A brief review on cardiovascular disease among obese adults

Chandra Sekher Upadhyay[1*] and Mithun Das[2]

[1] Research Scholar, Department of Anthropology & Tribal Studies, Sidho-Kanho-Birsha University, Purulia, West Bengal, India

[2] Associate Professor, Department of Anthropology & Tribal Studies, Sidho-Kanho-Birsha University, Purulia, West Bengal, India

*Corresponding author: shekherupadhayay@gmail.com

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Introduction

Obesity is so much concerning that it is increasing like fire, causing huge death on the global scenario. It is true that standing in the edge of 2021, we are having enough advancement in the field of medical and clinical tool to tackle any life impacting issue. But this should be taken into consideration that the prevalence of obesity is highly associated with the increase risk of morbidity and mortality with many chronic conditions including cardiovascular disease (CVD), cancer and type II diabetes(T2DM). Previously obesity was not classified as a disease until 2013, when American Medical Association classified obesity as a severe and deadly disease to draw huge attention of the physicians towards its negative impact(Rahman et al., 2020). It has been reported that the prevalence of obesity has doubled (Hosseini et al., 2017) or tripled (Andersson et al., 2018) up, from 3.2% to 10.8% in men and from 6.4% to 14.9% in women, in the recent decade. Many studies had reported that prevalence magnitude depend upon many factors such as the types of obesity, age, sex etc. (Rarau et al., 2019). Now a days this impact can be noticed among the young adults and children's also. Similarly, a report has been published that between 1980 and 2013 the prevalence of overweight and obesity has increased from 16% to 23% in developed countries and from 8% to 10% among developing countries (Andersson et al., 2018). Body mass incex (BMI) plays an important role in both maintaining and deteriorating the health outcomes because a study in 2017 reported that both obese and underweight were significantly for all-cause mortality (Kee et al., 2017). It has been known to us that the increase in BMI occurs with the increase in age but researches has proven the fact that the steeper increase in weight have been observed almost among every stages of life without age as a dependent factor, since childhood. Recent study in 2019 reported that the hazard ratio of CVD for obese is 1 to 1.29-fold higher than

non-obese (Kjollesdal et al., 2019). Obesity are of different types out of which particularly the abdominal obesity is a basic prevalent feature of metabolic syndrome (MetS), and proven that it is highly associated with hypertension, insulin resistance (IR) /pre diabetes, dyslipidemia and different known and unknown risk factors. By 2030 number of overweight and obese adults worldwide is projected to be at least 1.35 billion and 573 million individuals respectively in the world (Bostan et al., 2021). Cardiovascular disease is the leading cause of death globally (Paquissi et al.,2016; Saeed et al., 2020). According to WHO in 2019, nearly 17.9 million died due to CVD, which is 32% of all global death. The most non-refuse able fact is that 85% death occurs due to heart attack and stroke. Further it had reported that three quarters were from low- and middle-income countries(Paquissi et al.,2016; Saeed et al., 2020; Appiah et al., 2017;WHO, 2021). Out of 17 million premature death (age < 70years), 38% were caused by CVDs. Focusing on the obesity and CVD without concerning about MetS will make everything frameless because MetS act as a base for CVD and t2dm by sharing the common risk factors and this MetS itself mean any changes or disturbance in the equilibrium of metabolic activities or biochemical process inside the human body causing an ill effect or syndrome (Reaven, 1988). This metabolic syndrome consists of a group of knowing and unknowing factors such as hypertension, elevated cholesterol and obesity etc. results in causing disease like t2dm, cardiovascular syndrome etc. A study from 2020, reported that, the exact mechanism by how abdominal obesity is related to CVD and t2dm is not fully explored, but many researches have proposed multiple pathophysiologic pathways including free fatty acids, oxidative stress, endothelial dysfunction, low-grade inflammation, low HDL cholesterol, elevated TG and hyperinsulinemia etc.(Bostan et al., 2021).

Obesity

Obesity is a medical condition in which body fat accumulates to a certain abnormal degree this is further the result of a chronic positive energy balance, with energy intake exceeding energy expenditure (Elagizi et al., 2018). The classification of obesity is done with the help of some biological invasive and noninvasive tools like calculating BMI (body mass index), WC (waist circumference), AC (abdominal circumference), WHR (waist to hip ratio) and BIA (bio electrical impedance) etc. The measurement criteria of obesity have been proposed by many renowned Institutions and organization such as WHO(world health organization) defined as BMI $\geq$ 25 as overweight and BMI $\geq$ 30 as obesity and further the cut of value for WHR $\geq$ 0.8 and $\geq$ 0.9(female and male respectively), IDF(Indian diabetes federation) cut off value for obesity is WC $\geq$ 90 cm among female and $\geq$ 80 cm for male. Depending upon the ethnicity the criteria changes all over the world. On the basis of measurement there are three main types of obesity such as general obesity, central obesity and compound obesity (central + general obesity). The central obesity is proven to be the best predictive measure for obesity(Zhang et al., 2016).

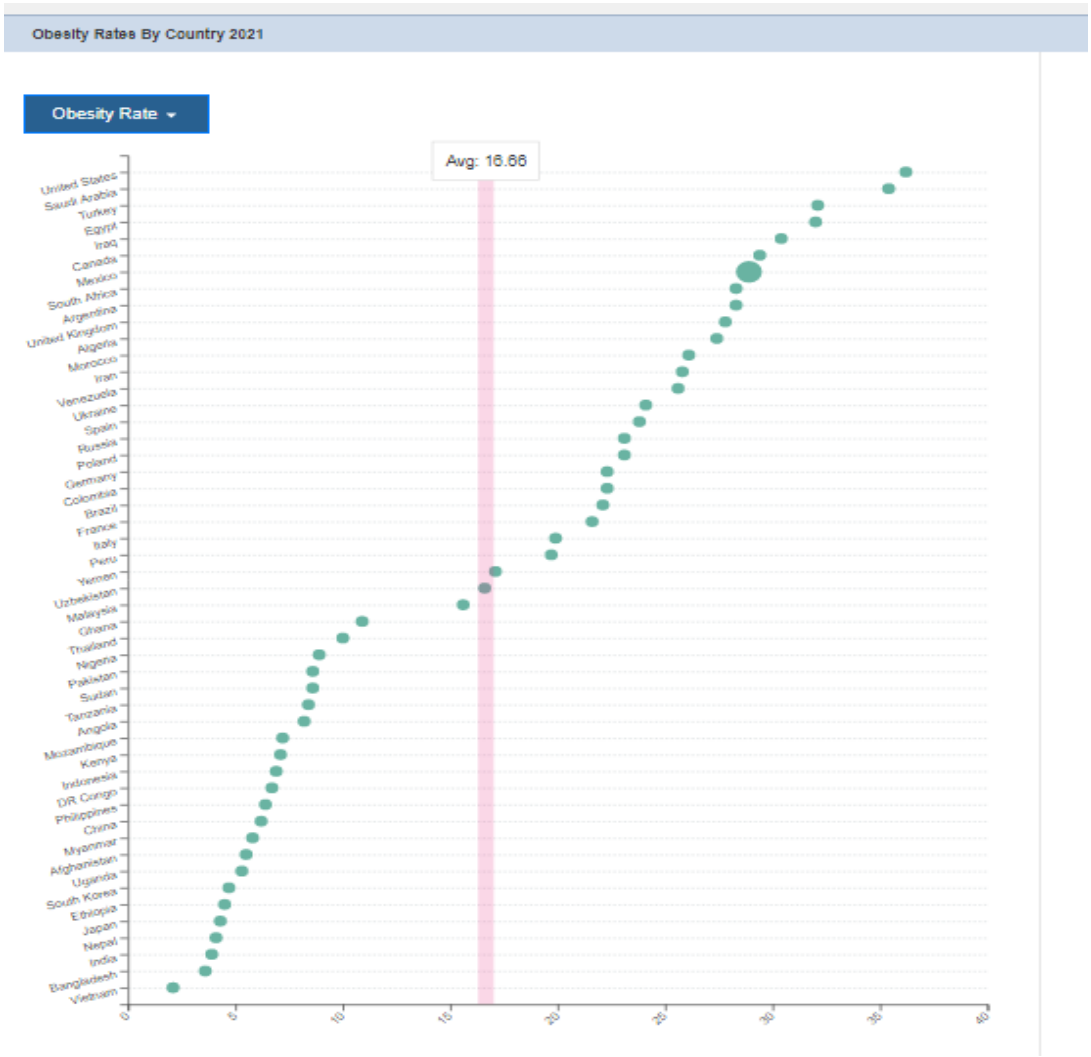


Figure 1 Present condition of prevalence of obesity among countries around the world (based on secondary data from internet).

Different concept and types of obesity (Zhang et al., 2016; Elagizi et al., 2018)

1. Normal Weight Obese (NWO): these are classified as patient or individuals with high WC or BF% (body fat percent) but having normal BMI and shown to have an increased MetS, CHD (coronary heart disease) and mortality risk.
2. Lean paradox: individuals with lower BMI categories, it can be said as fat free mass including skeletal muscle. Further a decrease amount of lean mass or skeletal muscle mass defines as a sarcopenia.
3. Sarcopenic obesity: Individuals with reduced skeletal along with excess fat mass.

4. Metabolically healthy obese (MHO): Individual with BMI ≥ 30 kg/m^2 butno hypertension, dyslipidemia and glucose abnormalities (have 0 criteria for MetS excluding wc). This is also known as" fat but fit "phenomenon.
5. Metabolically Unhealthy Overweight/Obese (MUOO): Individuals with obesity and have criteria for MetS.

Risk factors for overweight and obesity.

The main risk factors for obesity are modifiable (high calorie intake, non-balanced diet, western food, modern lifestyle, sedentary time table, more screen time, less physical activity, improper sleeping or disturbance{Mozaffari et al., 2019; Raza et al., 2020}) and non- modifiable (genetic, age and sex and family history {Yeboah et al., 2018}).

Physiological effect of obesity.

There is a complex association of obesity with CVD which may be mediated by increased preload and vascular damage. When the ectopic fat accumulates in the myocardium, it increased ventricular stiffness, which in turn leads to vascular dysfunction, hypertension and left ventricular hypertrophy (Elagizi et al., 2018). Independently, obesity-associated insulin and leptin resistance also promote inflammation and endothelial dysfunction which increases arterial stiffness, susceptibility to plaque formation and accelerated atherosclerosis. The adiposity is highly related with the activation of neurohormonal, renin- angiotensin-aldosterone system, sympathetic system and also associated with metabolic abnormalities, hyperleptinemia and dysregulation of insulin like growth factors. These aberrations in turn induced those factors which contribute to hypertension in obesity. Those factors are increased sodium retention, hyperinsulinemia and vascular reactivity (Elagizi et al., 2018). After the induced mechanism the adipose tissue is recognized as endocrine organ rather than storage depot. Further the myocardium may be affected by the hormone or the active molecule known as adipokines which are synthesis by adipocytes. Apart from these, the adipose tissue produced different pro-inflammatory cytokines, which are interleukin -1b, interleukin- 18 etc. which further creates diastolic dysfunction (Elagizi et al., 2018). The obesity completely affects the central blood volume, the cardiac output and the stroke volume. The flowing of blood in adipose tissue decrease with the increase in obesity (II and III) as compare to others organ, which further increase the venous return leading to increase in the left ventricle (LV) filing pressure which further lead to elevated pulmonary arterial and right heart pressure (Elagizi et al., 2018).

Cardiovascular Disease

The word CVD is the whole sum disease of both heart(cardio) and blood vessel(vascular) in the body. It occurs when the fatty deposits build up in the arteries(atherosclerosis), blocking the blood

circulation from reaching to their targeted organs and body parts and lastly causing dame to them. There are many types of CVD incidence (WHO, 2021), such as:

1) Coronary Heart Disease: This occurs when the oxygenated blood flows towards the heart muscle is blocked or reduced. The major's examples are angina (chest pain due to restricted blood flow to the heart muscle), heart attacks (blood flow towards the heart is suddenly blocked) and heart failure (heart fails to pump the blood around the body).
2) Stroke: A sudden cut off in the blood flow towards the brain causing brain damage and possibly death. But in case of a TIA (transient ischaemic attack) or mini stroke the blood towards the brain is temporarily blocked effecting the face(they can't feel the one side of the face or dropped or response less), arms(will fell numbness in the arms) and speeches(can't talk properly or clearly).
3) Peripheral Arterial Disease: when the blood flow towards the periphery(legs) parts gets blocked.
4) Aortic Disease: it happens due to many conditions affecting the aorta, causing interrupted blood flow toward the body parts. One of the major aortic disease is aortic aneurysm (aorta become weak and bulges outward).

Risk factors: Factors which are responsible for the CVD incidence and outcomes. There are many risk factors of CVD out of which some are categories as live style behaviours/ modifiable factors and non-modifiable factors such as:

1. Modifiable factors are those life style factors which can be modified in order to decrease the CVD outcomes. Those factors are given below with their cut off point.

Factors	**Criteria by WHO** (WHO, 2021) **(should avoid these and decrease these)**
Alcohol Consumption	Cessation is required if possible or decrease to a minimum limit
Diet	Diet rich in high fatty acid, saturated fat, high intake of salt, less fibre and absence of vegetable and fruits.
High Cholesterol	HDL-C level less than 35 mg/dl and 39 mm/dl in men and women respectively. Total Cholesterol level is more than 200mg/dl
High Blood Pressure	Equal to or more Systolic Blood pressure of 140 mm Hg and diastolic of 90 mm Hg

Diabetes	Impaired Fasting Glucose level of 101- 125 mg/dl and IGT level of 140-199 mg/dl 2 hour after intake of 75 gm of glucose.
Overweight or Obese	BMI equal to or more than 25 kg/m^2
Physical Inactivity	Less than 150 to 300 minutes of moderate intensity physical activity.
Smoking	Cessation is required if possible or decrease to a minimum limit
Triglyceride	150 mg/dl or higher

2. NON-Modifiable factors are those factors which cannot be modified in order to decrease the CVD outcomes. Those factors are given below:

Factors	**Criteria**
Age	Can't modify (but can keep track because after 50 years the chance increases due to lower in metabolism activity along with some modified factors.)
Sex	Can't modify (men tend to be affected earlier than female)
Ethnicity	Can't modify (occurs more to South Asians, African or Caribbean background)
Family History Of CVD	Can't modify (but being carefull of the modified factors can slow down)

The above said factors should be taken into consideration to avoid the CVD incidence and outcomes. It is true that most of the times we cannot stop the outcome but following those lifestyle factors and improving them will surely decrease the rate of incidence to particular level which further help us to live a healthy life. Many researches had proven that intervention of the physical activity, maintaining proper diet(Mozaffari et al., 2019; Raza et al., 2020), proper sleep and decreasing or stopping substance intake had decreases the prevalence rate of obesity, hypertension, t2dm and CVD etc.

Objectives:

1. To find out the various outcomes of obesity
2. To find out the impact of obesity on cardiovascular health.

Methodology:

Search Strategy

The following databases were used: MEDLINE, SCIENCE DIRECT, GOOGLE SCHOLAR, PUBMED, PLOS and COCHRANE etc. The following search terms were used individually or in combination such as: The search was limited to human studies with CVD(cardiovascular disease), T2DM(type II diabetes), Dyslipidemia, MetS (metabolic syndrome), Obesity, Mortality, Young Adult, Dietary pattern, Smoking, Hypertension, CVD outcomes and incidence, Socio-economic status, etc. with no restrictions on gender and ethnicity but stressed on age ≥ 18 .

Study Selection

Google scholar Citations from the searches were imported into referencing. Title and abstract were screened for the final studies.

Inclusion criteria

Only studies with case-control, cross-sectional, and prospective cohort, retrospective, designs with a control or reference group were included. Intervention studies, case studies, community based, population based, randomized control trials and quasi experimental studies, etc.

Exclusion criteria

Those researches like review paper, metanalysis and case reports etc.

Time frame and language: Researches from 2016 to 2021 were included with a stress on only English language.

Study Factor

The overall overweight and obesity were focused and primary outcome in studies was CVD risk factors and outcomes based on BMI, MetS criteria etc. Studies were not considered further when the title and abstract clearly indicated that the study did not meet the inclusion criteria described above. The primary reason for excluding studies was if the article contained our eligibility criteria or not.

Study Synthesis

A custom-designed table was form for the extraction of the data for further procedure. Extracted data included title of the study, study type, year of publication, place, continent, first author name, total

sample or n (male and female), age of n and findings. Since our main focus is on the impact of obesity on cardio vascular health, so main stressed was given on prevalence of overweight and obesity and their association with CVD.

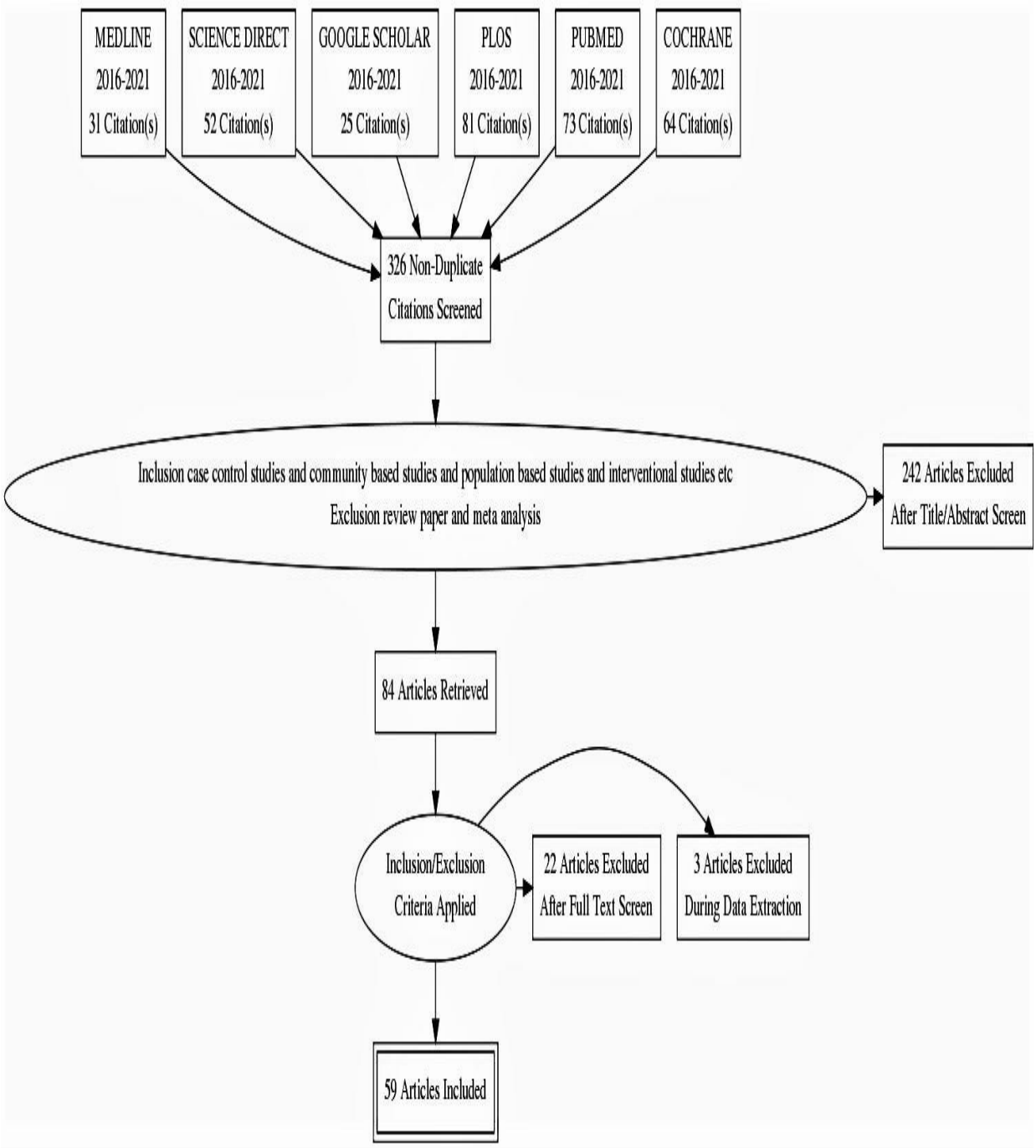


Figure 2 PRISMA Flow Diagram

FINDING & DISCUSSION

The sequencing of the findings was done on the basis of continents arranged in alphabetically order, then from 2021- 2016. The citation and referencing will follow the serial no of the study.

SL. No.	Author	Publication year	Place	Nature of study	N	Age of N (years)	Finding & prevalence's
				Continent: Africa			
1	Sharma et al.	2021	Mthatha	Cross-sectional	556 (83 males and 473 females)	18 and above	Averagely 47.6 % of BMI falls under obese, out of which 82.9% are hypertensive. Nearly76.5% individuals' intake western diet was associated with hypertension.
2	Chikafu et al.	2020	South Africa	Cross-sectional	392 (127 male and 265 female)	18 and above	The prevalence of obesity was 20%, males had 37% higher six-fold difference in sports and recreational activity (PA) than females with 441.4 min extra.
3	Rarau et al.	2019	Papua New Guinea	Cross-sectional, community-based survey	671 (308 male and 363 female)	15 –65	Females were having more RR for obesity by both WC (RR 5.78) and WHR (RR 1.18), have low HDLC (RR 1.53) and have MetS (RR 4.7) than males.
4	Twinamasiko et al.	2018	South Western Uganda	Cross-sectional	310 (155 male and 155 female)	35 and above	The prevalence of obesity, SBP and DBP was 46%, 24.5%, 31% and 9% diabetes. The sedentary workers will have 2.8 time more hypertension as compare to counterparts.
5	Kingue et al.	2017	Sub-Saharan African countries	Cross-sectional, Hospital-based	844 (360 males484 females)	35 above	The overall prevalence of MS, overweight, obese and morbidly obese were 39.4%, 32.3%, 31.8% and 4.6%. Hypertensive participants were more overweight (33.2 vs 30.5%) and obese (42.5 vs 16.8%) ($p<0.001$) than normotensive.

6	Yeboah et al.	2017	Ghana	Cross-sectional	364, (174 males and 190 females)	20-30	The prevalence of MetS components were: 17.1% abdominal obesity, 35.6% high SBP, 30.9% low HDLC, 18.2% IGF etc. The parental CVD is associated with participants abdominal obesity, low HDLC and increase the odds for MetS($p<0.037$).
7	Paquissi et al.	2016	Angola	Cross-sectional	781, (394 males and 387 females)	18- 65	The prevalence of obesity and overweight was 19.85% and 34.44%. Age group > 40 is significantly ($p<0.001$) related to hypertension, obesity, diabetes.
			Continent: North America				
8	T. Tran et al.	2021	Nevada, USA	Retrospective, Cross-sectional,	9,257 (3,908 males and 5,349 females)	18 and above	Individuals with high cholesterol status were 2.67 times more likely to have reported CVD compared to those with normal levels [OR = 2.67 (1.75, 4.07)].
9	Vella et al.	2020	Pacific Northwest	Cross-sectional	95(39 male and 56 female)	18-25	The prevalence of overweight and obesity were 35% and 3% respectively. The highest leisure screen time had significantly higher 9.5% BMI, 7.9%WC, 34% TG, 32% fat mass, 91% Lipid level, and 8% lower VO2peak ($p < 0.05$).
10	Medina et al.	2020	Mexico	Retrospective, Cross-sectional	29,268	35-64	A 3.8% increase in PI (physical inactivity) prevalence among 35–64-year-old Mexicans from 2006 to 2012 increases the incidence by 1%: T2D, 0.8%: CHD and stroke incidence, 0.5% etc.
12	Mazidi et al.	2018	US	Retrospective, Cross-sectional	17,689(8,607 male and 9,082 female)	18 and above	The overall prevalence of MetS was 28.3%. The cardiometabolic risk factors were positively associated with quartiles of DII (Dietary inflammatory index), except for HDL-cholesterol for which a

							decreasing pattern was observed (all p<0.001
13	Bridget et al.	2019	Urbana IL	Cross-sectional	117 (44 male and 73 female)	25-45	The prevalence of overweight and obesity was 45% and 55% respectively. The OR of hypertriglyceridemia for soluble and total fibre were 0.67 and 0.75 at p<0.05, indicates an inverse relationship between fibre consumption and triglyceride concentration > 15. mg/dl.
14	Zhang et al.	2018	US	Retrospective, Population based	9,162 (4,813 men and 4,349 women)	24-48	The prevalence of obese was nearly 23.4% and out of which 76.7% of obese were having a high-sodium diet. The elevation in obesity risk by 15% (OR: 1.15; 95% CI: 1.00, 1.33) occur with each 1 g increase in sodium intake (P-trend < 0.01).
15	Appiah et al.	2017	USA	Retrospective, Population based	35,820 (17,516 males and 18,304 females)	30-74	The prevalence of HEPHA (high excess predicted heart/vascular age) across countries was as follows: Ghana 36%, India 38%, US 45% Russia 52% China 56%, Mexico 59%, and South Africa 65%. The prevalence of PHA was almost 3% higher in 6 LMICs (lower- and middle-income countries) compared to the US (2.6%; CI: 0.1, 5.2; p = 0.043).
			Continent: South America				
16	Duarte-Clíments et al.	2021	Brazil, Cape Verde, Guinea Bissau, Mozambique etc.	Observational, Cross-sectional	2496	18 and above	The main risks of impaired cardiovascular function found in 86.8% of students were: family history of cardiovascular disease, sedentary lifestyle, dyslipidaemia, and insufficient knowledge.

							The value of Kappa index was above 0.72 for risk of impaired cardiovascular function.
17	Correa-Rodríguez et al.	2020	Columbia	Retrospective, Cross-sectional	1,354 (528 male and 826 female)	18-30	The prevalence of NWO (normal weight obesity) were 29.1% (54% men and 46% women). Further the study reported that NWO was associated with an increased cardiovascular risk, high BP, low HDL-C, high abdominal obesity and low muscular strength supporting that high prevalence of cardiometabolic abnormalities.
18	Mamani-Ortiz et al.	2019	Bolovia	Cross-sectional community-based	10,704(4,562 male and 6,142 female)	18 and above	The prevalence of Overweight and obesity were 35.84% and 20.49% of participants. The PR (prevalent ratio) risk of low physical activity was significantly lower in self employees (PR: 0.62, 95% CI: 0.60–0.64). employees (PR: 0.81, 95% CI: 0.77–0.85) when compared to students.
19	Diaz-Martinez et al.	2018	Santiago, Chile,	Retrospective, Cross-sectional	51,57 (2,084 males and 3,073 females)	15 and above	The physically inactiveness is strongly associated with a higher probability of central obesity (OR: 1.92[1.42, 2.58], p <0.0001) and metabolic syndrome (OR: 1.74 [1.23 ; 2.47], p <0.0001) in men but not in women(central obesity OR: 1.01 [0.73, 1.41], p = 0.919; metabolic syndrome OR: 1.18 [0, 90; 1.54], p = 0.217).
20	Lanas et al.	2016	Argentin, Chile, Uruguay,	Retrospective, Cross-sectional	7,524 (3,165 men and 4,359 women)	35-74	The prevalence of overweight, obesity and central obesity were 41.3%, 35.7% and 52.9% respectively. The individuals with 3 or more risk factors were 46.3% (among normal weight) and 68.9% (among obese).

				Continent: Asia			
21	Bae et al.	2020	Korea	Cohort study (12 years)	8,900 (4,243 males and 4,657females)	40-69	The HR (hazard ratio at 95% CI) for incident CVD for men is 1.63 for BMI of 21.4 as compare to BMI of 27 and for women, the risk of incident CVD increased at a BMI above 28.7 kg/m2 with HR of 1.56 compared to BMI of 22.
22	Rahman et al.	2020	Bangladesh	Cross-sectional	400 (235 males and 165 females)	18-93	The prevalence of obesity was 6.75% (male 6.81%; female 6.67%). The age group 51-65 had highest prevalence with 8.11% obesity $p<0.05$.
23	Said et al.	2020	Saudi Arabia,	Random, Interventional studies	23 (9 for diet group and 14 for diet with physical training group).	19-24	The change in the CVD risk factors were significant for both the groups but more in DTG with difference of changes in FBG level ($p = 0.022$), TG level ($p = 0.001$), TC ($p=0.006$) etc.
24	Fekri et al.	2020	Tehran	Prospective, population based cohort study	7,529 (3,411 men and 4,118 women)	30 and over	The overweight was associated with 2.6 (95% CI: −4.6, − 0.2) and 2.8 (−4.6, −0.7) fewer years lived free of CVD in men and women, respectively.
25	Ghazizadeh et al.	2020	Mashhad, Iran	Cohort study (6 years)	9,549, (3,829 males and 5,720 females)	45-60	The prevalence of obesity among men and women was 12.9 % and 36.8% respectively. Those, women with the very high degrees of obesity had a greater risk of CVD (HR: 1.91, 95% CI: 1.06-3.43, P = 0.03).
26	Xiang et al.	2020	Japan	Case-Control Study	241 Males	middle-aged	The ORs (95% CIs) for CVD were 1.60 (1.38-1.85), 1.53 (1.33-1.78), 1.56 (1.35-1.81) for 1 SD increase in BMI, WC, and WHtR respectively.

27	Jang et al.	2019	Korea	Retrospective, Cross-sectional	1,310(651 men and 659 women)	18-66	The prevalent of MS was higher in male (6.5%) than female (4.1%). The BMI with >30 is associated with 4 MetS risk factor and BMI 25 – 30 kg/m^2 with at least 3 risk factors.
28	Rayyan et al.	2019	Israel, 2018	Cross-sectional, cross community	34,72,44(1, 70,102 male and 1,77,142 female)	24 and more	The MetS was highly prevalent with chronic diseases with prevalence of 76.4%, 80.5%, 82.1% and 79.6% for cancer, CVD, CKD and COPD. (CKDs)and chronic obstructive
29	Mozaffarie t al.	2019	Iran	Cross-sectional	371 women	20 - 50	There was a strong positive association of TG levels between the highest DAL (dietary acid load) score with OR (odd ratio) of 4.28 and 492 with 95% CI for PRAL (P = 0.002) and NEAP (P = 0.001). The NEAP is positively associated with obesity(p=0.00001).
30	Gutierrez et al.	2018	Saudi Arabia, 2018	Cross-sectional	432 (235 males and 197 females)	18 and above	The prevalence of overweight and obese was 69.9% with the mean BMI was 28.3 Kg/m^2. BMI was positive correlated with HTN and DM (r = .200** and .149**, respectively at p<.001), whereas the r= .366** at p<.001 between HTN and DM.
31	Zakiet al.	2018	Kuala Lumpur, Malaysia, 2018	Quasi-experimental study conducted (for 12 months)	255	18 to 59	A significant reduction of fat mass density (p = 0.053), body fat percentage (p = 0.532) and visceral fat (p = 0.016) in the intervention group was noticed when compared to control group.
32	Li et al.	2018	China, 2018	Retrospective Cross-sectional,	1,09,551(49,736 men and 59,815 women)	40 and above	The prevalence of MetS according to ATP III was 18.4% (13.2% men and 237% women). In case of economic development, the OR of MetS for developed (1.20) was

							higher than under developed (1.00) with p<0.001.
33	Kee et al.	2017	Malaysia	Retrospective study, cohort	32,304 (15,020 male and 17,284 female)	18 and above	It was found that both underweight (HR=1·93; 95% CI 1·05, 3·54) and severe obesity (HR=3·24; 95% CI 1·46, 7·18) were found to increase risk of CVD mortality.
34	Lv et al.	2017	China	Retrospective, Cohort analysis	4,61,211 (females)	30 -79	The average PAR% (95% CI) of MCE, IHD, and IS for 6 low risk factors are 67.9%, 43.2% and 39.1% This study further claims that participants with at least 4 low risk factors will reduce the risk by 58%, 43% and 39% for MCE, IHD and IS.
35	Peng et al.	2016	Jilin Province, China,	Cross-sectional	18,137 (8,401 males and 9,736 females)	18 to 79	The prevalence of general obesity (0.3%), central obesity (36.1%) and compound obesity (14.7%) were observed. Nearly 91.5% of the compound obesity had highest risk factors for CVD (1 or more factors) followed by central obesity 86.1% and general obesity 76.9%.
36	Kalaf et al.	2016	Saudi Arabia,	Cross-sectional	833 women	20-40	Here 85% women have 1 or more risk factors, factors = 1 (57.5%), 2 ≥ (20.8%), 3 ≥ (6.7%). The higher risk is among oldest age group (35-39) because of its high obesity 56.9% (p<0.001) and 17.9 % hypertension(p=0.05).
				INDIA			
37	Datta et al.	2021	India	Retrospective, Cross-sectional	3,56,853 females	20-35	The odds of having uncontrolled hypertension for tobacco users is 1.10 times higher than non-users. The odds of uncontrolled hypertension for tobacco users were

							higher for overweight (1.88) and obese (2.82).
38	Kokane et al.	2020	Madhya Pradesh,	Community based cross-sectional		18- 69	Prevalence of raised fasting glucose was 6.8% (95% CI) which was higher in males 8.4% (95% CI). In case of risk factor Men were found to be having more multiple risk factors in both the age categories of <45 and >45 was 36.6% and 54.6% as compared to females.
39	Kaur et al.	2020	Jammu	Cross-sectional	300 (149 males and 151 females)	18-40	The prevalence of obesity is 33.3% (52% male and 48% female). The median value for MVV (Maximum Voluntary Ventilation) decreases with the shift towards obesity such as 93.2, 88.22 and 81.27 for Normal, Overweight and Obese respectively with $p<0.004$.
40	Kaur et al.	2019	Tamil Nadu	community-based cohort study (7 years)	5641 (2570 males and 3071 females)	25-64	Men's were having 3-fold higher incidence rate for CVD than women's (7.2 vs 2.7 per 1000 person years). The CVD risk increases by 1.6, 1.7 and 2-fold smoking, alcohol consumption and hypertension.
41	Gupta et al.	2019	All states	Cross sectional, (Retrospective)	6,44,006	15-49	The prevalence % (at 95 % CI) of overweight and obesity among the respondents was 22.7% and 10.8%. Urban areas, watching television almost every day increased the odds of overweight and obesity by 24% compared to not watching television at all ($p< 0.001$).
42	Dutta et al.	2019		Retrospective, Cross-national	7,46,672 (1,00,410 males and 6,46,262)	15-49	The prevalence % of overweight/obesity among men almost doubled from 9.3 to 17.1 in 2005-06 to 2015-16 and for women it

							was (13.6-18.6). The men and women with highest wealth quintile were 5.10 and 5.63 times more obese than those in the lowest wealth quintile.
43	Mukherjee et al.	2019	Rourkela	Cross-sectional	218 males	20 and above	The overweight (48.6%) was higher than obese (23.9%). The obesity is significantly having positive correlation with TG (p=0.0381), WC (p <0.001), BP (p =0.0077), plasma glucose (p=0.0011) and TC (p =0.0181).
44	Ray et al.	2018	India	Prospective case, control study	151 (72 MetS and 79 controls) (90 male and 61 female)	35-60	The values of BMI, WC, and LAP index are higher in cases than in controls with significant (P < 0.05) difference in each parameter. MetS cases had 2.5 higher LAP index than control group.
				Continent: Australia			
45	Dash et al.	2019	Sydney	Retrospective, Cross-sectional	3,024(1,343male and 1,681female)	25 and over	In women abnormal increase in lipid markers was significant from early to middle adulthood such as 23.1% to 53.9% for LDL and 24.9% to 56.4% for total cholesterol.
46	Livingstone et al.	2017	Geelong	Retrospective, Cross-sectional	4,908, (2,346 male and 2,562 female)	19 and above	The prevalence of hypertension was higher among overweight and obese individuals with the hypertension DP (dietary pattern like non whole grain bread, processed meat, beer and cider etc) PR 1.26, 95% CI 1.02, 1.55, p=0.034. Further this study identified that high hypertension was associated with DP having low fibre density and high Na:K and SFA:PUFA ratio.

47	Li et al.	2016	Australia,	Retrospective, Cross-sectional	3,632	35-70	Employment, education status is significantly related with the CVD and T2DM. BMI and regular alcohol intake accelerate CVD by 1.3% and 3 % respectively over time period.
48	Whatnallet al.	2016	Australia,	Cross-sectional, randomised controlled trial	49 (females)	18–35	The prevalence of obesity was 44.9%. There is a significant inverse association between alcohol intake and BMI ($p = 0.012$), waist circumference ($p = 0.003$) and diastolic blood pressure ($p = 0.039$).
49	Elliottet al.	2016	Australia	Cross-sectional	206 (140 males, 66 females)	Mean age 31.63	The night officers had a significantly higher SBP (nearly 5 mmHg) with $p < 0.03$ than their day counterparts. This disrupt the body's natural diurnal cycle and impact cardiometabolic health thereby increasing BP.
				Continent: Europe			
50	Raza et al.	2020	Netherlands,	Cross-sectional	149 (110 males and 39 females)	22-72	The prevalence of obesity is 52% (39% male and 13% female). High western food is inversely associated with high BMI.
51	Fernberg et al.	2019	Örebro, Sweden,	Retrospective, cross-sectional	220	18-25	The BMI is significant inversely associated with arterial distensibility in both women and men ($p < 0.01$ and $p < 0.05$ respectively).
52	Kjollesdal et al.	2019	Norway,	Observational, cohort study	3,98,297 (1,90,777 males and 2,07,520 females)	18-25	In comparison with normal weight, hazard ratios (HR) of CVD mortality among obese participants (men and women) was 2.39 and 2.08 among high SEP (socio economic position), similarly for low SEP it was 1.88 and 1.75.

53	Marques et al.	2018	20 European countries,	Retrospective, cross national	34,814 (16,467 males and 18,347 females	18 and above	The prevalence of overweight and obese were 37.6(44.7% male and 30.5% female) and 15.9(15.9% both male and female). On the basis of house hold income (low - high) the prevalence of obesity low and high income was 19.3% and 12.8%.
54	Lassale et al.	2018	Pan-European countries,	Case Cohort Aanalysis(12. 2 years)	17,733	35-70	The risk of CHD doubled with higher BMI 32.7 kg/m2 as compare to low 21.5 kg/m2 at p<00001.
55	Ilow et al.	2017	Poland	Cross-sectional	1,168 (276 men and 892 women)	18 and above	Participants with high physical activity had lower BMI, BF%, WHR. women with abdominal obesity had significantly higher BMI, SBP, DBP, heart rate, body fat percentage, hip circumference and WHR, compared
56	Moreno et al	2017	Madrid, Spain	Randomized controlled, clinical trial	45 females (22 for VLCK diet and 23 for LC diet)	18–65	The completers-only reported that the amount of kg reduction observed in the VLCK diet was double that of the LC diet. The values or reduction at 24 months were 12.8 kg in the VLCK group and 4.4 kg in the LC group ($p < 0.001$).

DISCUSSION

Based on the analysis of the studies and available secondary data on internet, we have tried to cross check a finding from this study that prevalence of obesity is more among the highest of higher and lowest of lowersocio-economic status (Li et al., 2016; Appiah et al., 2017; Kjollesdal et al., 2019; Rarau et al., 2019). Focusing on this we had try to plot a graph with recent GDP (Gross Domestic Product) and obesity of 2021 from different countries, to check that whether obesity act as a dependent variable on GDP or not, by keeping GDP as base factor.

Table 2.representing the countries with highest GDP vs Obesity.

COUNTRY	GDP 2021 (billions of $/Int. $)	obesity %
UNITED STATES	22,675.27	36.20%
CHINA	16,642.30	6.20%
JAPAN	5,378.14	4.30%
GERMANY	4,319.20	22.30%
UNITED KINGDOM	3,124.00	27.80%
INDIA	3,049.70	3.90%
FRANCE	2,938.27	21.60%
ITALY	2,106.29	19.90%
CANADA	1,883.49	29.40%
KOREA	1,8.67.10	11.50%

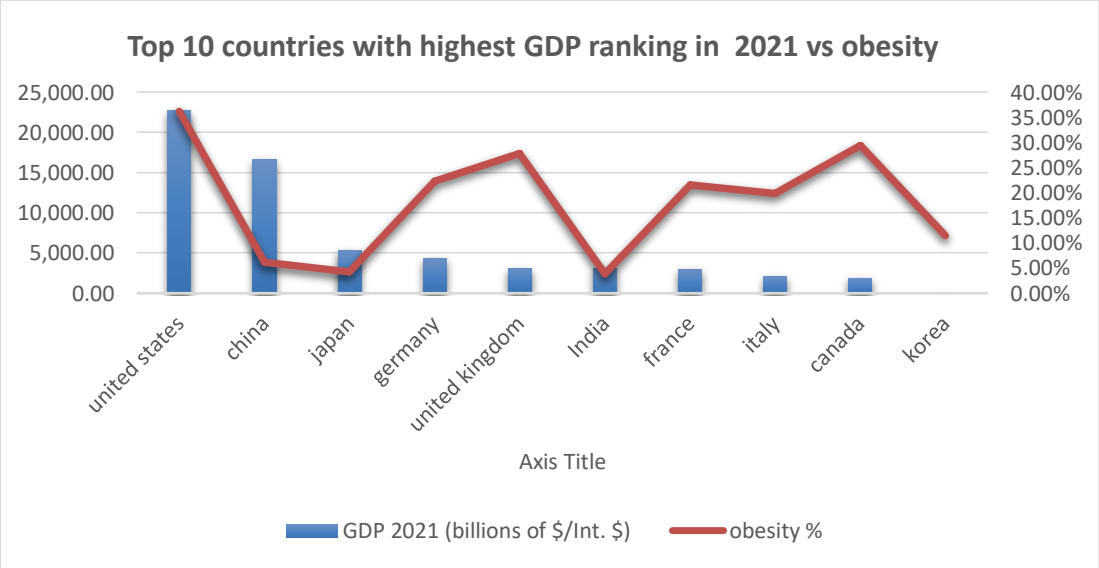


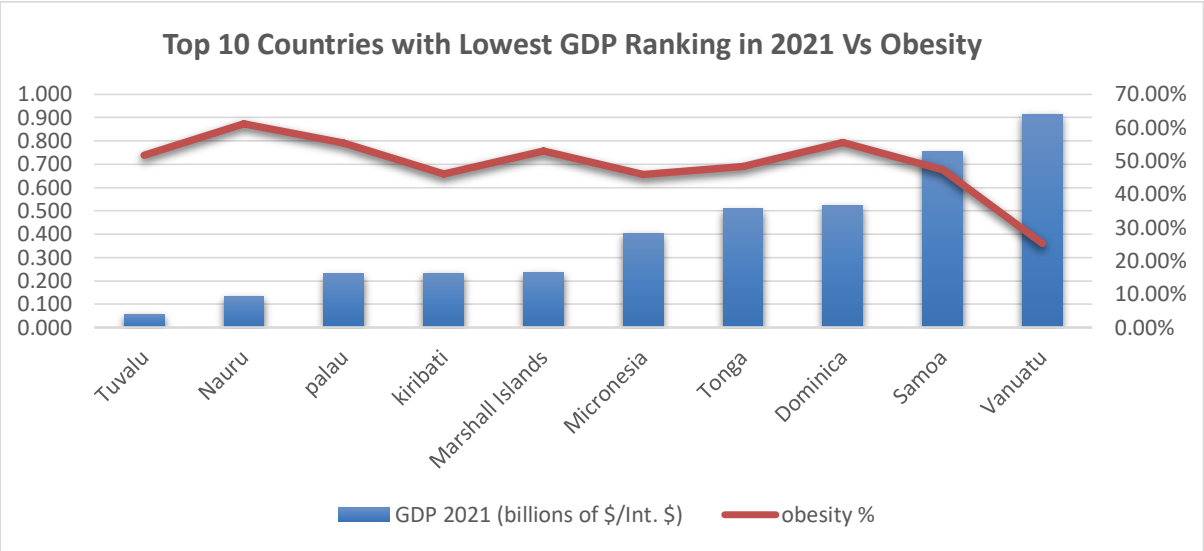
Figure 2 Global trend of obesity by highest GDP

It is clear from the figure 2 that the increase in prevalence of obesity is high in both the highest and lowest GDP ranking countries like United states vs Korea. Though Korea have GDP nearly 12 times less than the United States but have approximately 1/3rd of the prevalence rate of united states. Hence prevalence flow fast among low income countries.

Table 3.representing the countries with lowest GDP vs. Obesity.

Country	GDP 2021 (billions of $/Int. $)	obesity %
Tuvalu	0.057	51.60%
Nauru	0.133	61.00%
Palau	0.229	55.30%
Kiribati	0.231	46.00%
Marshall Islands	0.234	52.90%
Micronesia	0.401	45.80%
Tonga	0.508	48.20%
Dominica	0.523	55.50%
Samoa	0.752	47.30%
Vanuatu	0.912	25.20%

Figure 3 Global obesity by lowest GDP



It is clear from the figure 3 that the increase in prevalence of obesity is high in both the average lowest GDP and worst lowest GDP ranking countries like Vanuatu vs Tuvalu. Though Tuvala have GDP nearly 16 times less than Vanuata, but have approximately 2 times high prevalence rate of Vanuata. Hence prevalence flow fast among low income countries

Conclusion

The above studies are showing that how prevalence of obesity is working for different risk factors of CVD. This shows the association of lifestyle factors of obesity with CVD.

The overall summary of the studies was multi enlightening in the way of understanding various magnitudes of health outcomes. Starting from the basic, adiposity is measured through BMI, WHR and WC, but if we add these two parameters to make compound adiposity then it will provide a great structure of adiposity because it generally means that the measurement around the waist and hip in respect to height. The word Sedentary is like a full stop, because whenever we sedent ourselves, we are shaking hand with the various impairment metabolic disorder. It might be by increasing BMI, effecting lipids level or by excessive abnormal sleep and depending more on-screen time. But it has to be note that researchers had found that both the obesity like underweight and overweight will deliver a worst effect on health system and both are more prone to all cause of mortality. Due to the change in life style and adverse dietary pattern, the young generation are no longer free from this grasp. In case more and more effect is seen among both younger and adult generations. The magnitude of the effect of risk factors might be different on the basis of environment, age, sex, body makeup and ethnicity. At last, hypertension, high BMI, WC, TG and TC level etc will push towards the room of metabolic syndrome, t2dm and CVD. To tackle different health issue primarily different health strategies, intervention etc are formed. Study had proved the intervention work properly by decreasing the risk factors. More over for a better health we should focus on improving the modifiable factors.

It is true that great obesity comes with great risk, to avoid this we have to think great towards our health otherwise everything will finish. So regular health check-up, maintaining proper diet, cessation of substance intake along with proper physical activity will surely help to decrease the prevalence rate up to a limit “If we wish”.

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Secondary data from internet

- Figure.1, Obesity prevalence chart (Obesity Rates By Country 2021 (worldpopulationreview.com) accessed on 22.07.2021) as it is copied.
- Figure 2 and 3 (GDP data taken from - GDP Indicators 2021 - StatisticsTimes.com accessed on 22.07.2021).
- WHO fact sheet on CVD(Cardiovascular diseases (CVDs) (who.int)) accessed on 18.08.2021.