you get restful sleep. Try setting a regular sleep schedule, spend time relaxing at night, exercise during the day, avoid daytime naps, and make your bedroom comfortable. The national Sleep Heart Health Study found that regularly sleeping less than 7 hours a night and more than 9 hours a night was associated with an increased prevalence of hypertension. Regularly sleeping less than 5 hours a night was linked to a significant risk of hypertension long term.

12. Eat garlic or take garlic extract supplements: Fresh garlic or garlic extract are both widely used to lower blood pressure. According to one clinical study, a time-release garlic extract preparation may have a greater effect on blood pressure than regular garlic powder tablets. One 2012 review noted a study of 87 people with high blood pressure that found a diastolic reduction of 6 mm Hg and a systolic reduction of 12 mm Hg in those who consumed garlic, compared to people without any treatment.

13. Eat healthy high-protein foods: A long-term study concluded in 2014 found that people who ate more protein had a lower risk of high blood pressure. For those who ate an average of 100 grams of protein per day, there was a 40 percent lower risk of having high blood pressure than those on a low-protein diet. Those who also added regular fiber into their diet saw up to a 60 percent reduction of risk. However, a high-protein diet may not be for everyone. Those with kidney disease may need to use caution, so talk to your doctor. It's fairly easy to consume 100 grams of protein daily on most types of diets. High-protein foods include: fish, such as salmon or canned tuna in water, eggs, poultry, such as chicken breast, beef, beans and legumes, such as kidney beans and lentils, nuts or nut butter such as peanut butter, chickpeas, cheese, such as cheddar.

A 3.5-ounce (oz.) serving of salmon can have as much as 22 grams (g) of protein, while a 3.5-oz. serving of chicken breast might contain 30 g of protein. With regards to vegetarian options, a half-cup serving of most types of beans contains 7 to 10 g of protein. Two tablespoons of peanut butter would provide 8 g.

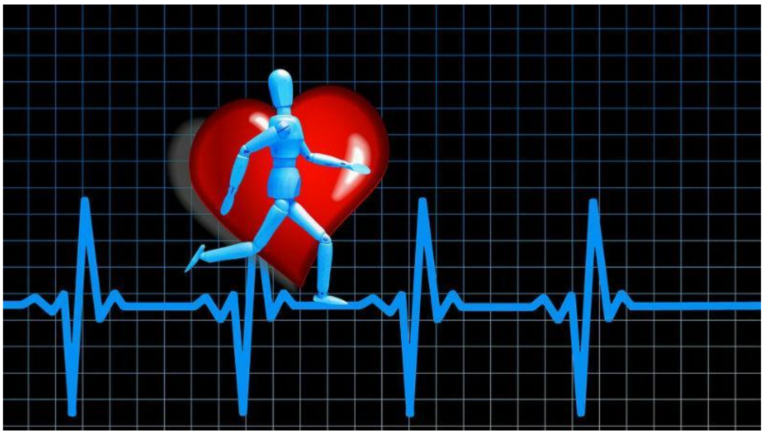
14. Take these BP-lowering supplements: These supplements are readily available and have demonstrated promise for lowering blood pressure:

Omega-3 polyunsaturated fatty acid: Adding omega-3 polyunsaturated fatty acids or fish oil to your diet can have many benefits. A meta-analysis of fish oil and blood pressure found a mean blood pressure reduction in those with high blood pressure of 4.5 mm Hg systolic and 3.0 mm Hg diastolic.
Whey protein: This protein complex derived from milk may have several health benefits, in addition to possibly lowering blood pressure.
Magnesium: Magnesium deficiency is related to higher blood pressure. A meta-analysis found a small reduction in blood pressure with magnesium supplementation.
Coenzyme Q10: In a few small studies, the antioxidant CoQ10 lowered systolic blood pressure by 17 mm Hg and diastolic up to 10 mm Hg.

15. Drink less alcohol: Alcohol can raise your blood pressure, even if you're healthy. It's important to drink in moderation. Alcohol can raise your blood pressure by 1 mm Hg for each 10 grams of alcohol consumed. A standard drink contains 14 grams of alcohol. What constitutes a standard drink? One 12-ounce beer, 5 ounces of wine, or 1.5 ounces of distilled spirits. Moderate drinking is up to one drink a day for women and up to two drinks per day for men.

16. Consider cutting back on caffeine: Caffeine raises your blood pressure, but the effect is temporary. It lasts 45 to 60 minutes and the reaction varies from individual to individual. Some people may be more sensitive to caffeine than others. If you're caffeine-sensitive, you may want to cut back on your coffee consumption, or try decaffeinated coffee. Research on caffeine, including its health benefits, is in the news a lot. The choice of whether to cut back depends on many individual factors. One older study indicated that caffeine's effect on raising blood pressure is greater if your blood pressure is already high. This same study, however, called for more research on the subject.

17. Take prescription medication: If your blood pressure is very high or doesn't decrease after making these lifestyle changes, your doctor may recommend prescription drugs. They work and will improve your long-term outcome, especially if you have other risk factors. However, it can take some time to find the right combination of medications. Talk with your doctor about possible medications and what might work best for you.



CONCLUSION

Heart is a muscular organ which is all time busy [24×7] in pumping blood to the entire viscera *in-vivo* which needs the supply of oxygen because blood has haemoglobin having Fe^{2+} as prosthetic group as a carrier of oxygen. Both oxygenated and deoxygenated blood as a liquid tissue flows from heart and covers the vicious cycle entire the body. Heart beats in the regular rhythm by normal cardiac cycle which controls automation of cardiac pulse. Abnormality in cardiac output is generally called hypertension/hypotension that focusses on normal systole-diastole of heart pumping rate. Normal electrocardiogram [ECG] gives the potentiality of P-Q-R-S-T peaks of cardiac action potential which gets disturbed in cardiac abnormality to produce cardiovascular diseases like angina, hypercholesterolemia, high BP, low BP, myocardial infarction etc. So many remedies are being prescribed my medical practitioners to prescribe medications but all of these have some adverse effects. Natural remedies are also very acceptable as these are harmless.

REFERENCE

1. Piyush A. Gediya, Nadim M. Chhipa, Viraj P. Jatakiya, Sachin M. Patel and Prof. Dr. Dhrubo Jyoti Sen; Antioxidant coenzyme Q10 as free radical scavengers in hypercholesterolemia: Internationale Pharmaceutica Sciencia, 2012; 2(4): 18-25.
2. Dhrubo Jyoti Sen, Satyanand Tyagi, Anil Gupta, Surinder Kumar, Sonal Dinkar Patil, Megha Sahu, Prabodh V. Sapkale, Mayur Ashok Chaudhari and Kamlesh R. Prajapati; Holistic supplement omega fatty acids: a challenge for smart heart by saying no to atherosclerosis and yes to homeostasis: Journal of Drug Discovery and Therapeutics, 2013; 1(7): 01-13.
3. Nilang S.Doshi, Ashish M. Parmar, Girish M. Kapadiya, Bhavesh S. Patel, Keyur D. Patel and Dr. Dhrubo Jyoti Sen; Ion exchange mechanism of bile acid sequestrants in preventing reabsorption of bile salts in hypercholesterolemia: World Journal of Pharmaceutical Sciences, 2014; 2(10): 1283-1289.
4. Prof. Rameshbhai Devrajbhai Chaudhary and Prof. Dr. Dhrubo Jyoti Sen; Yoga: a holistic way of harmony in life!: World Journal of Pharmaceutical Research, 2015; 4(4): 1405-1425.
5. Prof. Dr. Badmanaban Ramalingam, Dr. Bharat Mishra, Prof. Dr. Dhrubo Jyoti Sen, Mr. Manu Jose and Mr. Fels Saju; Correlation approaches of fatty acid binding proteins and myocardial infarction: World Journal of Pharmaceutical Research, 2017; 6(17): 422-454.
6. Prof. Dr. Dhrubo Jyoti Sen; Health risk factors of trimethylamine N-oxide and remedy: European Journal of Biomedical and Pharmaceutical Sciences, 2018; 5(4): 1041-1048.
7. Franklin SS, Gustin W, Wong ND, Larson MG, Weber MA, Kannel WB, Levy D. "Hemodynamic patterns of age-related changes in blood pressure. The Framingham Heart Study". Circulation, 1997; 96(1): 308–15.
8. Gurven, Michael; Blackwell, Aaron D.; Rodríguez, Daniel Eid; Stieglitz, Jonathan; Kaplan, Hillard. "Does blood pressure inevitably rise with age?: longitudinal evidence among forager-horticulturalists". Hypertension, 2012; 60(1): 25–33.
9. Tkachenko BI, Evlakhov VI, Poyasov IZ. "Independence of changes in right atrial pressure and central venous pressure". Bull. Exp. Biol. Med., 2002; 134(4): 318–20.
10. Rothe, C. F. "Mean circulatory filling pressure: its meaning and measurement". Journal of Applied Physiology, 1993; 74(2): 499–509.
11. Gottdiener JS, Panza JA, St John Sutton M, Bannon P, Kushner H, Weissman NJ. "Testing the test: The reliability of echocardiography in the sequential assessment of valvular regurgitation". American Heart Journal, 2002; 144(1): 115–21.