Personalized Mobile Patient Guidance System for Early Detection and Management of Metabolic Syndrome

TMP-23-226

Final Project Thesis – Individual

B M G Peiris

BSc (Hons) In Information Technology Specializing In Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka – **September 2023**

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Declaration, copyright statement and the statement of the supervisor

We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The supervisor/s should certify the proposal report with the following declaration. The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

…… ….10/09/2023….

Signature of the supervisor Date

Abstract

Metabolic syndrome is a group of related illnesses that can lead to catastrophic illnesses such as type 2 diabetes, heart disease, and stroke. It is caused by a genetically predisposed condition and environmental variables and is treated with drugs and lifestyle changes. AI-based health recommendation systems can help reduce the risk of delayed or ineffective treatment due to metabolic syndromes by providing tailored advice based on a person's medical history, lifestyle, and other health-related data. AI can be used to provide individualized advice, diet plans, customized food and physical activity advice, daily reminders, risk prediction algorithms, motivational messages, specialized guidance for fitness Persons, AI-powered analyzers, medication schedules and other lifestyle modifications, drug development, and creating more precise risk forecasts.AI systems can also be used to categorize patients into sub-categories based on their objectives and modify and improve their suggestions. Our system generates recommendations and suggestions based on 5 diseases, using Machine learning, Deep Learning and Artificial Intelligence, tacking technologies and goal setting tools. Collect patient information, analyze data, develop personalized recommendations, and identify patterns or trends to detect Metabolic Syndrome. Provide feedback and guidance, provide individualized recommendations, monitor, and adjust recommendations, and continuously track and update patient data to help manage Metabolic Syndrome. The recommendation system should be able to provide personalized food advice, suggestions for vigorous exercise, medication management advice, customer interaction, predicted analyses, and communications and reaction. It should also be able to classify individuals at risk of metabolic syndrome and offer preemptive advice to delay their emergence. Agile method emphasizes teamwork, client input, and adaptation to changing needs. The most important details in this text are that the project aims to make a mobile app for metabolic syndrome health assistance popular among people living in remote areas of Sri Lanka. I have shown in my result whether those concerned people have metabolic syndrome or not and what health recommendation suggestions should be given to those concerned people.

Key words – metabolic syndromes, recommendations and suggestions, AI, mobile app , diseases.

Acknowledgement

My research supervisors, Ms. Sanji Chandrasiri and Ms. Suriyaa Kumari, have my sincere gratitude for their assistance and supervision throughout the study. Ms. Sanji Chandrasiri and Ms. Suriyaa Kumari have been incredibly supportive and have given me the opportunity to investigate other approaches. They have also had some wonderful conversations on the study**.** Thank you to every one of the research groups. I will also remember their help with the specific topic assessment form and how I have used their great advice in recent weeks. I am grateful and thankful for my learning materials. I would like to convey my appreciation for their help and accessibility during my research work. Their expertise has helped me finish this proposal.

Finally, I would want to express my appreciation to everyone who has contributed their resources and expertise to assist me with this research.

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List of abbreviations

AI	American Indian
CF	Content based filtering
ACLS	Aerobics Center Longitudinal Study
CRF	Cardiorespiratory Fitness
METS	Metabolic Syndromes
IDF	International Diabetics Federation
SDG	Sustainable Development Goal
CVD	Cardiovascular disease
NCD	Noncommunicable disease
FAO	Food & agricultural organization
MAI	Mediterranean Adequacy Index
EHR	Electronic Health Record
DL	Deep Learning
HDL	High-Density Lipoprotein
LDL	Low-Density Lipoprotein

List of Appendix

1 INTRODUCTION

1.1Background

Metabolic syndrome is a dangerous disease that affect to the human body including five main factors and they are;

1. Waist measurement to assess abdominal obesity

2. Elevated levels of serum fasting triglycerides

3. Low HDL and high LDL levels

4. high blood pressure

5. Elevated levels of fasting plasma glucose

The risk of major clinical illnesses like cardiovascular disease, cancer, and form type of diabetes might be raised by metabolic syndrome, a collection of illnesses. There have been numerous tips and advice that could really help with controlling metabolic syndrome and lowering the possibility of serious consequences. Adopting healthy, balanced food plan rich in fruit and vegetables, whole carbohydrates, and controlling protein and minimal in saturated and trans fats is one key suggestion for controlling metabolic syndrome. Frequent exercise too is crucial since it lowers both cholesterol and blood pressure while enhancing glucose tolerance.

Weight loss through a mix of proper diet and higher levels of exercise can help persons who also are obesity enhance their metabolism. Furthermore, crucial are giving up cigarettes and controlling anxiety levels with workouts like relaxation techniques or meditation. A healthcare professional may also recommend drugs to treat excessive blood cholesterol, elevated pressure, and diabetes. Those with diabetes or prediabetes should also constantly review their levels of glucose in their blood. All in all, medical therapies targeted at lowering health conditions and enhancing general health are integrated with dietary modification to maintain metabolic syndrome. To maintain metabolic syndrome and lower the risk of major complications, a customized plan can be created with the assistance of a medical professional.

1.2 Literature Survey

Diabetes is on the rise among American Indian (AI) groups, which poses a significant public health risk. With concurrent improvements in excess weight and lower levels of exercise, the rate and frequency of diabetes have massively improved. In this article, they suggest a constructive approach for advising blood sugar level self-care to diabetics via artificial intelligence. Patients are encouraged to maintain a healthy routine to combat their blood sugar levels. They select smartphones as the platform to deliver intelligent personal care for AI individual patients to the almost universal usage of smartphones among the majority of AI tribes[1].

The system can provide tailored advice (for example, dietary patterns and regular exercise) according to the specific socioeconomic, social, as well as physiographic condition in general and especially to **Artificial intelligence - based** clients through embedding the existential resume of the Artificial intelligence-based customers with diagnostic obesity suggestions & recommendations. Mobile apps were used to achieve the proposed methodology. The efficiency of the system has been verified through research papers and classification and recognition confirmation.

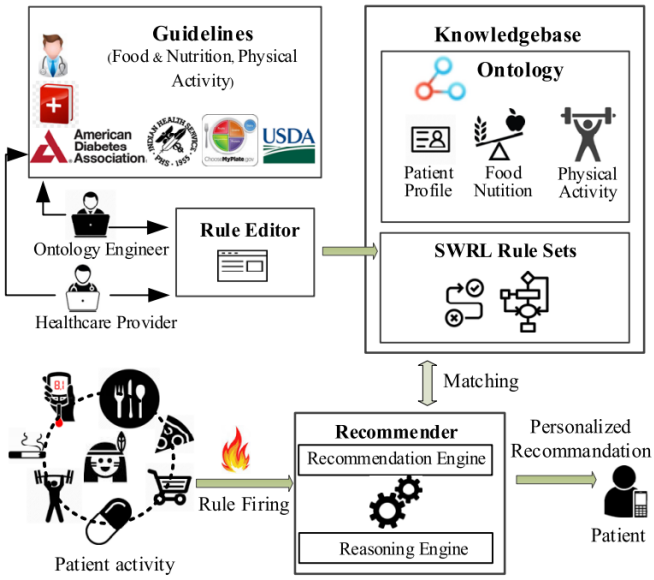


Figure 1:System of Customized Guidelines to Assist AIs' Diabetes Self-Management [1].

To offer greater individualized treatments for Automation people with diabetes, they presented an annotation review system. In Fig. 1.2.1, the evaluate the development is depicted. A set of semantic rule sets and an annotation centralized repository serve as the foundation of the suggested system. The semantic level of expertise enhances patient characteristics with details on their diseases, interests, ethnicities, socioeconomic backgrounds, and characteristics of the environment. Today, a variety of recommendation systems have emerged to provide consumers with helpful healthy lifestyle suggestions for taking part in a particular task that will enhance their well-being, according to their present physical well-being and a collection of information obtained from their past and the histories of all other consumers who are equivalent to each other. We divide decision support systems into three different groups according to the techniques they employ: machine learning-based, interactive spam detection, and regulation methods.

They used under methods as well,

Personalized health recommendation system based on machine learning

One of the fastest-growing technologies in the medical industry is machine learning. It offers significant advantages for better illness detection, analysis, and treatment. This offers significant advantages for better illness detection, analysis, & treatment. Numerous methods that utilize machine learning have been created to offer individualized guidance or therapies**[1].**

Design of this system

A thorough assessment of insulin control and therapy is necessary for a diabetic management system **[1]**.They thoroughly investigated public health recommendations from four different angles, including general recommendations for managing diabetes, dietary advice, exercise recommendations, and medical suggestions concerning artificial intelligence.

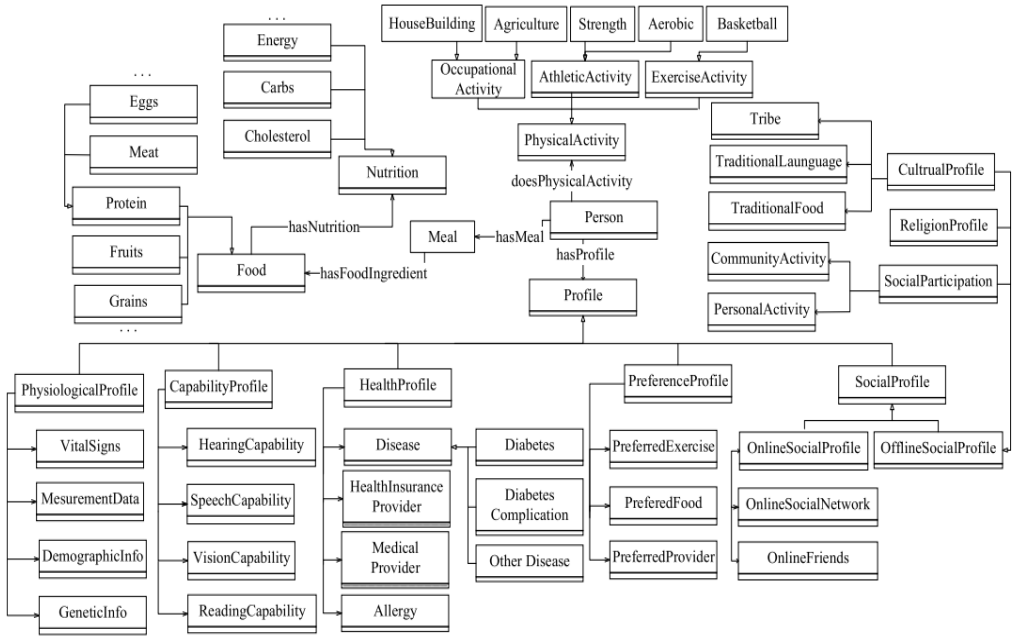


Figure 2:high-level ontology [1].

Person(?user)	^
Weight(?user,?w)	^
Height(?user, ?h)	^
Age(?user, ?age)	^
hasBMI(?user,?bmi)	^
Gender(?user,Male)	^
lessThan(?bmi,VeryActive)	^
swrlb:greaterThanEqual(?age,19)	^
swrlb:multiply(?t1,15.91,?w)	^
swrlb:multiply(?t2,?age,9.53)	^
swrlb:multiply(?t3,?h,539.6)	^
swrlb:add(?tmp,?t1,?t3,662)	^
swrlb:subtract(?eer,?tmp,?t2)	->
EER(?user, ?eer)	

Person(?user)	^
hasMeal(?user,?meal)	^
hasFat(?meal,?fat)	^
hasFatMaxLimit(?meal,?limit)	^
swrlb:greaterThan(?fat,?limit)	->
isRecommended(?meal, false)	

Figure 3:Estimated Power Need [1].

They had developed two primary types of SWRL regulations for this venture: integer arithmetic policies and health piece of advice guidelines. The integer arithmetic method gathers accessible established information using equations like mathematical operations to infer implicit messages, including such definitions and values. The formula above, for instance, determines an Exergy efficiency (Estimated Power Needed) for just a non-active older man. The guideline that promotes well-being makes suggestions depending on cause-and-effect reasoning. This guideline, for instance, determines if a human's meal has more fat than is permitted.

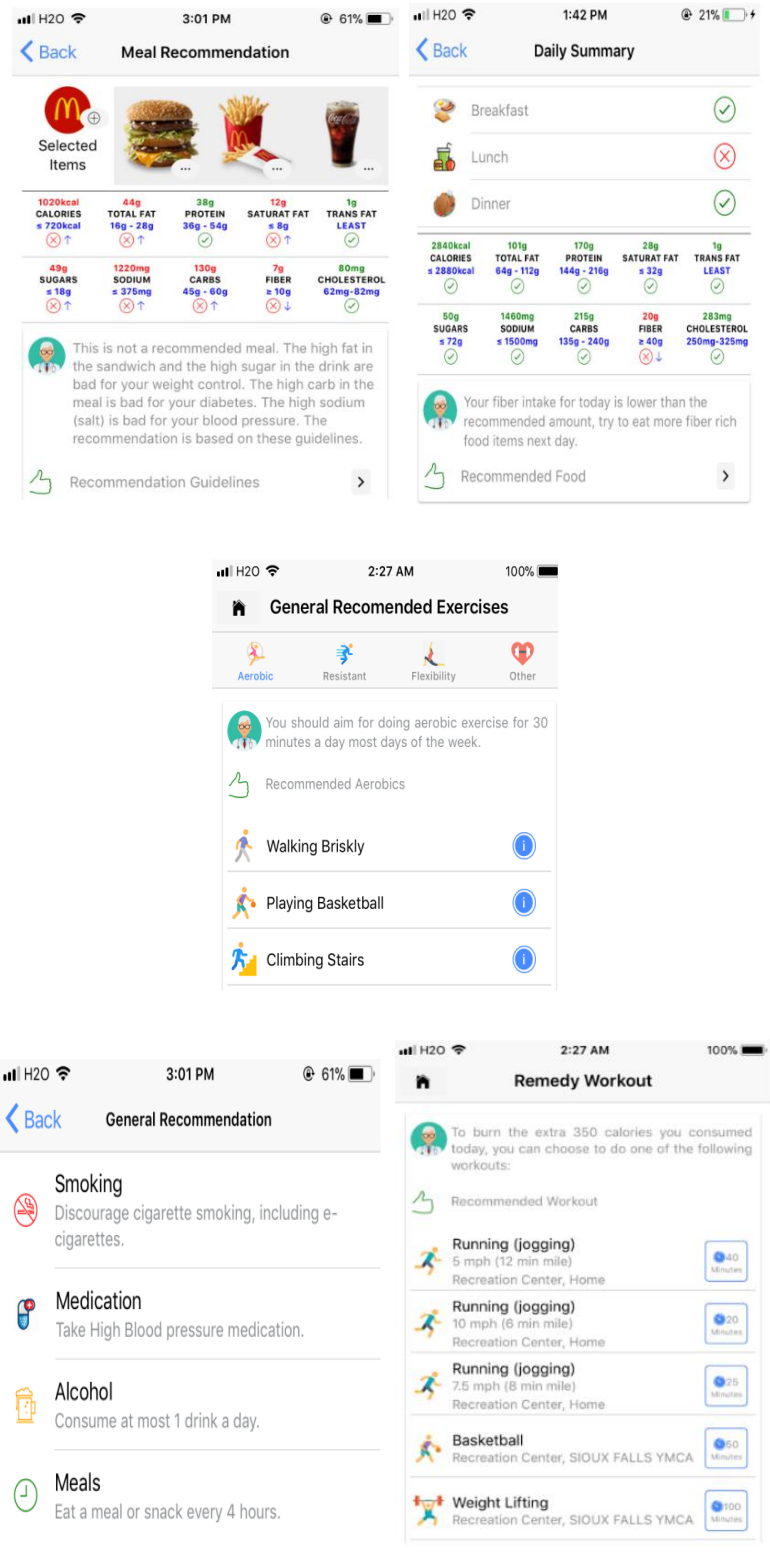


Figure 4:Some Screenshots of their Recommendation and suggestion System [1].

They found that in this cohort, the probability of getting Metabolic Syndromes increased with increasing BMI categories of normal weight, overweight, and obesity. This detected positive development resulted in a greater risk of mortality from all causes and CVD compared to males with body mass and metabolism. Nevertheless, when accounting for CRF, the greater risk of mortality was significantly reduced. despite one's body weight or the existence of Metabolic Syndromes, it seems that CRF has a neuroprotective effect against cardiac events. The quantity of exercise needed to get the amounts of CRF that were beneficial in this research is 30 min of moderate exercise on most days of the week, which is the amount of exercise presently suggested for wellness. Consequently, despite being overweight and having metabolic problems, our findings emphasize the value of continuing to lead an active lifestyle. Considering the increased risk of dying, individuals with low CRF levels should be the primary objective of health promotion efforts **[2] .**

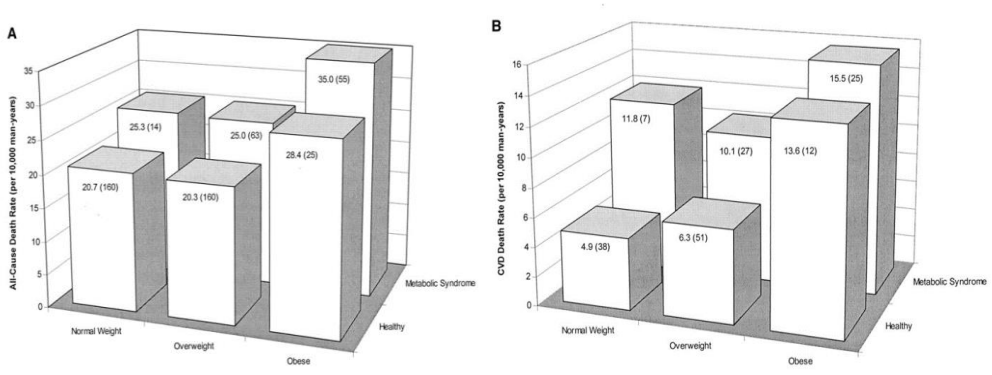


Figure 5:BMI level and death from all causes (A) and cardiovascular disease (B) in healthy men and men with Metabolic Syndromes in the ACLS[2].

When ages and testing years can be taken into account, the numbers in the bars represent the death rates per 10,000 person-years of follow-up, while the figures in parenthesis represent the actual body count. Men having Metabolic Syndromes showed a greater mortality risk than healthy individuals in each BMI range. Obese men had greater fatality rates than overweight and underweight men, regardless of their Metabolic Syndromes diagnosis.

	Normal weight			Overweight		
	Healthy	**MetS**	**Healthy**	**MetS**	**Healthy**	**MetS**
n	7,153	352	7,256	1,792	1,019	1,601
Age (years)	41.4 ± 10.0	47.0 ± 10.1	43.4 ± 9.3	46.8 ± 9.4	43.2 ± 9.3	44.9 ± 9.1
BMI (kg/m^2)	23.2 ± 1.3	23.7 ± 1.1	26.9 ± 1.3	27.7 ± 1.4	32.2 ± 2.4	33.2 ± 2.9
Waist circumference (cm)	85.4 ± 5.9	88.6 ± 5.5	94.7 ± 5.6	99.8 ± 6.1	107.1 ± 9.2	111.9 ± 9.2
Triglycerides (mmol/l)	1.11 ± 0.61	2.41 ± 0.92	1.39 ± 0.76	2.58 ± 1.11	1.37 ± 0.63	2.49 ± 1.11
HDL cholesterol (mmol/l)	1.27 ± 0.31	0.92 ± 0.17	1.19 ± 0.28	0.92 ± 0.21	1.19 ± 0.25	0.95 ± 0.22
Glucose (mmol/l)	5.38 ± 0.64	6.00 ± 1.14	5.47 ± 0.60	6.06 ± 1.38	5.50 ± 0.54	6.13 ± 1.52
Systolic blood pressure (mmHg)	117.2 ± 12.0	127.2 ± 12.9	119.1 ± 12.1	127.3 ± 13.0	121.1 ± 11.1	127.5 ± 12.7
Diastolic blood pressure (mmHg)	77.7 ± 8.7	85.5 ± 8.1	79.9 ± 8.7	86.3 ± 8.8	82.0 ± 8.8	87.1 ± 9.2
Maximal METs	13.0 ± 2.0	11.4 ± 2.0	11.8 ± 1.8	10.6 ± 1.6	10.6 ± 1.6	9.7 ± 1.5
Cigarette smoking (%)						
Never	50.9	40.1	44.2	39.7	43.9	39.6
Former	34.2	38.1	37.2	39.1	38.6	40.1
Current	14.8	21.9	18.6	21.3	17.6	20.3
Alcohol Use (%)						
None	25.3	29.3	23.6	28.1	29.6	32.2
Light	32.7	27.8	29.3	26.4	28.2	27.4
Moderate	22.4	17.6	21.6	19.2	18.8	17.0
Heavy	19.7	25.3	25.5	26.3	23.4	23.4
Possible CVD (%)‡	5.8	15.9	7.5	13.7	8.4	14.7

Table 1:screenshot of list of the general characteristics of 19,173 men first from ACLS who are average weight, overweight and obese[2].

3,745 men (19.5%) in the current sample of 19,173 men at the start were determined to have Metabolic Syndromes by NCEP standards. Table 1 provides the pattern's basic data. Among the groups of normal body weight

(4.7%), overweight (19.8%), and obesity (61.1%), the incidence of Metabolic Syndromes increased. As predicted, individuals with Metabolic syndrome were substantially older than healthy men in all BMI categories and had greater value for all physiological indicators (lower for HDL cholesterol) compared to those without the condition (P 0.05).

In the Metabolic syndrome category, there was also a higher percentage of smokers and heavy drinkers among men who were average weight and overweight (P 0.05), but just not obese men. The odds ratios (ORs) for the occurrence of Metabolic syndrome were 4.7 (95% CI 4.2-5.3) in overweight and 30.6 (26.7-35.0) in obese boys and men, according to cross-sectional logistic regression analysis of BMI category and Metabolic syndrome at the start, adjusting for the year of examination, smoked, and alcoholic use.

		All-cause mortality					Cardiovascular disease mortality
	Man-years of follow-up [*n* (%)]	Deaths (*n*)	RR of death (95% CI)*	CRF-adjusted RR of death (95%	Deaths (*n*)	RR of death (95% CI)*	CRF-adjusted RR of death (95% CI)‡
Normal weight							
Healthy	77,225 (39.4)	160	1.00 (ref.)	1.00 (ref.)	38	1.00 (ref.)	1.00 (ref.)
MetS	3,708 (1.9)	14	1.11 (0.64–1.92)	0.92 (0.53–1.60)	7	2.06 (0.92–4.63)	1.60 (0.71–3.61)
Overweight							
Healthy	73,569 (37.6)	160	0.94 (0.75–1.17)	0.79 (0.63–0.99)	51	1.27 (0.83–1.94)	1.00 (0.65–1.54)
MetS	17,860 (9.1)	63	1.09 (0.82–1.47)	0.80 (0.59–1.08)	27	1.80 (1.10–2.97)	1.19 (0.72–1.99)
Obese							
Healthy	9,281 (4.7)	25	1.31 (0.86–2.01)	0.88 (0.57–1.36)	12	2.70 (1.40–5.19)	1.59 (0.81–3.12)
MetS	14,140 (7.2)	55	1.55 (1.14–2.11)	0.93 (0.66–1.30)	25	2.83 (1.70–4.72)	1.43 (0.82–2.49)
CRF							
MetS	—	—	—	0.81 (0.77–0.86)	—	—	0.74 (0.67–0.82)

Table 2:screenshot of death rates from all causes and CVD in 19,173 men who had or did not have Metabolic syndrome who are obese, overweight, and average weight[2].

However ,The World Health Organization (WHO) reports that in 2016, more than 1.9 billion adults worldwide were overweight, with over 650 million of them being considered obese. Additionally, since 1975, the incidence of obesity has risen by more than threefold. It's vital to note that since my information cutoff in September 2021, these data may have modified .

In the past several decades, the obesity rate and metabolic disease have rapidly increased in emerging nations, raising the risk of CVD and the ensuing death and disability. The situation is made more challenging by the simultaneous occurrence of undernourishment and overfeeding in developing countries. Fast dietary change, rural-to-urban migration, sedentary jobs and lifestyles, and parental variables are some of the causes driving an increase in NCDs. Even though both genetic and natural factors appear to play a part, the influence of the environment seems to be more significant. Both children and adults need to receive the necessary health treatments to reduce or avoid illness and death**[7]** .

Author and year	Country	Sample (n)	Age range (yr)	Criteria for measuring overweight/obesity	Prevalence (%)
Hirschler *et al*., 2006 (235)	Argentina	321	4.39[a]	Overweight: BMI ≥ 85th percentile,	At risk of overweight: 19.0
				obesity: BMI ≥ 95th percentile	Overweight: 18.4
Silveira *et al*., 2006 (236)	Brazil	1420	14–19	Obesity/overweight: BMI ≥ 85th percentile	Overweight: 15.2
Liu *et al*., 2007 (237)	China	262,738	3.5–6.4	Overweight/obesity: age- and gender-specific BMI (IOTF)	Overweight & obesity: 7.4
Nunez-Rivas *et al*., 2003 (238)	Costa Rica	1718	7–12	Overweight: BMI ≥ 85th percentile	Overweight: 34.5
				Obesity: 7–9 yr: triceps skinfold ≥85th percentile for age and sex[b]	Obesity: 26.2
				10–12 yr: BMI ≥ 85th percentile and both triceps and subscapular	

Table 3:Table of overweight in children in underdeveloped nations[7]

Treatments must emphasize better eating habits, education programs, and increased physical exercise. Effective society treatment initiatives have been documented in affluent nations, and emerging nations must adopt a similar strategy. Descriptions of randomized experiments, particularly those geared toward kids, in both India and China had produced hopeful outcomes, but extensive initiatives including both adults and kids are needed. Other medical solutions, including those involving personal and group actions supported by administrative and regulatory actions, might also aid in reducing the rising incidence of obesity and metabolic disorders in emerging nations.

Age groups (yr)	Obesity (waist circumference)[a]	Triglycerides	HDL-C	Blood pressure	Glucose (mmol/liter) or known T2DM
6 to <10	≥90th percentile	Metabolic syndrome cannot be diagnosed, but further measurements should be made if there is a family history of metabolic syndrome, T2DM, dyslipidemia, CVD, hypertension, and/or obesity			
10 to <16	≥90th percentile or adult cutoff if lower	≥1.7 mmol/liter (≥150 mg/dl)	<1.03 mmol/liter (<40 mg/dl)	Systolic ≥130/diastolic ≥85 mm Hg	≥5.6 mmol/liter (100 mg/dl) [if ≥5.6 mmol/liter (or known T2DM) recommend an OGTT]
16+	Use existing IDF criteria for adults, *i.e.*				
	Central obesity (defined as waist circumference ≥94 cm for Europid men and ≥80 cm for Europid women, with ethnicity specific values for other groups[a])				
	plus any two of the following four factors:				
	• Raised triglycerides: ≥1.7 mmol/liter				
	• Reduced HDL-C <1.03 mmol/liter (<40 mg/dl) in males and <1.29 mmol/liter (<50 mg/dl) in females or specific treatment for these lipid abnormalities				
	• Raised blood pressure: systolic blood pressure ≥130 or diastolic blood pressure ≥85 mm Hg or treatment of previously diagnosed hypertension				

Table 4:Table of metabolic syndrome in kids and teens is defined by the IDF[7] .

Author and year	Country/region and urban/rural area	Age (yr)	Sample (n)		Cutoffs of BMI (kg/m^2) or waist circumference (cm)	Prevalence o obesity (%)	
			Male	Female		Male	Fema
Shapo *et al.*, 2003 (205)	Albania (Urban)[a]	>25	535	585	BMI ≥ 30	22.8	35.6
Monteiro *et al.*, 2001 (206)	Brazil[a]	>20	1971	2588	BMI ≥ 30	4.4	12.6
Zaman *et al.*, 2001 (207)	Bangladesh (rural)	>18	238	272	WC ≥ 94 (M), ≥80 (F)	2.9	16.8
Fezeu *et al.*, 2006. (36)	Cameroon (urban)	>25	1301	1530	WC ≥ 94 (M), ≥80 (F)	18.0	67.0
Du *et al.*, 2002 (208)	China[a]	18–49	2796	2936	BMI ≥ 25	15.3	17.1
Gu *et al.*, 2005 (40)	China[a]	35–74	15540[b]		BMI ≥ 25	26.9	31.1
Jadue *et al.*, 1999 (209)	Chile[a]	24–64	1020	2100	BMI ≥ 30	15.7	23.1

Table 5:Table of overweight incidence in underdeveloped nations[7]

According to the Global Financial Forecast Report of the International Financial Services Authority, published in April 2008, developing nations have been classed. The keywords overweight, insulin, metabolic disease, diabetes, cholesterol, diet, activity level, and developing nations were used to look up research from 1966 to June 2008 in the big dataset PubMed (The National Library of Medicine, Bethesda). From the retrieved papers, a manual search of the pertinent cited references was also done. Also, information was gathered from dietary evaluations conducted in various developing nations as well as from the world health organization and the Agriculture and Food Institution's sites and published materials (FAO). It's critical to remember that despite thorough literature searches, information on overweight as well as metabolic disease is not easily accessible **[7]**.

Persons in the modern age deal with busy, busy lifestyles on a routine basis. Encouragement of individuals to choose or maintain healthier choices to lower their chance of getting chronic diseases is thus one of the current societal major challenges. Therefore, it is crucial to attract and inspire citizens with healthy behaviors that are customized to their best interest to safeguard good health from a precautionary standpoint, which is aligned with the pursuit of Sustainable Development Goal (SDG) 3 "health and well-being" as this will start serving as a major driver in the procedure. This has been one of the causes for the current developments in studies toward health recommender systems, notably in the areas of food and exercise. Whenever they establish daily exercise as a routine, it has a significant impact on both their emotional and physical wellness. Just 21% of persons in the United States over the age of 21 adhere to the Disease Control and Prevention's recommendations for vigorous exercise**[8]**.

Even though being conscious of these recommendations for physical activity, people nevertheless frequently fall short of their targets for a variety of causes, such as a lack of gym and a lack of understanding of the value of regular exercise. With the recent introduction of fitness apps as well as other portable gadgets like smartwatches and wristbands, sensors can now accurately record and communicate information about people's regular exercise. In this research, the authors illustrated how wearable technology and mobile apps can monitor movements. The additional investigation established the accuracy of these gadgets' step estimates. Previous research used sensor readings to precisely categorize different body motions, including lying, jogging, and lying**[8]**.

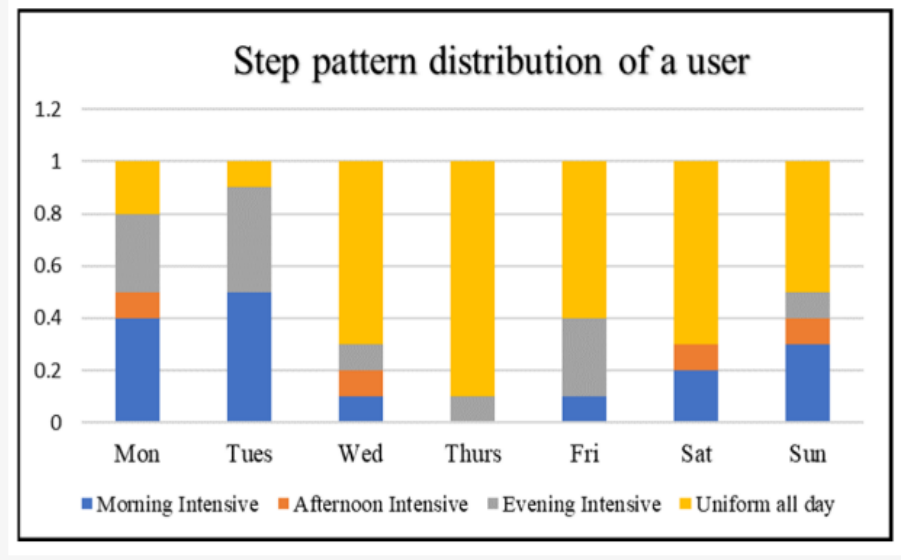


Figure 6:screenshot of the patient's weekly average of daily steps taken[8].

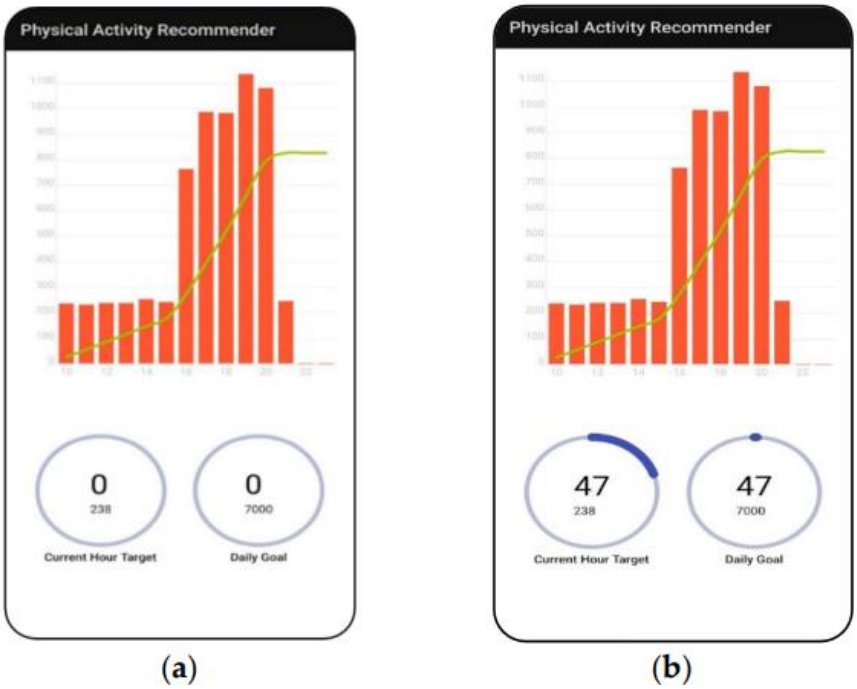


Figure 7:screenshot of a) suggested exercise schedule, b) progress monitor for steps[8].

The application opens daily step objective is represented by the left circular toolbar, and their daily movement objective is represented by the circular navigation bar. The smooth curves & graphs are generated automatically based on the time of day. The arc shows the mean step objective for each hour, while the graph displays the daily step counting goal for the hours needed. A specific suggestion to the individual user on the pattern inside the prior week has been made using the patient's daily step count that is kept in the Present in significant amounts. Demonstrates the step-counting status monitor, which records the user's steps via tracker sensors. To reduce user interaction, this program operates quietly. The prediction model provides information about the daily steps, movement differential, and total movements after each period of the day in addition to additional characteristics.

Users want the applications to make recommendations regarding their actions depending on how they are feeling **[6]**. The recommendations may be items that are already included in the application, like perusing uplifting articles, receiving health advice, or keeping up with the latest information, or they might be items that customers have already enjoyed or marked as items that have succeeded for them.

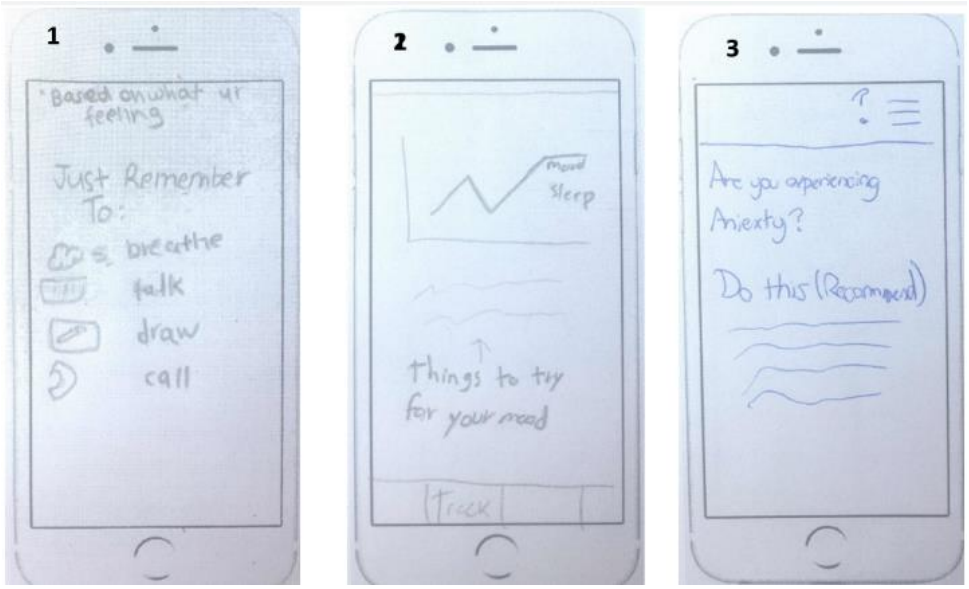


Figure 8:screenshot of (1) advise activities should focus on the input emotions, (2) make advice to elevate mood according to information gathered, (3) offer broad recommendations [6].

Some recommendation plans they had used;

Offering breathing techniques.

The application might include methods for symptom treatment such as relaxation techniques, meditation, writing down thoughts, a feature for forgiving others, and a remorse tool. Some individuals questioned the value of the regret option because it would make them recall bad or depressing events, but it wouldn't improve their mood. I wish to record my ideas. Recording stuff gives you the impression that you were talking to somebody else when you need someone to talk to about your anxiousness. I want to add a tool that allows us to forgive those who have wronged us every month.

Some few simple videogames

Members thought the application's contents should have been entertaining and engaging, therefore they built in activities to various designs. Just on the main page, there are 4 symbols in each of the primary classifications, which included a gaming symbol.

Offering soothing music

The concept of having a calming voice, such as song, ambient noises, and worshiping and religious audio files, was highly rated by respondents **[6].**

Health and lifestyle are important factors that affect both good health and disease, disability, and even premature death. The current urban lifestyle is characterized by insufficient physical activity, junk food, and excessive stress levels, all of which undermine people's well-being. Long-term effects of this lifestyle include health issues and diseases like diabetes, high blood pressure, obesity, strokes, and cardiovascular disease. This wellness app can learn about the subject, categorize her or him by analyzing some of her or his unique traits (physical attributes and lifestyle), and provide tailored recommendations to improve her or his well-being. By tracking the evolution of the defined features over time, the application can also provide feedback on their efficacy and act as a motivator for the client to pursue their wellness objectives**[9]**. **utilizing goals setting tools** - This is done to persuade them to

choose to change their behavior or to keep it changed. This is accomplished through the employment of a reasoning module, which evaluates the wellness performance indicators and determines what kinds of recommendations are required to guide the user toward the adoption of appropriate behaviors. For instance, if the Time spent per Week on Physical Activity Index is too low about recommendations, the app can advise increasing the amount of time spent engaging in physical activity.

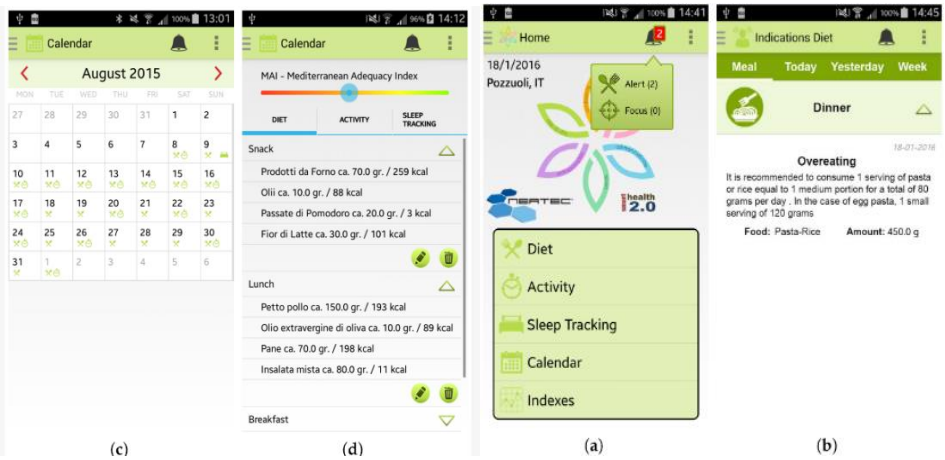


Figure 9:screenshots of the wellness app(a)dashboard, (b)insert the new meal , (c)calendar , (d)all details [9].

The Wellness App's primary menu is accessible once the user has entered his or her information. By choosing, for instance, the special option "Diet" from the main menu, as seen in Figure 1.2.10a, the user can enter details about a new meal. The software offers a straightforward user interface to make interacting with it easier when adding new data possible. For instance, as seen in Figure 1.2.10b, some pre-set quantities have been offered to facilitate the quick inclusion of new meal data. There are a few examples of the types of foods that can be entered into the Wellness App as meals in . Based on the entered meals, the Wellness App automatically calculates the Mediterranean Adequacy Index (MAI) every day and every week.

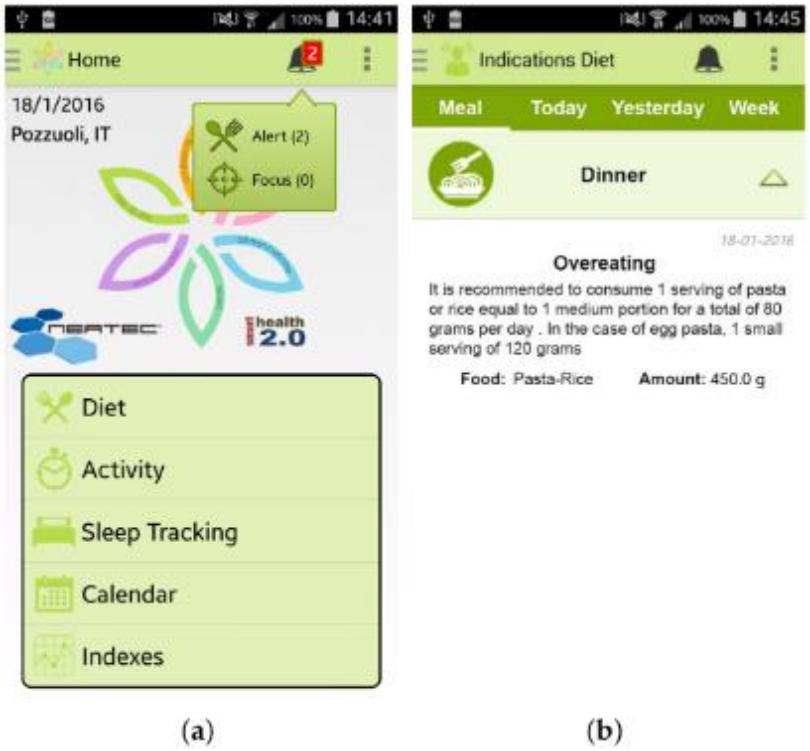


Figure 10:screenshots of the wellness app.(a)the main menu when the alert is notified (b)detailed view of the notification[9].

Utilizing routinely gathered EHR data, the created artificial intelligence model based on DL demonstrated good exclusionary capabilities for forecasting laboratory studies. The use of DL methods can help patients choose the best laboratory tests, which could enhance patient safety.

Further research is advised to determine whether using this model in actual healthcare situations will be an expense **[10].**

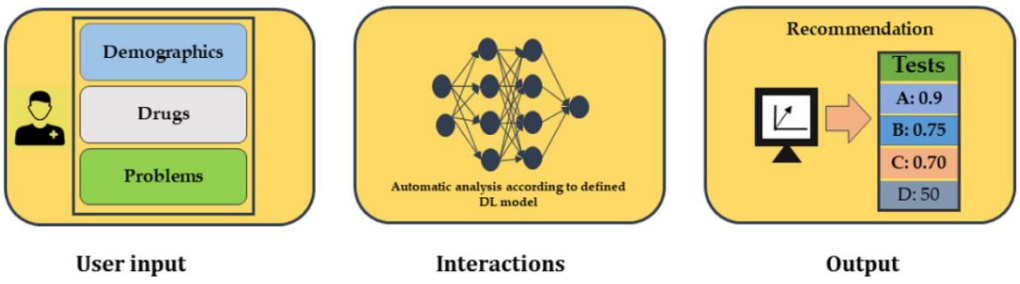


Figure 11:screenshot of Proposed infographic recommendation tool using deep learning [10].

The goal of this work was to create an automated artificially intelligent model that can prescribe laboratory studies based on straightforward factors found in EHRs.

1.3 Research Gap

Many models for recommendation systems for metabolic syndromes have been used in past research papers. However, it has some problems. I can also introduce novelties in advance. The literature review indicates that the identification of the issue with the existing system has been greatly aided by earlier studies. There are many drawbacks to not having an appropriate recommendation system for metabolic syndromes:

1. Clients may well not get an actual diagnosis or treatment services in the absence of a sound recommender. This can result in the metabolic syndrome being treated too slowly or ineffectively, which can cause major side effects like heart illnesses and strokes.[2],[3],[8]
2. Without a recommender, patients could not get the right care that is suited to their particular needs. Poor treatment results, such as inefficient patient care, insufficient management of risk variables, and lower quality of life, may result from this.[3],[8]
3. Without a mechanism for making recommendations, health professionals would find it difficult to recognize and effectively treat metabolic syndrome. Due to lengthier hospitalizations, repeated physician appointments, and pointless medical testing, this may result in higher healthcare expenses[7],[10]
4. With the right recommender, people can get instruction on managing their medications as well as lifestyle changes like diet and exercise. Users might not completely comprehend the value of controlling metabolic syndrome or the best way to do so in an efficient manner without this instruction.[2]
5. Not user-friendly [7],[11].
6. Not user attractive [9], [1].

I have planning offer some essential ways to apply my part.

I have planned to apply,

- individualized advice
- diet plans
- Customized food and physical activity advice (With AI, nutritional and activity advice can be created or customized for those with metabolic syndrome. Ai systems can produce specialized suggestions by examining patient data, including biological details, metabolic profiles, and activity levels, and taking into consideration each person's particular needs and preferences.)
- daily reminders.
- AI-based risk prediction algorithms (AI can be utilized to construct appropriate risk forecasting models for prediabetes. These algorithms can combine a wide range of patient data, including demographic data, lifestyle factors, and biomarkers, to give tailored risk evaluation and inform prevention treatments.)
- inspirational messages
- specialized guidance for fitness Persons.
- AI-powered analyzer (Compared to conventional approaches, AI can aid in the earlier and more precise diagnosis of metabolic syndrome. Ai systems, for instance, can examine MRI or CT scans of the body to look for indicators of illnesses connected to metabolic syndrome, including a condition known as fatty liver.)
- medication schedules and other lifestyle modifications.
- AI-based drug development (AI can be used to find novel medications or reuse ones that are already on the market to treat obesity in metabolic syndrome. For instance, AI systems can examine enormous chemical collections to find those with potential therapeutic qualities or can find new pharmacological targets according to the established biological mechanisms of medical therapies.)
- the system will be able to modify and improve its suggestions.
- Creating more precise risk forecasts (By examining massive data of medical and genetic data, Ai systems can be utilized to create more precise risk statistical models) by using **goal-setting tools and tracking technologies.**

	Previous	Our system
Used technologies and predicting disease.	Only using Deep learning or Machine learning [8],[11],[12] and electronic health records to diagnose disease [10].	Using **Machine learning, Deep Learning and Artificial Intelligence, tacking technologies and goal setting tools.**
Scalability range	previous mobile apps give health recommendations based only one disease [1],[11],[12].	My system gives health recommendations based **5 diseases including.** • **Low HDL and high LDL levels (Cholesterol)** • **Abdominal obesity** • **elevated triglycerides level** • **high blood pressure** • **Elevated plasma glucose level.**
Predicting the weight of the disease	Not used proper predicting method [12].	My system Gives health recommendations and suggestions based on the risk Weight of the prediction. **Found five accurate formulas with the special doctors and nutritionists** to predict the weight of the disease. **ABDOMINAL OBESITY** Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((Weight Value >= Weight Threshold) * Weight Weight) +((Height Value >= Height Threshold) * Height Weight) **CHOLESTOROL LEVEL** Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((fbs Value >= fbs Threshold) * fbs Weight) +((thalach Value >= thalach Threshold) * thalach Weight) **HIGH BLOOD PRESSURE** Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((fbs Value >= fbs Threshold) * fbs Weight) +((thalach Value >= thalach Threshold) * thalach Weight) **HIGH BLOOD SUGAR** Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((BMI Value / BMI Threshold) * BMI Weight) + ((Glucose Value >= Glucose Threshold) * Glucose Weight)

Use predicting Levels.	Past research did not use proper predicting levels	**TRYGLISARIDE LEVE** Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((BMI Value / BMI Threshold) * BMI Weight) +((TG Value >= TG Threshold) * TG Weight) **In my system gives suitable health recommendations from using Low , Medium and High levels .** ❑ low than (-2.5) = give low health recommendations ❑ (-2.5) to (4.0) = give medium health recommendations ❑ more than (4.0) =give high health recommendations — Abdominal obesity ❑ low than 15 = give low health recommendations ❑ 15-25 = give medium health recommendations ❑ more than 25 =give high health recommendations — Cholesterol ❑ low than 15 = give low health recommendations ❑ 15-25 = give medium health recommendations ❑ more than 25 =give high health recommendations — High blood pressure ❑ low than 15 = give low health recommendations ❑ 15-25 = give medium health recommendations ❑ more than 25 =give high health recommendations — High blood Sugar ❑ low than 15 = give low health recommendations ❑ 15-25 = give medium health recommendations ❑ more than 25 =give high health recommendations — Triglyceride level

Table 6:table of Differences between previous research and our system

1.4 Research Problem

The term "metabolic syndrome" refers to a group of related illnesses, such as high blood pressure, high blood sugar, excess body fat around the waist, and excessive cholesterol or serum triglycerides, rather than a single disease. The biggest issue with metabolic syndrome is how much more likely it makes people get catastrophic illnesses like type 2 diabetes, heart disease, and stroke. Significant disability, a decline in quality of life, and early mortality can all result from these illnesses. Also, individuals with metabolic syndrome frequently have insulin resistance, which indicates that their systems have trouble adequately utilizing insulin, resulting in elevated blood sugar levels and a higher risk of developing insulin. Although the precise cause of the metabolic syndrome is unknown, it is thought to be a result of a genetically predisposed condition as well as environmental variables such as poor diet, inactivity, and obesity. Metabolic syndrome is often treated with drugs to control specific risk factors, such as high blood pressure or high cholesterol, as well as lifestyle changes like increased exercise and a nutritious diet.

A lack of appropriate ideas and recommendation systems for metabolic syndrome can result in several problems, such as:

1. Accurate diagnosis is more likely without an AI-based health recommendation system, which increases the risk of delayed or ineffective treatment. This can significantly worsen a patient's health state and perhaps lead to fatalities.

2. Because everyone has different health needs, a one-size-fits-all approach to healthcare is ineffective. Based on a person's medical history, lifestyle, and other health-related data, an AI-based health recommendation system can offer tailored advice.

3. Due to their numerous duties, doctors and other medical experts may not have enough time to thoroughly review the available medical data and formulate the most appropriate suggestions. Large amounts of data can be promptly analyzed by an AI-based health recommendation system to give healthcare professionals pertinent insights and recommendations.

4. Healthcare practitioners may rely on trial-and-error techniques that can result in expensive and needless testing and treatments in the absence of an AI-based health recommendation system. By offering more precise and effective diagnoses and treatment plans, artificial intelligence can help lower healthcare expenses.

5. The lack of AI-based health recommendation systems can make access to healthcare in some locations even more difficult. Patients in places without access to medical facilities or staff can receive remote diagnosis and treatment thanks to AI-based technologies.

Some Real world health issues :

- Cardiovascular disease: The chance of developing cardiovascular diseases, such as heart disease and stroke, is increased by metabolic syndrome. This is due to the possibility of blood vessel damage and atherosclerosis when high blood pressure, high blood sugar, and abnormal cholesterol or triglyceride levels are present[11].

- Diabetes type two - Metabolic syndrome poses a considerable risk for the onset of diabetes type two. The metabolic syndrome's high blood sugar levels can eventually cause insulin resistance and diabetes[13].

- Non-alcoholic fatty liver disease (NAFLD) [5] - The metabolic syndrome is linked to a higher chance of developing NAFLD, a condition in which extra fat accumulates in the liver. This may result in liver scarring and inflammation, which could ultimately cause liver failure.

- Sleep apnea- Metabolic syndrome is associated with a higher chance of developing this illness, which causes frequent pauses in breathing while you sleep. This may result in unsatisfactory sleep and other health problems[14].

- Chronic kidney disease and end-stage renal disease are two kidney diseases that are more likely to occur as a result of metabolic syndrome.[12],[4].

- Heart failure is one of the metabolism syndrome's most prevalent side effects. Cardiovascular disease, which can cause a stroke or heart attack, is more likely to occur in those with metabolic syndrome. Almost 650,000 Americans lose their lives to cardiovascular disease each year in the U.S., according to the American Heart Association.[11]

As a result, it's critical to have appropriate metabolic syndrome suggestions and suggestion systems to enhance health outcomes, raise awareness, deliver effective treatment, enhance the quality of life, and save healthcare costs.

High blood pressure, excessive blood sugar, increased body fat around the waist, and abnormal cholesterol or triglyceride levels are all symptoms of metabolic syndrome. A higher risk of cardiovascular disease, type 2 diabetes, and early death is linked to metabolic syndrome. Depending on the population and the particular illness under consideration, different metabolic syndromes have different fatality rates. For instance, it is thought that around one-third of adults in the United States have metabolic syndrome, which is linked to a higher risk of death. According to a 2019 study that was published in the Journal of the American College of Cardiology, people with metabolic syndrome had a 1.5 to 2 times higher chance of developing cardiovascular disease and a 1.2 to 1.5 times higher risk of dying from any cause[11].

The fatality rate from type 2 diabetes[13], which is strongly related to metabolic syndrome, was shown to be 2.5 times higher in women and 2.4 times higher in men when compared with the overall population, according to a 2015 study published in the journal Diabetes Care[13]. Overall, the high mortality rates related to metabolic syndrome highlight the significance of treating this disease with dietary modifications and medicinal therapies.

2. OBJECTIVES

2.1 Main Objective

Giving persons with metabolic disorders individualized advice and support is the primary goal of the suggestions and recommendation function. To properly manage the complex and multifaceted illness known as metabolic syndrome, a comprehensive strategy is needed. Suggestions and ideas can assist people in understanding their condition, choosing the best lifestyle adjustments, and getting the right medical care using goal-setting tools and tracking technology**.**

Ex: solving many health problems of people in remote areas in Sri Lanka based on metabolic syndromes. Specially, Monaragala, Puttalam, Batticaloa.

2.2 Specific Objectives

1. Suggestions and recommendations can assist people in identifying their metabolic syndrome risk factors and taking action to stop the disorder from progressing or developing.

2. Management of the metabolic syndrome must be customized to take into account each patient's particular risk factors and requirements. Suggestions and recommendations can offer specific information on dietary and exercise changes, medication use, and other lifestyle adjustments.

3. Managing metabolic syndrome correctly can lower the risk of contracting serious illnesses like type 2 diabetes, heart disease, and stroke. Individuals can manage their conditions more successfully with the support of recommendations and ideas, which can enhance health outcomes.

4. Suggestions and ideas can assist people in understanding their disease and the lifestyle adjustments required to manage it. This could result in better self-management and the prevention of metabolic syndrome by raising awareness and educating people about the problem.

5. Using goal-setting tools and tracking technologies, offer individualized advice on exercise and diet. To encourage adherence to the health plan, provide daily reminders and inspirational messages

3.METHODOLOGY

3.1 Collect patient information.

made the registration or onboarding process user-friendly. designed screens that allowed users to enter their personal and medical data. Validate input to guarantee accurate data entry. tooltips or instructions were given for each field to help users enter accurate data. For each type of data (age, weight, height, etc.), the proper input type was used (text fields, number fields, dropdowns).

3.2 System displays disease status.

System will display status of the **highest risky disease** and system also shows whether the **person has metabolic syndrome or not.** opted for a reliable database solution to safely store user data. created a database structure to support user profiles, health metrics, and other pertinent data. To safeguard sensitive data, such as passwords, encryption and hashing techniques were implemented. to prevent unwanted access, established practices for database security were followed.

3.3 Calculate weight of above disease using this highest risky disease.

Depending on the information provided by the user, developed algorithms to determine the risk factors for each condition. analyzed the generated risk scores to identify the disease with the highest risk. Displayed the risk factor levels and if the user matched the requirements for metabolic syndrome using simple graphic components.

3.4 Display the weight of above disease.

Give each risk factor a weight to represent how important they are in causing metabolic syndrome. For instance, if abdominal obesity was determined to be the greatest risk factor, a larger weight was allocated to it. Combining the weighted risk factors, an overall "weight" for the disease with the highest risk was determined. The determined weight of the disease with the highest risk was shown on the interface. used a number, a bar graph, or a visual representation to denote the seriousness. Included a succinct explanation of the meaning and consequences of this weight.

3.5 Using this weight calculate if weight is Low or High or Medium.

On the user's profile or dashboard, displayed the calculated weight of the highest-risk disease. Used numerical values to predict the weight of the disease.

Defined thresholds for categorizing risk levels (low, medium, high) based on the calculated disease weight.

<u>for abdominal obesity person:</u>

low than (-2.5) = give low health recommendations
(-2.5) to (4.0) = give medium health recommendations
more than (4.0) =give high health recommendations

for High triglycerides person:
low than 15 = give low health recommendations
15-25 = give medium health recommendations
more than 25 =give high health recommendations

for Cholesterol person:
low than 15 = give low health recommendations
15-25 = give medium health recommendations
more than 25 =give high health recommendations

for high blood pressure person:
low than 15 = give low health recommendations
15-25 = give medium health recommendations
more than 25 =give high health recommendations

for diabetic person:
low than 15 = give low health recommendations
15-25 = give medium health recommendations
more than 25 =give high health recommendations

3.6 Finally, system will generate health diet plans and exercise plans.

worked together to create individualized diet and exercise plans with nutritionists and fitness professionals. designed a questionnaire or dynamic form to gather extra data, such as dietary requirements, allergy information, and exercise objectives. customized the recommendations based on the user's risk level and particular risk variables. presented the plans in an understandable manner, potentially with meal planning, recipe ideas, and exercise guidelines.

Throughout the process of development:

- Given top priority to data security and user privacy.
- Made sure the user interface was fluid and clear.
- Consistently updated the app to include fresh medical knowledge.
- sought the assistance of medical experts to provide proper health advice.
- extensively tested the app to find and fix any bugs or usability problems.

I applied →

Patient Age range	highest risky disease	Weight of the highest risky disease	Scalability	Health Recommendation for highest risky disease
10-15 years 16-35 years 36-50 years More than 50 years	Low HDL and high LDL levels (Cholesterol)	May be 1% or 99% or 0.5% or any other value.	Low Middle high	Food recommendation Exercise recommendations
10-15 years 16-35 years 36-50 years More than 50 years	High level of Triglycerides level	May be 1% or 99% or 0.5% or any other value.	Low Middle high	Food recommendation Exercise recommendations
10-15 years 16-35 years 36-50 years More than 50 years	Abnormal obesity	May be 1% or 99% or 0.5% or any other value.	Low Middle high	Food recommendation Exercise recommendations
10-15 years 16-35 years 36-50 years More than 50 years	High blood pressure	May be 1% or 99% or 0.5% or any other value.	Low Middle high	Food recommendation Exercise recommendations
10-15 years 16-35 years 36-50 years More than 50 years	High blood suggar	May be 1% or 99% or 0.5% or any other value.	Low Middle high	Food recommendation Exercise recommendations

Table 7:The System plan of the Recommendation Component

In our system gives diet plans and exercise plans only more than 10 years old persons. In age range: If the person Less than 10 years old, system displays this message, *"If the person Less than 10 years old, you must get the medical advice and meet your doctor."*

3.7 Expected sample UI

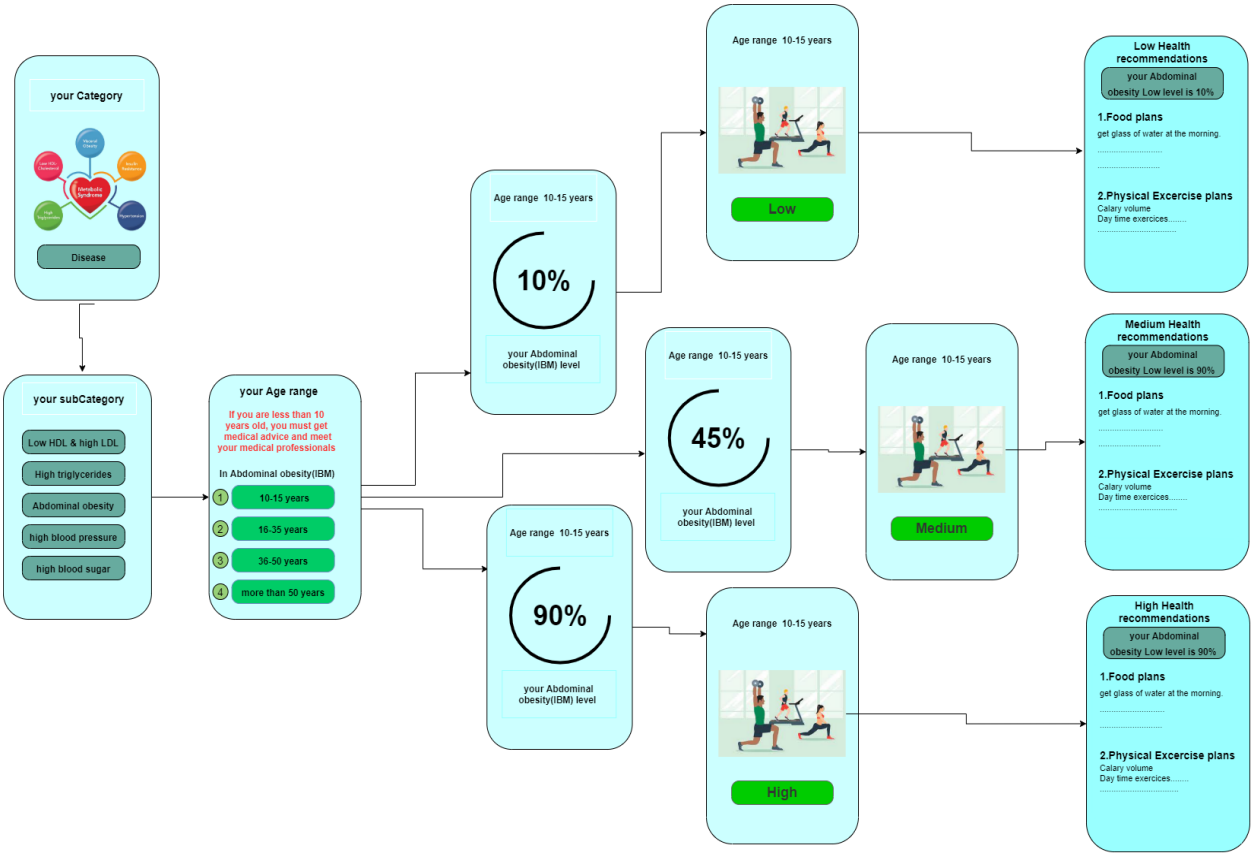


Figure 12:Entire System sample output UI

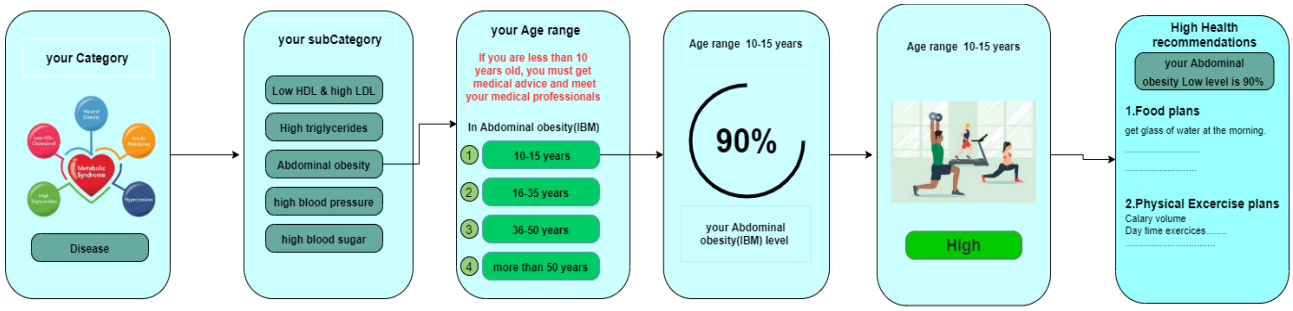


Figure 13:One side System sample output UI

3.8 Backend Logic

How to find Five accurate Formulas?

ABDOMINAL OBESITY

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((Weight Value >= Weight Threshold) * Weight Weight) + ((Height Value >= Height Threshold) * Height Weight)

- ✓ Age: 30 Weight: 55kg [patient input data]
- ✓ Height: 55cm [patient input data]

Age:

- 10-15 years: Threshold = 10, Value = 1
- 16-35 years: Threshold = 16, Value = 2
- 36-50 years: Threshold = 36, Value = 3
- More than 50 years: Threshold = 50, Value = 4

- Age Value = 2
- Age Threshold = 16
- Age Weight = 30 [patient input data]

- Height Weight = 55cm [patient input data]
- Height Threshold = 70cm
- Height Value = 0

(If the Height that entered by the patient is less than 70cm, the Height value is 0. If the Height that entered by the patient is greater than 70cm, the Height value is 1)

- Weight Weight = 55kg [patient input data]

- Weight Threshold = 81kg
- Weight Value = 0

(If the weight that entered by the patient is less than 81kg, the weight value is 0. If the weight that entered by the patient is more than 81kg, the weight value is 1)

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((Weight Value >= Weight Threshold) * Weight Weight) + ((Height Value >= Height Threshold) * Height Weight)

Percentage Rate = ((2 / 16) * 30) + ((0 >= 81)*55) + ((0 >=70)*55)

= (0.125 * 30) + 0 + 0

= 3.75 + 0 + 0

= 3.75%

- ❑ low than (-2.5) = give low health recommendations
- ❑ (-2.5) to (4.0) = give medium health recommendations
- ❑ more than (4.0) =give high health recommendations

there fore 3.75% is medium health recommendations.

CHOLESTEROL LEVEL

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((thalach Value >= thalach Threshold) * thalach Weight) + fbs Value

- ✓ Age: 60 [patient input data]
- ✓ Maximum Heart Rate (thalach): 170 [patient input data]
- ✓ Fasting Blood Sugar (fbs): 1 [patient input data]

Age:

10-15 years: Threshold = 10, Value = 1

16-35 years: Threshold = 16, Value = 2

36-50 years: Threshold = 36, Value = 3

More than 50 years: Threshold = 50, Value = 4

- Age Value = 4
- Age Threshold(measuring stick) = 50
- Age Weight = 60 [patient input data]

- thalach value=0
- thalach Threshold(measuring stick) = 180
- thalach Weight = 170 [[patient input data]

If the thalach value entered by the patient is less than 180, the thalach value is 0. If the thalach value entered by the patient is more than 180, the thalach value is 1.

- fbs Value = 1 [patient input data]

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((thalach Value >= thalach Threshold) * thalach Weight) + fbs Value

Percentage Rate = ((4 / 50) * 60) + ((0 >= 180) * 170) + 1

= (0.08 * 60) + (0 * 170) + 1

= 4.8 + 0 + 1

= 5.8%

- low than 15 = give low health recommendations
- 15-25 = give medium health recommendations
- more than 25 =give high health recommendations

there fore 5.8% is low health recommendations.

HIGH BLOOD PRESSURE

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((thalach Value >= thalach Threshold) * thalach Weight) + fbs Value

- ✓ Age: 60 [patient input data]
- ✓ Maximum Heart Rate (thalach): 170 [patient input data]
- ✓ Fasting Blood Sugar (fbs): 1 [patient input data]

Age:

10-15 years: Threshold = 10, Value = 1

16-35 years: Threshold = 16, Value = 2

36-50 years: Threshold = 36, Value = 3

More than 50 years: Threshold = 50, Value = 4

- Age Value = 4
- Age Threshold(measuring stick) = 50
- Age Weight = 60 [patient input data]

- thalach value=0
- thalach Threshold(measuring stick) = 180
- thalach Weight = 170 [[patient input data]

If the thalach value entered by the patient is less than 180, the thalach value is 0. If the thalach value entered by the patient is more than 180, the thalach value is 1.

- fbs Value = 1 [patient input data]

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((thalach Value >= thalach Threshold) * thalach Weight) + fbs Value

Percentage Rate = ((4 / 50) * 60) + ((0 >= 180) * 170) + 1

= (0.08 * 60) + (0 * 170) + 1

= 4.8 + 0 + 1

= 5.8%

- ❑ low than 15 = give low health recommendations
- ❑ 15-25 = give medium health recommendations
- ❑ more than 25 =give high health recommendations

there fore 5.8% is low health recommendations.

HIGH BLOOD SUGAR

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((Glucose Value >= Glucose Threshold) * Glucose Value)

- ✓ Age:40 [patient input data]
- ✓ Glucose level:170 [patient input data]

Age:

10-15 years: Threshold = 10, Value = 1

16-35 years: Threshold = 16, Value = 2

36-50 years: Threshold = 36, Value = 3

More than 50 years: Threshold = 50, Value = 4

- Age Value = 3
- Age Threshold = 36
- Age Weight = 40 [patient input data]

- Glucose Value = 1 (glucose level is equal or above the 100)
- Glucose Threshold = 100

Percentage Rate = ((Age Value / Age Threshold) * Age Weight) + ((Glucose Value >= Glucose Threshold) * Glucose Value)

Percentage Rate = ((3 / 36) * 40) + ((1 >= 100) * 1)

= (0.0833 * 40) + (0 * 1)

= 3.33 + 0

= 3.33%

- ❑ low than 15 = give low health recommendations
- ❑ 15-25 = give medium health recommendations
- ❑ more than 25 =give high health recommendations

there fore 3.33% is low health recommendations.

TRYGLISARIDE LEVE

Percentage Rate = ((Age Value / Age Threshold) * 100) + ((BMI Value / BMI Threshold) * 100)

- ✓ Age: 40 [patient input data]
- ✓ BMI: 27.2 [patient input data]

Age:

10-15 years: Threshold = 10, Value = 1

16-35 years: Threshold = 16, Value = 2

36-50 years: Threshold = 36, Value = 3

More than 50 years: Threshold = 50, Value = 4

Age: 40 years (36-50 years)

- Age Value = 3
- Age Threshold = 36

When looking for the triglyceride equation, we do not take the age that the patient inputs into the equation. We use that value to find the age value and the age threshold.

BMI:

0-18.5: Threshold = 18.5, Value = 1

18.5-24.9: Threshold = 24.9, Value = 2

24.9-29.9: Threshold = 29.9, Value = 3

more than 30: Threshold = 30, Value = 4

- BMI Value = 3
- BMI Threshold = 29.9

We do not take the BMI that the patient inputs into the equation when searching for the triglyceride equation. We use that value to find the BMI value and the BMI threshold.

Percentage Rate = ((Age Value / Age Threshold) * 100) + ((BMI Value / BMI Threshold) * 100)

In this equation, 100 is a constant.

Percentage Rate = ((3 / 36) * 100) + ((3 / 29.9) * 100)

= (0.0833 * 100) + (0.1003 * 100)

= 8.33 + 10.03

= 18.36%

- ❑ low than 15 = give low health recommendations
- ❑ 15-25 = give medium health recommendations
- ❑ more than 25 =give high health recommendations

there fore 18.36% is Medium health recommendations.

3.9 Model Training Part

I trained Cholesterol Model

Logistic Regression

```
[304]
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report

lr = LogisticRegression()
lr.fit(X_train, Y_train)
y_pred = lr.predict(X_test)

lr_train_acc = accuracy_score(Y_train, lr.predict(X_train))
lr_test_acc = accuracy_score(Y_test, y_pred)

print(f"Training Accuracy of Logistic Regression Model is {lr_train_acc}")
print(f"Test Accuracy of Logistic Regression Model is {lr_test_acc}")
```

```
Training Accuracy of Logistic Regression Model is 0.8547717842323651
Test Accuracy of Logistic Regression Model is 0.7868852459016393
```

```
[305]
# confusion matrix
confusion_matrix(Y_test, y_pred)
```

```
array([[19,  9],
       [ 4, 29]], dtype=int64)
```

```
[306]
# classification report
print(classification_report(Y_test, y_pred))
```

```
              precision    recall  f1-score   support
```

Figure 14:Logistic Regression

KNN

```
[319]
from sklearn.neighbors import KNeighborsClassifier
k_model = KNeighborsClassifier(n_neighbors=16)
kfitModel = k_model.fit(X_train, Y_train)

# accuracy score on training data

kX_train_prediction = kfitModel.predict(X_train)
training_data_accuray = accuracy_score(kX_train_prediction,Y_train)
print('Accuracy on training data  : ', training_data_accuray)

# accuracy score on testing data
kX_test_prediction = kfitModel.predict(X_test)
kx_lgr_test_data_accuray = accuracy_score(kX_test_prediction,Y_test)
print('Accuracy on test data      : ', kx_lgr_test_data_accuray)
```

```
Accuracy on training data  :  0.8547717842323651
Accuracy on test data      :  0.819672131147541
```

Figure 15:KNN model

SVC

[307]
```
from sklearn.svm import SVC

svc = SVC()
svc.fit(X_train, Y_train)

y_pred = svc.predict(X_test)

svc_train_acc = accuracy_score(Y_train, svc.predict(X_train))
svc_test_acc = accuracy_score(Y_test, y_pred)

print(f"Training Accuracy of SVC Model is {svc_train_acc}")
print(f"Test Accuracy of SVC Model is {svc_test_acc}")
```

```
Training Accuracy of SVC Model is 0.9087136929460581
Test Accuracy of SVC Model is 0.8360655737704918
```

[308]
```
# confusion matrix
confusion_matrix(Y_test, y_pred)
```

Figure 16:Support vector classification

DecisionTreeClassifier

[310]
```
from sklearn.tree import DecisionTreeClassifier

dtc = DecisionTreeClassifier()
dtc.fit(X_train, Y_train)

y_pred = dtc.predict(X_test)

dtc_train_acc = accuracy_score(Y_train, dtc.predict(X_train))
dtc_test_acc = accuracy_score(Y_test, y_pred)

print(f"Training Accuracy of Decision Tree Model is {dtc_train_acc}")
print(f"Test Accuracy of Decision Tree Model is {dtc_test_acc}")
```

```
Training Accuracy of Decision Tree Model is 1.0
Test Accuracy of Decision Tree Model is 0.7049180327868853
```

[311]
```
# confusion matrix
confusion_matrix(Y_test, y_pred)
```

```
array([[17, 11],
       [ 7, 26]], dtype=int64)
```

[312]
```
# classification report
print(classification_report(Y_test, y_pred))
```

```
              precision    recall  f1-score   support
```

Figure 17:Decision tree

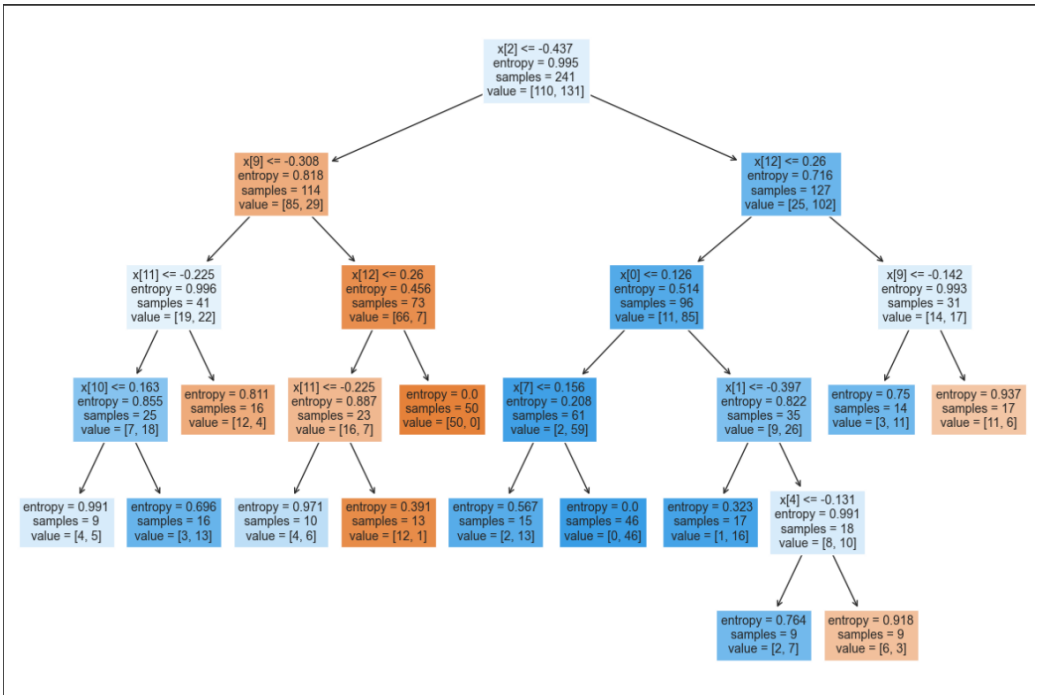


Figure 18:Decision tree visualization

Random Forest Classifier

[318]

```
from sklearn.ensemble import RandomForestClassifier

rand_clf = RandomForestClassifier(criterion = 'gini', max_depth = 3, max_features = 'sqrt', min_samples_leaf = 2, min_samp
rand_clf.fit(X_train, Y_train)

y_pred = rand_clf.predict(X_test)

rand_clf_train_acc = accuracy_score(Y_train, rand_clf.predict(X_train))
rand_clf_test_acc = accuracy_score(Y_test, y_pred)

print(f"Training Accuracy of Random Forest Model is {rand_clf_train_acc}")
print(f"Test Accuracy of Random Forest Model is {rand_clf_test_acc}")
```

```
Training Accuracy of Random Forest Model is 0.8879668049792531
Test Accuracy of Random Forest Model is 0.819672131147541
```

Figure 19:Random forest

XGB Classifier

[325]
```
from xgboost import XGBClassifier

xgb = XGBClassifier(booster = 'gblinear', learning_rate = 1, n_estimators = 10)
xgb.fit(X_train, Y_train)

y_pred = xgb.predict(X_test)

xgb_train_acc = accuracy_score(Y_train, xgb.predict(X_train))
xgb_test_acc = accuracy_score(Y_test, y_pred)

print(f"Training Accuracy of XGB Model is {xgb_train_acc}")
print(f"Test Accuracy of XGB Model is {xgb_test_acc}")
```

```
Training Accuracy of XGB Model is 0.8506224066390041
Test Accuracy of XGB Model is 0.7868852459016393
```

[326]
```
models = ['Logistic Regression', 'KNN', 'SVC', 'Decision Tree', 'Random Forest','Gradient Boosting', 'XgBoost']
scores = [lr_test_acc, kx_lgr_test_data_accuray, svc_test_acc, dtc_test_acc, rand_clf_test_acc,gb_test_acc, xgb_test_acc]

models = pd.DataFrame({'Model' : models, 'Score' : scores})
```

Figure 20:XGB classifier

GradientBoostingClassifier

[320]
```
#Gradient Boosting Classifier
from sklearn.ensemble import GradientBoostingClassifier

gb = GradientBoostingClassifier()

parameters = {
    'loss': ['deviance', 'exponential'],
    'learning_rate': [0.001, 0.1, 1, 10],
    'n_estimators': [100, 150, 180, 200]
}

grid_search = GridSearchCV(gb, parameters, cv = 5, n_jobs = -1, verbose = 1)
grid_search.fit(X_train, Y_train)
```

```
Fitting 5 folds for each of 32 candidates, totalling 160 fits
```

GridSearchCV
estimator: GradientBoostingClassifier
GradientBoostingClassifier

[321]
```
# best parameter and best score

print(grid_search.best_params_)
print(grid_search.best_score_)
```

```
{'learning_rate': 1, 'loss': 'exponential', 'n_estimators': 200}
0.8051870748299319
```

Figure 21:Gradient Boosting classifier

4. Results

4.1 Recommendations

Abdominal obesity -> 10-16 years -> Low

Here this is the user recommendation of the **Low** range Meal plan of **Abdominal obesity** person & age range is **10-16 years**

Meal Plan

I can provide you with some general recommendations for a dietary plan for a 10-15-year-old person with low-level abdominal obesity. However, please note that it is always best to consult with a healthcare professional or a registered dietitian for personalized advice. Additionally, keep in mind that calorie intake can vary depending on factors such as age, gender, activity level, and specific dietary needs. Here's a sample meal plan:

Breakfast:

- Scrambled eggs (90-150 calories per 100g) with vegetables like spinach and bell peppers.

- Whole grain toast (250-300 calories per 100g) with a thin spread of avocado.

- A serving of mixed fruits like berries or a small apple (approximately 50-70 calories per 100g).

Lunch:

- Grilled chicken breast (165-195 calories per 100g) with a side of steamed vegetables such as broccoli and carrots.

- Quinoa (120-140 calories per 100g) or brown rice (110-120 calories per 100g) as a whole grain option.

- A small mixed green salad with a light vinaigrette dressing (varies depending on ingredients).

Snack options:

- Greek yogurt (80-130 calories per 100g) with a handful of mixed nuts (e.g., almonds, walnuts).

- Baby carrots with hummus dip (around 50-60 calories per 100g).

- Sliced cucumber with a low-fat yogurt dip (calories vary based on dip used).

Dinner:

- Baked salmon fillet (150-200 calories per 100g) seasoned with herbs and lemon.

- Steamed asparagus or green beans as a side (20-30 calories per 100g).

- Sweet potato mash (90-110 calories per 100g) as a healthier alternative to regular mashed potatoes.

Remember to focus on portion control, prioritize whole foods, and limit added sugars and processed foods. It's important to encourage regular physical activity and drink plenty of water throughout the day.

Specially, I mentioned how many calories per 100g in the recommended meal plan .

Exercise Plan

10 to 15 Years Old:

Low Abdominal Obesity:

- - Monday: Seated Marches, Seated Leg Extensions, Standing Side Leg Lifts
- - Wednesday: Standing Wall Push-Ups, Chair Squats, Seated Torso Twists
- - Friday: Seated Bicycle Crunches, Modified Plank on Chair, Seated Shoulder Circles

Medium Abdominal Obesity:

- - Monday: Standing Wall Push-Ups, Chair Squats, Seated Marches
- - Wednesday: Modified Plank on Chair, Seated Bicycle Crunches, Seated Leg Extensions
- - Friday: Standing Side Leg Lifts, Seated Torso Twists, Seated Shoulder Circles

High Abdominal Obesity:

- - Monday: Seated Marches, Seated Leg Extensions, Seated Torso Twists
- - Wednesday: Seated Bicycle Crunches, Chair Squats, Modified Plank on Chair
- - Friday: Seated Shoulder Circles, Standing Wall Push-Ups, Standing Side Leg Lifts

4.2Final user interfaces

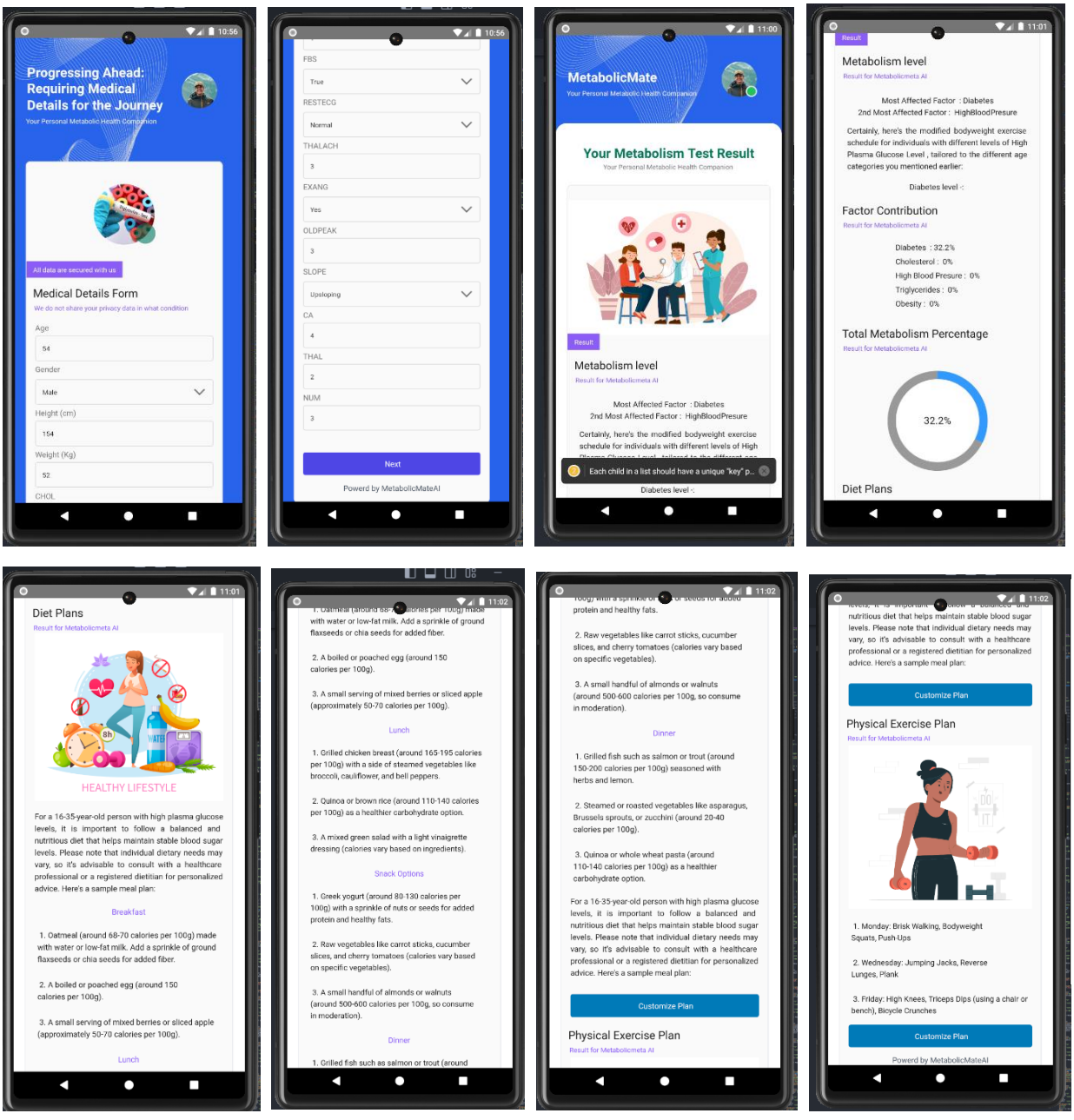


Figure 22:Entire System final interfaces

4.3 Discussion

Discussion of the Findings

A big step forward in the promotion of individualized healthcare and preventative actions has been made with the effective creation and implementation of the metabolic syndrome's mobile application. The main conclusions and ramifications of the application's findings are explored in this discussion.

The Gathering and Storage of Patient Data

Users provide their necessary health information during the application's initial patient contact phase. Our tailored method is built on this data set, which enables the system to adjust health suggestions based on user preferences. The application ensures a smooth and secure flow of information by keeping patient data in a separate database, enabling fast updates and modifications to the user's health profile.

Plans for Personalized Health

The application's capability to develop personalized diet regimens and exercise schedules is one of its outstanding results. The application analyzes the patient's input data using machine learning algorithms and produces recommendations that are individualized to meet each person's unique needs. This not only covers the variety of metabolic syndromes but also highlights the significance of individualized care in successfully treating and avoiding these disorders. Machine learning is used in these programs to increase their accuracy over time as the system iteratively improves its suggestions in response to user feedback and changing health patterns. The tracking and monitoring capabilities of the application are a crucial component of its functionality. The application promotes a sense of accountability and incentive by routinely tracking the patient's development and adherence to the advised plans. Users are motivated to stay committed to their health journey by receiving regular updates and reminders. This encourages beneficial behavioral adjustments that can reduce the risks related to metabolic disorders. The real-time tracking aspect of the application enables users to see their advancement, generating a constructive feedback cycle that strengthens their will to lead better lifestyles.

Diagnoses and Treatment Advice

One of the application's most important features is its capability to precisely determine whether users display symptoms of metabolic syndrome. This diagnostic skill acts as an early detection system, enabling people to control their health in a proactive manner before the illness worsens. The program offers users actionable strategies to address their particular health concerns with advice that are grounded in evidence-based guidelines. The application serves as a virtual healthcare companion by providing users with thorough information and recommendations, enabling them to make decisions regarding their well-being.

Future Directions and Implications

The findings of this study demonstrate how mobile applications could fundamentally alter how we think about metabolic syndromes and other related health issues. The recommendations made by the application are individualized, which is consistent with the move toward precision medicine, where interventions are customized to patient characteristics. There are chances for the features of the application to be improved and expanded as technology develops further. The usefulness and reach of the program could be increased by integrating wearable devices for real-time health data input and investigating partnerships with healthcare experts.

4.4 conclusion

Finally, the creation of the metabolic syndromes mobile application utilizing React Native marks a significant advancement in the management of personalized healthcare. Patients can successfully submit their information into the program, which is subsequently securely stored in a patient details database. This data is the basis for creating individualized health food and activity programs that take a comprehensive approach to treating metabolic abnormalities. The application's functionality has been enhanced by the incorporation of machine learning methods. The system can correctly determine whether patients have metabolic syndrome by examining the patient information presented, offering insightful data that can help medical practitioners make wise decisions. The health recommendations that are provided are based on a careful examination of the patient's data, ensuring a precise and concentrated approach to the treatment of metabolic syndromes.

One noteworthy feature of the software is its capacity to monitor patient development over time. By enabling patients to follow their progress, this monitoring system fosters a sense of control over their health journey. Additionally, it gives medical professionals the ability to evaluate the efficacy of recommended programs and make changes as necessary, which contributes to a dynamic and flexible healing process.

Overall, the mobile application for metabolic disorders is an essential tool in contemporary medicine. Its user-friendly design, individualized recommendations, integration of machine learning, and progress tracking place it at the cutting edge of health management technology. This application has the potential to greatly improve the quality of life for people with metabolic syndromes and pave the path for a more patient-centric approach to healthcare by bridging the gap between patients and their healthcare needs.

5.PROJECT REQUIREMENTS

5.1Functional Requirements

1. Privacy and Security (To secure patient data, the recommendation system should abide by privacy and security laws.)

2. Customized Food Advice (Depending just on a person's metabolic parameters, which includes their sugar levels and cholesterol levels, food requirements, and health records, the advice system should be able to produce individualized food advice.)

3. Suggestions for Vigorous Exercise (The recommended system ought to be capable to produce tailored recommendations for physical activity based on the patient's metabolic profile, including their present fitness status, physical restrictions, and inclinations for various kinds of exercise.)

4. Medication Management Advice (Based on the patient's medical history, current medications, and metabolic profile, the recommendation system should be able to produce suggestions for medication management.)

5. Customer Interaction (To support obedience to advise and stimulate behavioral changes, the referral system ought to have the capacity to engage patients through a variety of means, including such smartphone apps, web portals, or Text messages.)

6. Predicted Analyses (The guidance that the system be capable to classify individuals that are at a significant likelihood of developing metabolic syndrome and offer preemptive advice to delay the condition's emergence using data analytics.)

7. Communications and Reaction

5.2Non-Functional Requirements

- Accuracy
- Usability
- performance
- Efficiency
- Compatibility
- Regular compliance
- Reliability
- Security
- scalability

6.Technologies

Programming Languages

- Python, JavaScript, react for developing the system backend, JavaScript for developing the frontend and mobile apps.

Some Model training –

- Logistic Regression
- KNN
- SVC
- Decision Tree
- Random Forest Regressor
- XgBoost
- Gradient Boosting

Frameworks

- Node.js, spring boot or Django for the backend.
- React Native for the frontend and mobile apps.

- GitLab : Opensource Version Control System
- GitHub: Opensource Version Control System

Databases

- firebase for storing individual health information and medical history.

Tools

- Draw.io – design the UI parts.
- Figma – design the UI parts.
- PyCharm - software to develop Models.

Cloud computing platforms

- AWS/Azure.

7.Software Solution

1. Agile method

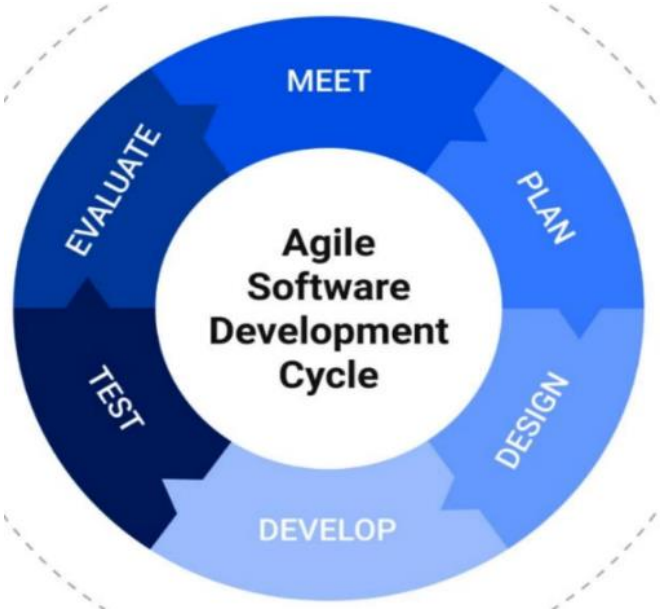


Figure 23:screenshot of Agile method

Method to iterative and incremental creation. Emphasizes teamwork and regular client input. Places a high value on adaptation and versatility to changing needs. Need a development team that works extremely well together and autonomously. Programs with high degrees of complexity and unpredictability, or those whose requirements are likely to alter, might be a better fit.

8.SYSTEM OVERVIEW DIAGRAM

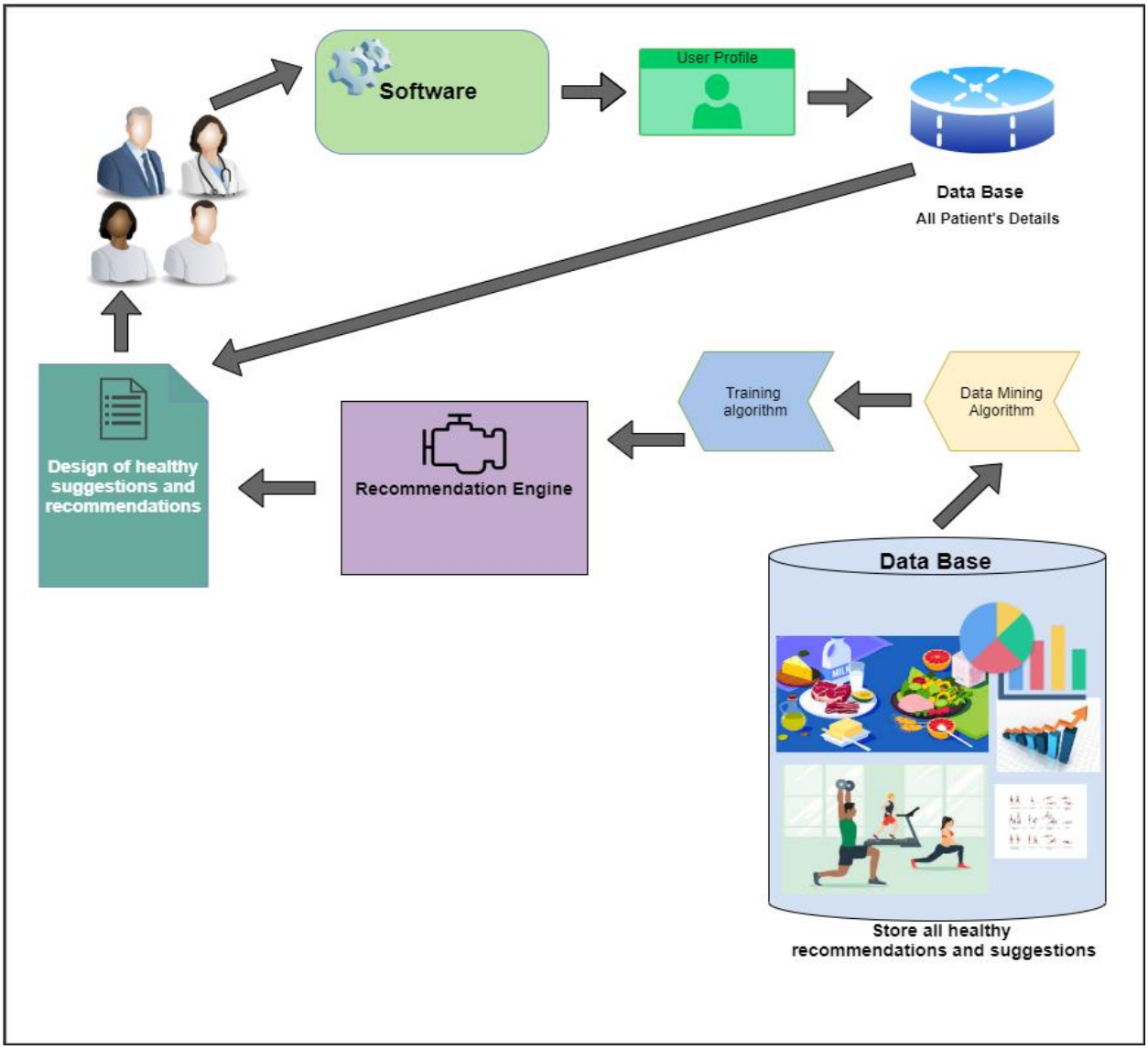


Figure 24:Entire system of recommendation suggestion function

9.WORK BREAKDOWN CHART

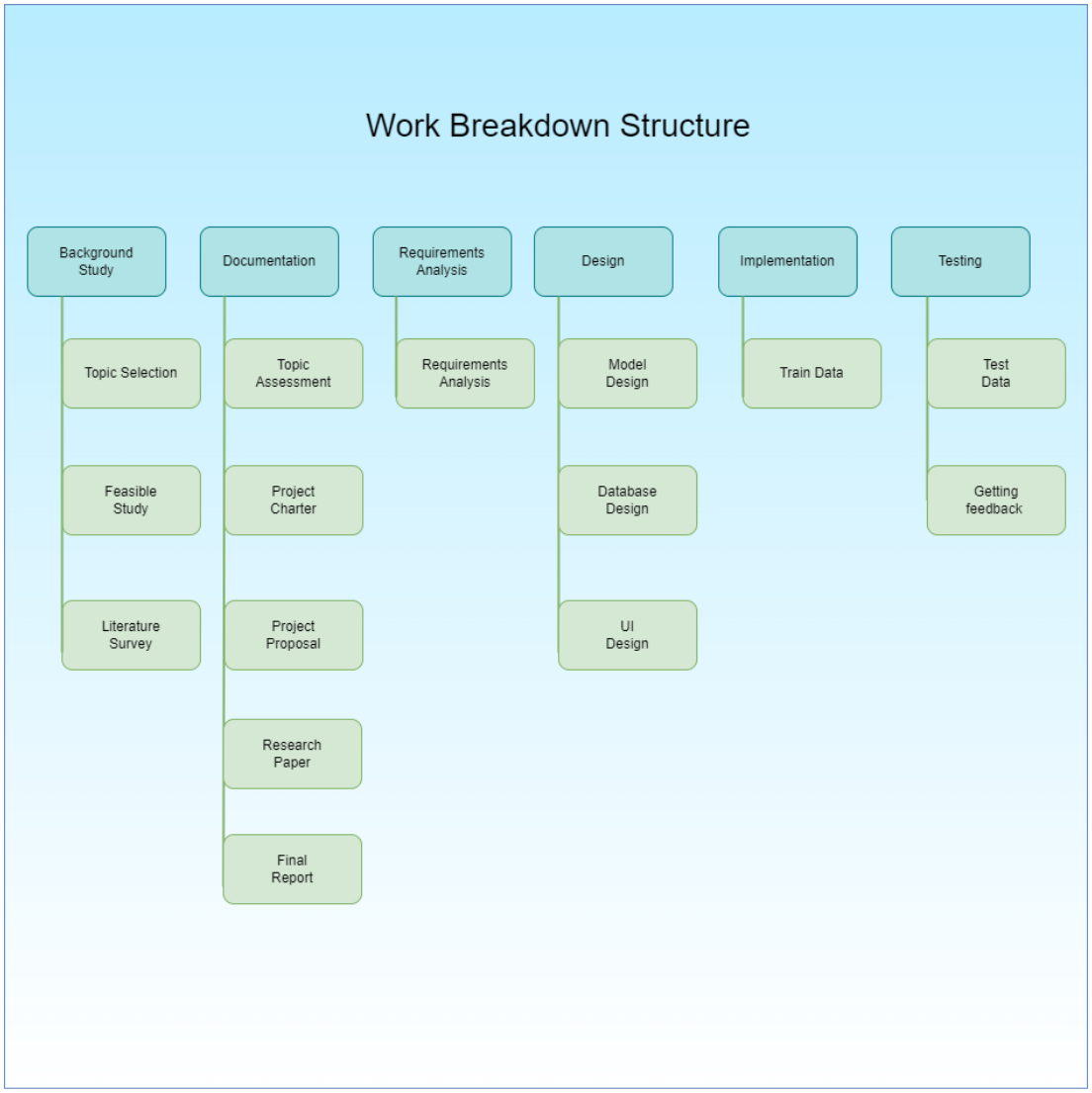


Figure 25:work break down chart

10.GANTT CHART

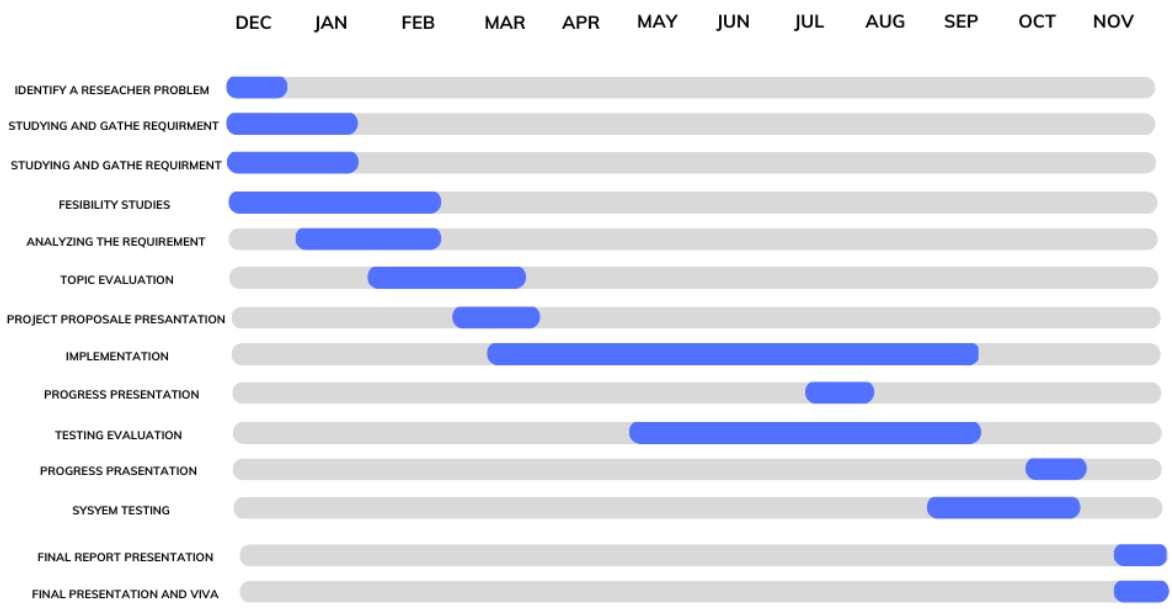


Figure 26:Gantt chart

11.DESCRIPTION OF PERSONAL AND FACILITIES

Student Id	Task description
IT20147396	1. Mainly, our system generates recommendations and suggestions by scanning reports and tracking patient's details and other facilities are also available (typing patient's details). 2. If you do something now like exercise or diet plan or any other recommendation is generated from our system, I will expect to display different charts like bar charts, pie charts, and cartesian graphs that will indicate an opportunity to get a clear understanding in advance of the situation you will reach in the future. 3. I gives recommendations based on 5 diseases including Low HDL and high LDL levels, obesity, elevated triglycerides level , high blood pressure and Elevated plasma glucose level. 4. Using Machine learning, Deep Learning and Artificial Intelligence, tacking technologies and goal setting tools.

Table 8:personal description and facilities

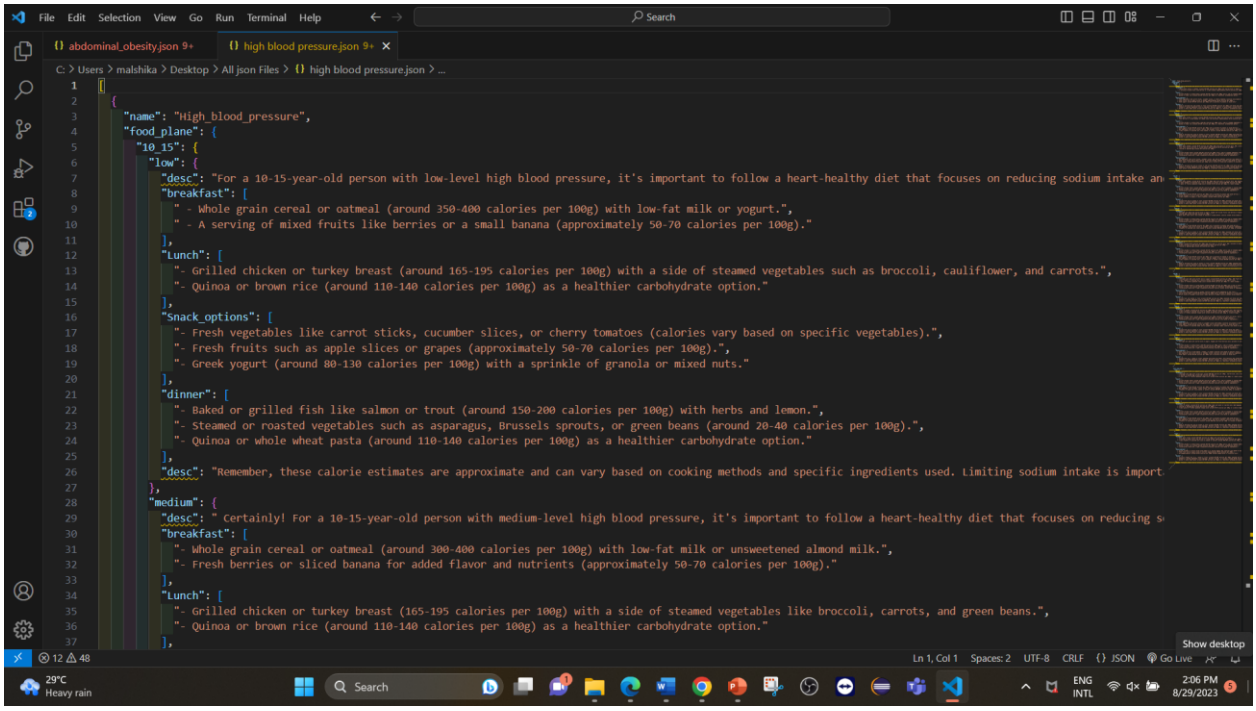
12. BUDGET AND BUDGET JUSTIFICATION

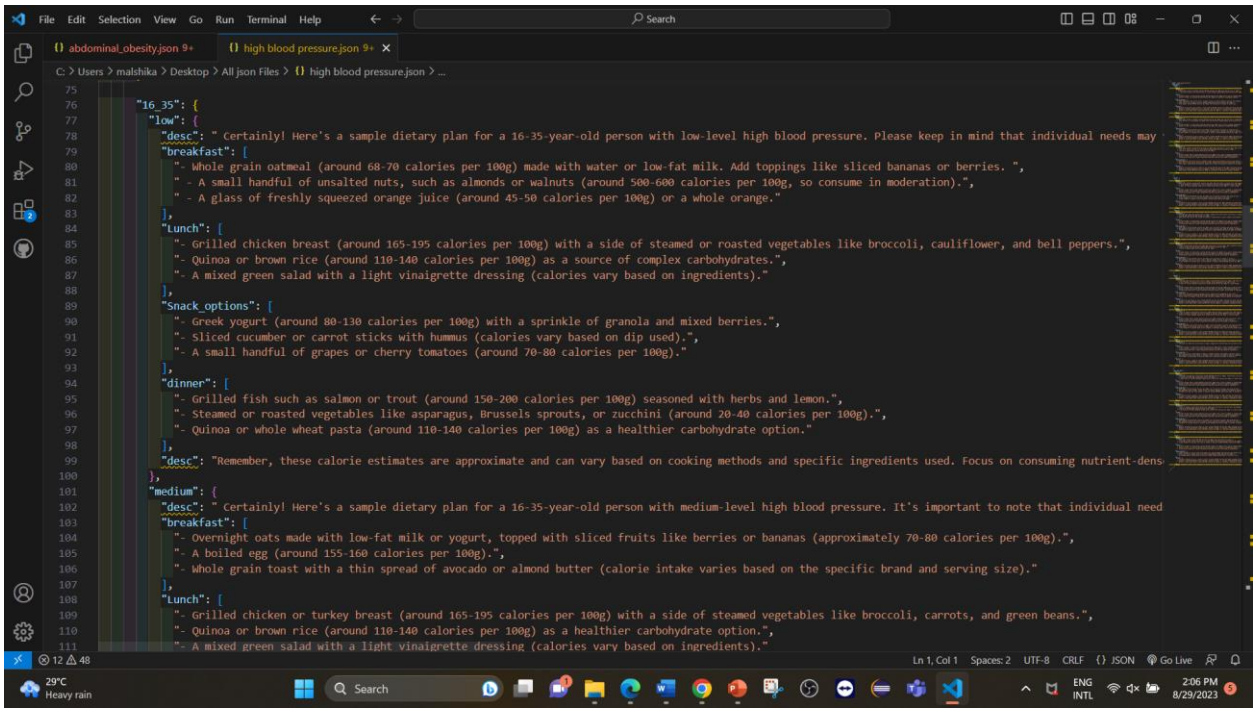
12.1COMMERCIALIZATION

We hope that after the successful completion of our project, we will make this mobile app popular among the people living in remote areas of Sri Lanka. With the corona epidemic, most people in Sri Lanka are using smartphones, so using this app can solve many health problems of people in remote areas. Specially, Monaragala, Puttalam, Batticaloa. We will be precise about the special value our mobile app or service offers, and we must explain this to health consumers. We must also establish relationships with important stakeholders, like investors, healthcare professionals, and clients, to increase support for our product. Also, we will investigate how innovation, such as telemedicine, smartphone apps, or other toolkits, may improve our product or service.

We must ascertain the economic feasibility of our study, do a market analysis, and pinpoint the market's need, target audience, and rivals. If licenses, trademarks, copyrights, or any other intellectual property protections are required, we must obtain them as soon as feasible. We must write a thorough business plan including our project's strategy, finances, and business model. We must also look for funding possibilities like grants, venture funding, angel investors, or other sources of funding that are suitable for our idea.
To advertise our smartphone application, we will aim to gather a group of specialist’s doctors, mobile engineers, and other medical professionals. We will also construct a functional prototype of our health mobile application or service that can be evaluated and improved. For our metabolic syndrome medical counseling mobile app to be effective and secure, we must perform clinical studies and gather data. It's time to publish our product (a mobile app for metabolic syndrome health assistance) and begin introducing it to clients once we have finished all of the required stages.

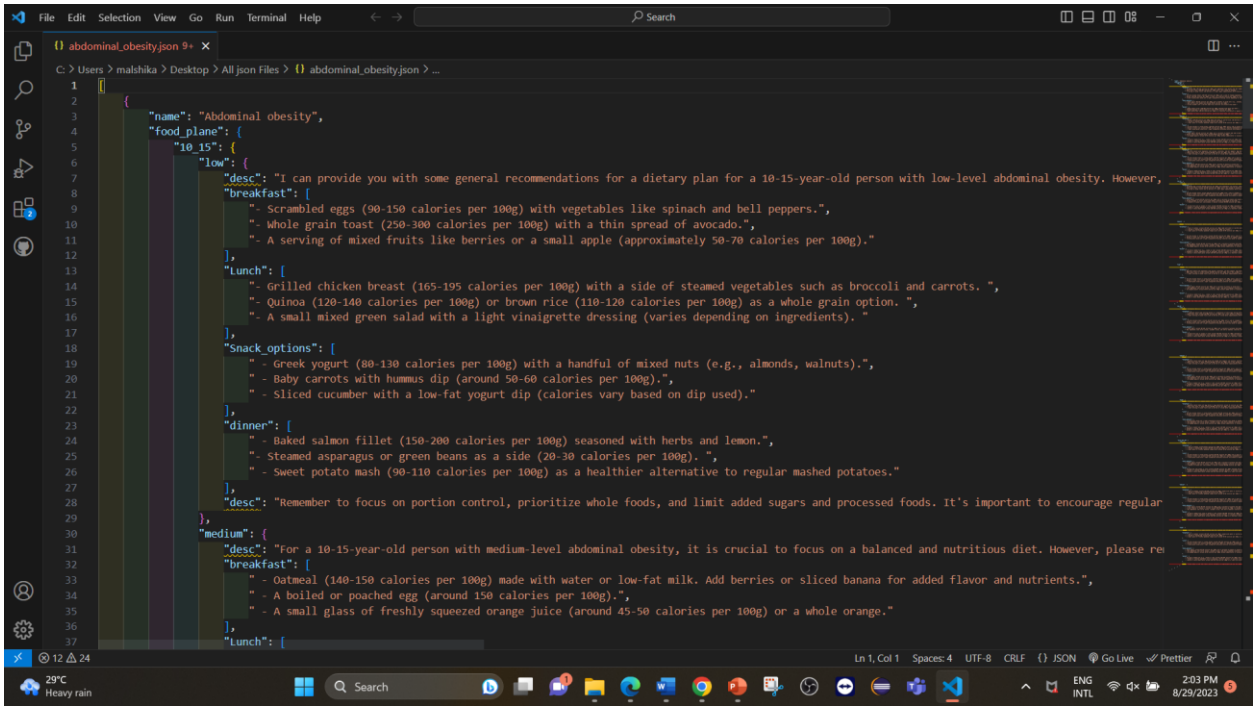
Appendix 1

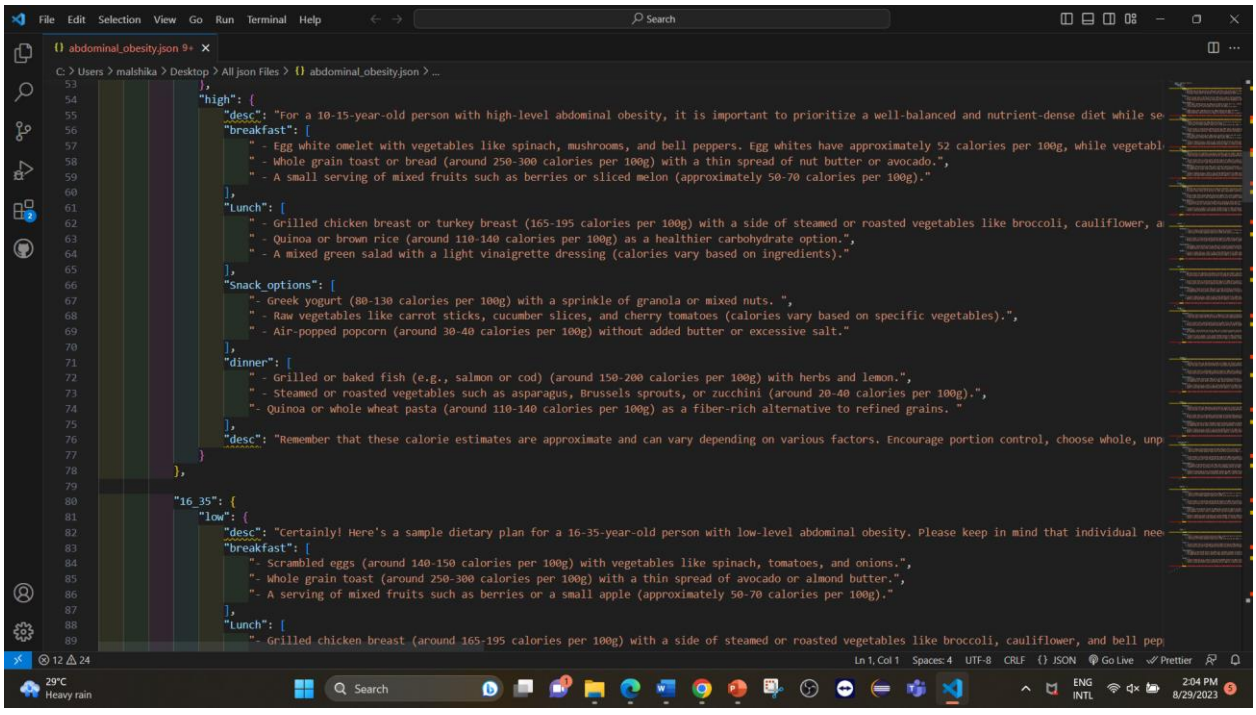




Appendix 1 –Json code for High blood pressure

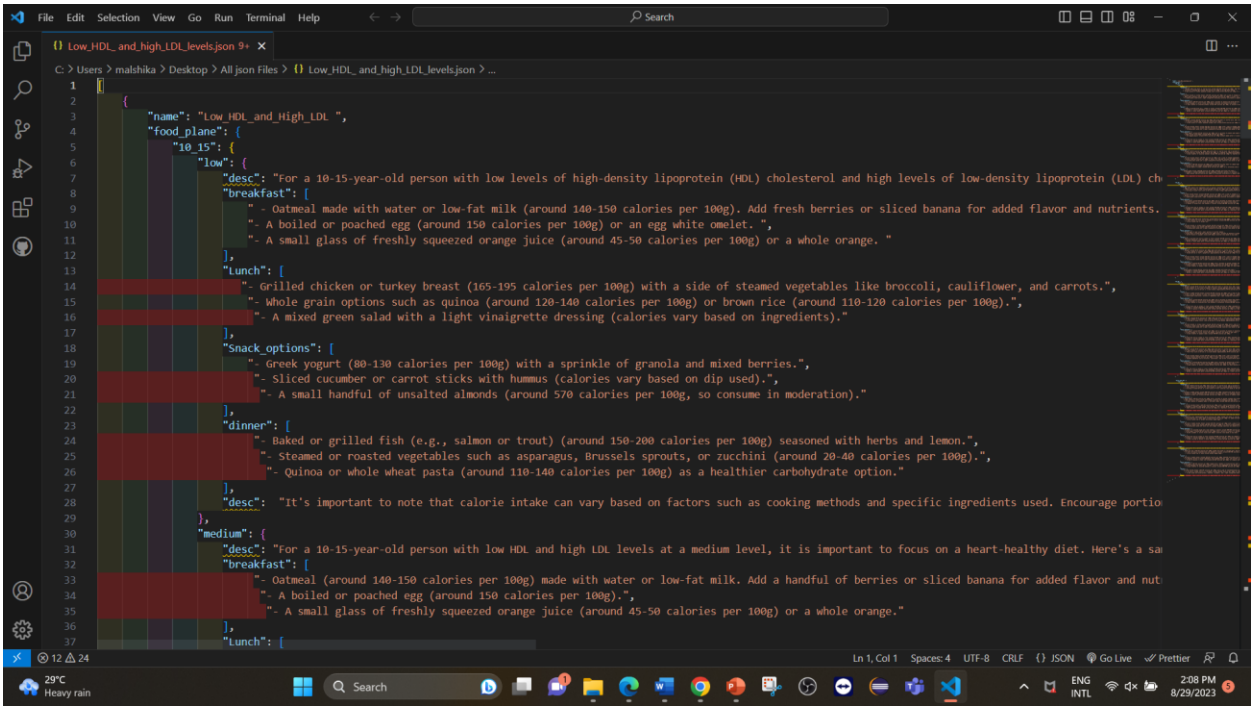
Appendix 2

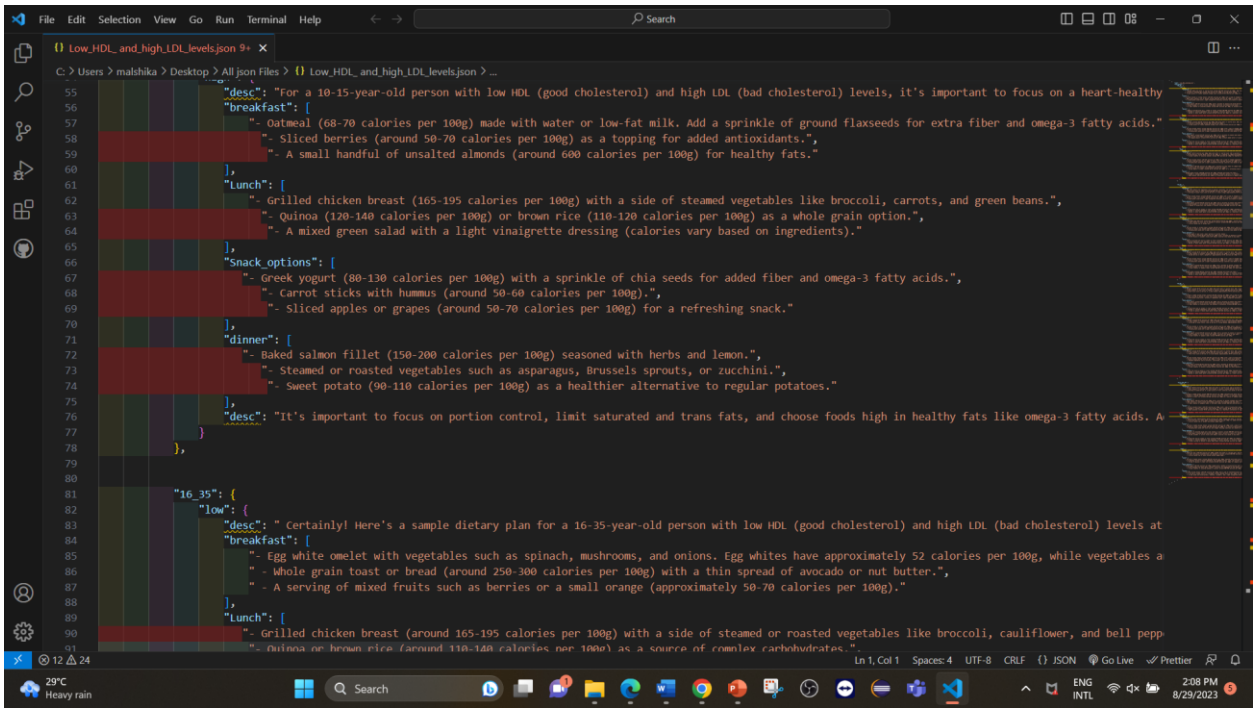




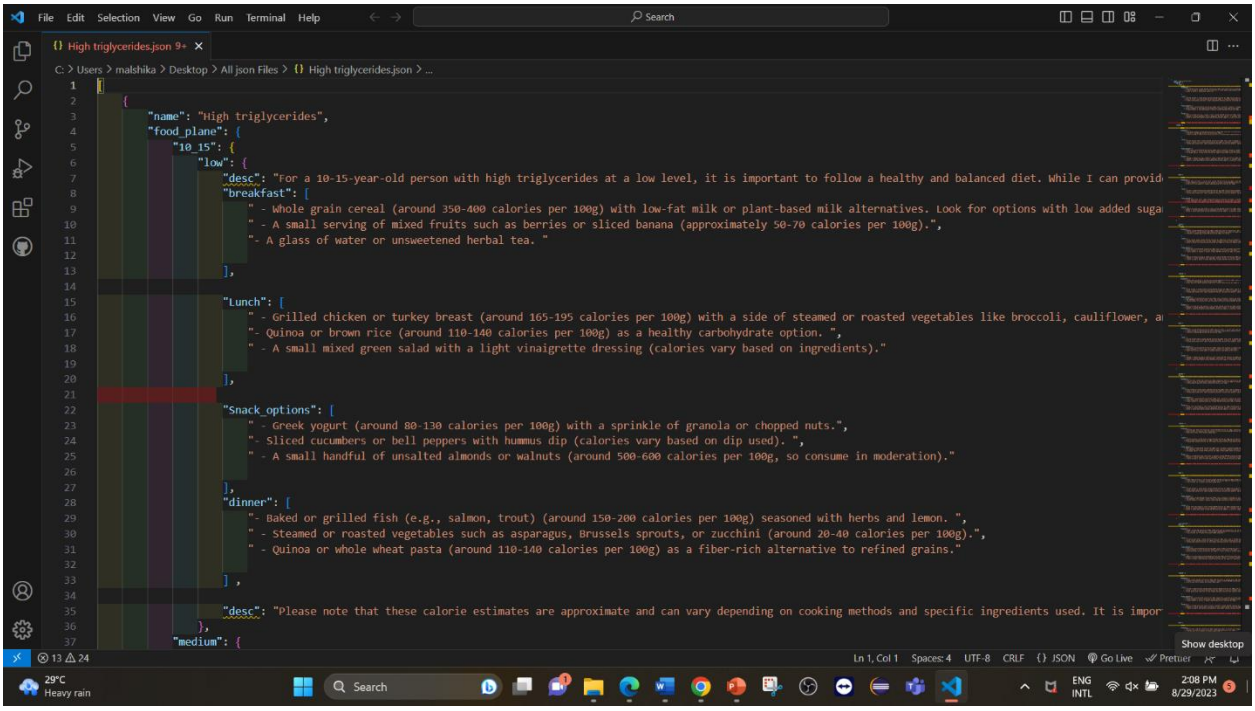
Appendix 2 – Json code for Abdominal obesity

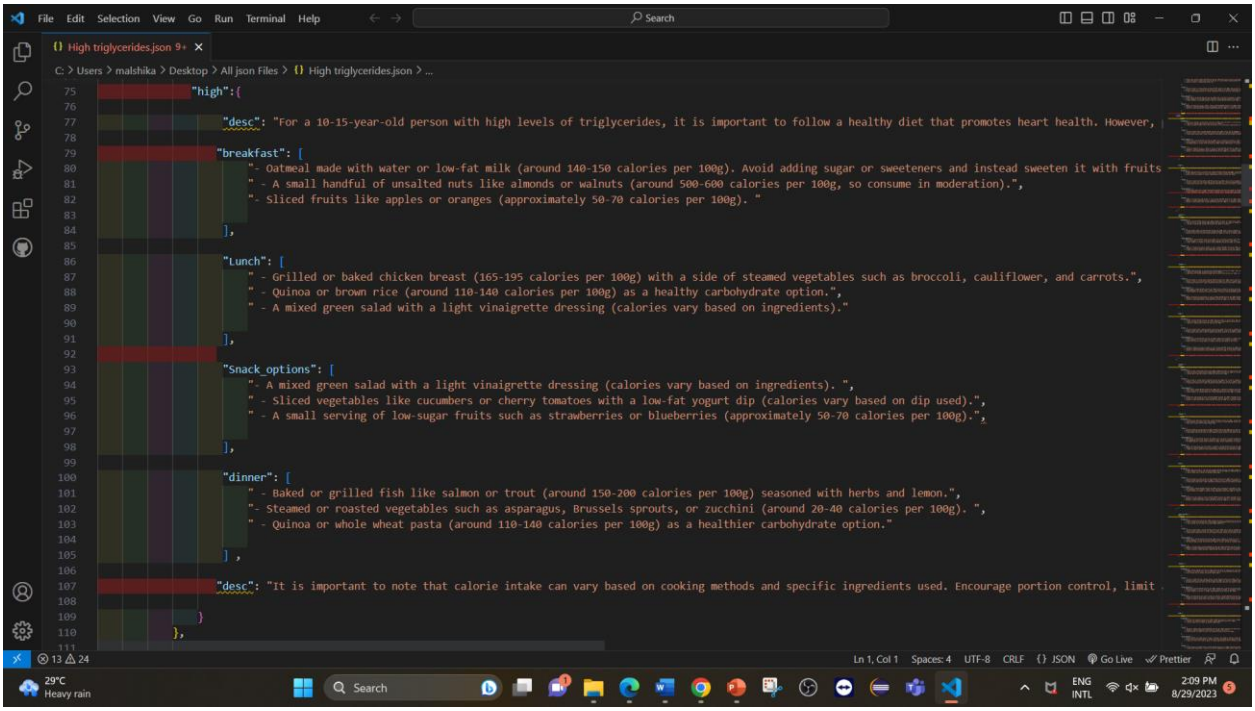
Appendix 3





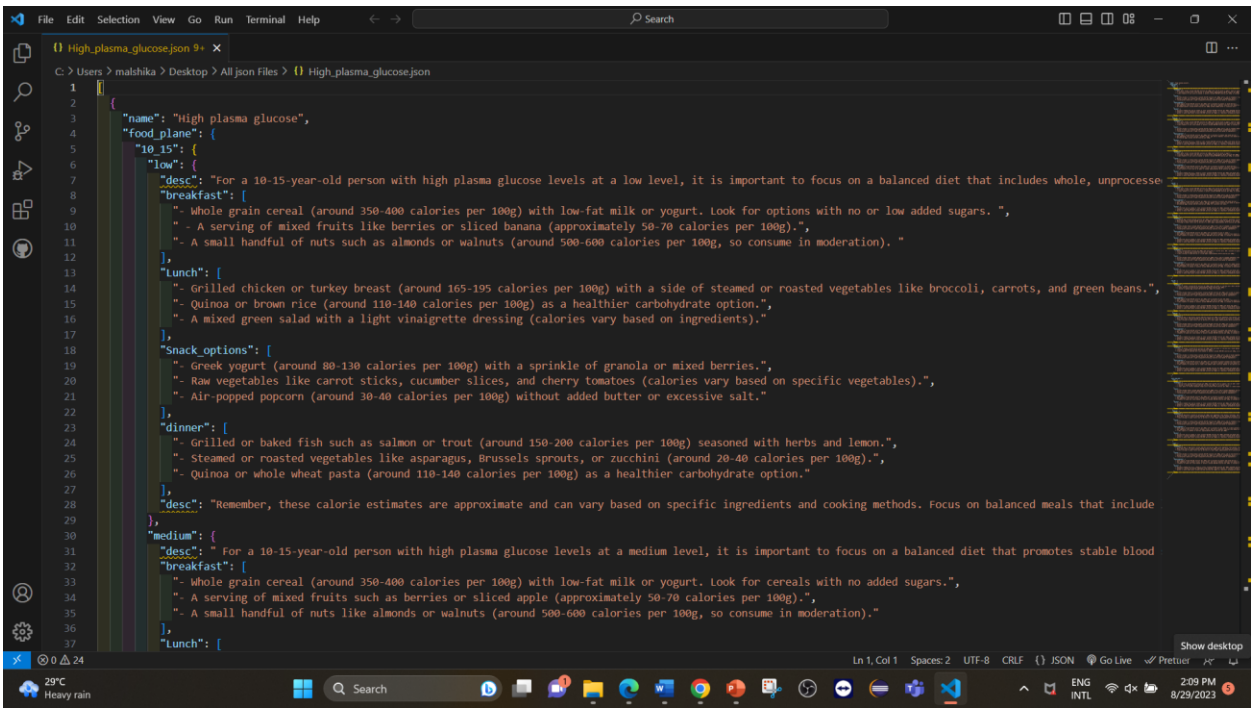
Appendix 3 – Json code for Cholesterol level

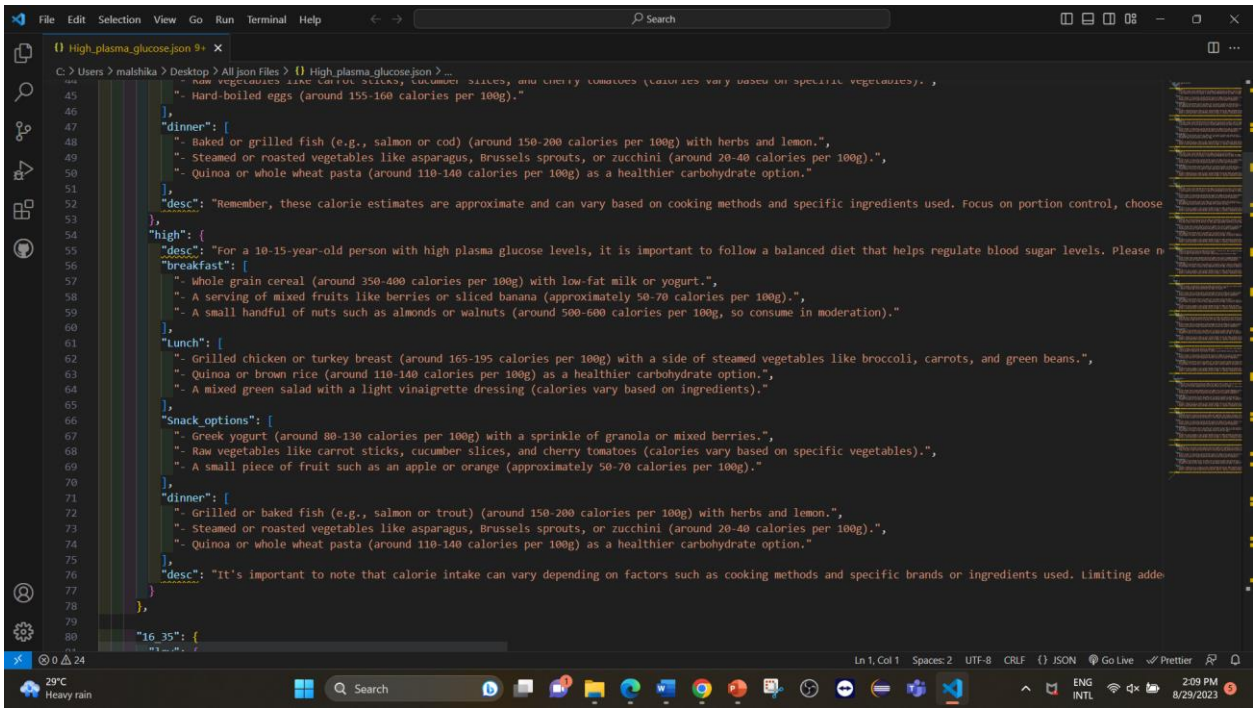




Appendix 4 – Json code for High Triglyceride level

Appendix 5





Appendix 5 – Json code for High plasma glucose level

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