Heart Health & Heart Attack Detection

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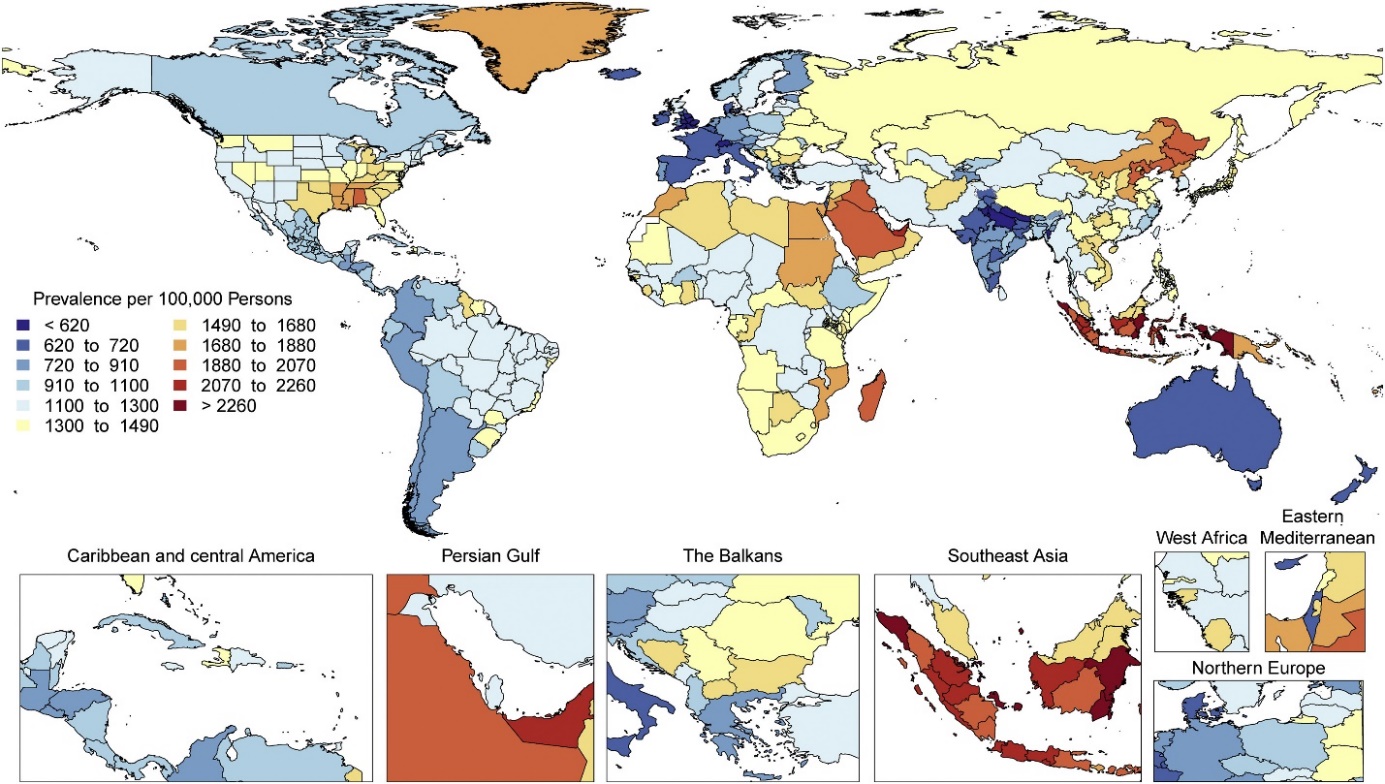
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**Abstract**

**This paper presents a new and detailed collection of data and a method for predicting heart health, which can help in heart research and public health studies. This collection of data is very thorough and includes many different types of information related to heart health and illnesses. It has basic personal details like age, gender, and ethnicity, lifestyle habits like what people eat, how much they exercise, and if they smoke or drink alcohol. It also includes a person's medical background, such as if their family has a history of heart problems, and key health measures like blood pressure, cholesterol levels, and body weight. On top of this, the data also has results from several heart tests, like ECGs (which check the heart's rhythm), echocardiograms (which look at the heart's structure and function), and tests that measure how the heart works when someone is under stress.**

# Introduction

The world health organization (WHO) described cardiovascular diseases (CVDs) as the leading cause of death globally, at an estimated 200 million deaths in 2019, and in Jordan, at an estimated 17.9 million deaths in 2019 <https://www.emro.who.int/jor/jordan-infocus/jordan-implements-who-hearts-in-primary-health-care-to-strengthen-management-of-cardiovascular-diseases-and-related-risks.html> . Identifying those at highest risk of heart disease and helping them get better informed about the dangers of CVDs and ways to lower the risk of contracting them.



This graph designed by the American college of cardiology show CVDs prevalence around the world in 2019 <https://www.acc.org/Latest-in-Cardiology/Articles/2020/12/09/14/50/CV-Disease-Burden-Deaths-Rising-Around-the-World> based on a study published by the American college of cardiology journal in 2019 <https://www.jacc.org/doi/10.1016/j.jacc.2020.11.010>

There are many ways to diagnose CVDs which include: blood tests, electrocardiogram (ECG), exercise stress test, echocardiogram (ultrasound) and MRIs. Blood tests show levels of substances that increase during muscle damage which help determine if the heart has been damaged and to what extent. Imaging methods test the morphology and pumping capabilities of the heart <https://www.healthywa.wa.gov.au/Articles/A_E/Common-medical-tests-to-diagnose-heart-conditions> .

Herein, we propose the use of large language models (LLMs) to help the public understand the dangers of such diseases and whether they are at risk or not. The prediction approach depends on the collection of data that includes questions that the public usually asks and answers provided by professionals in the field of cardiology and general health. to process the data, extract meaningful information and provide useful replies, we developed an LLM.

This study relies on LLM methods that have not been applied in this field yet such as the use of llama index to connect multiple sources of data to an LLM and applying llama2 LLM and combine multiple datasets of plant disease images.

# Related Works

The field of natural language processing (NLP) has seen remarkable growth in healthcare, particularly in the area of question answering (QA). Despite this progress, the majority of existing healthcare QA datasets are primarily concentrated on medical imaging, clinical notes, or structured electronic health record data. This has led to a notable gap in the integration of electrocardiogram (ECG) data.[1] Addressing this gap, we introduce ECG-QA, the first dataset specifically tailored for ECG analysis within the QA framework. ECG-QA is comprised of 70 question templates, each encompassing a broad spectrum of ECG-related clinical topics, meticulously reviewed by an ECG expert to ensure their clinical applicability. The dataset features a variety of ECG interpretation questions, including those necessitating the comparison of two distinct ECGs. Moreover, we conducted extensive tests to illuminate potential future research directions. ECG-QA holds promise as an invaluable resource in advancing QA systems, aiding physicians in the analysis of ECG data and enhancing healthcare delivery.[2]

Asma Ben Abacha and Dina Demner-Fushman. 2019. "A Question-Entailment Approach to Question Answering." BMC Bioinformatics 20, no. 1: 511:1–511:23.

Ben Abacha, A., & Demner-Fushman, D. (2019). A Question-Entailment Approach to Question Answering. BMC Bioinformatics, 20(1), 511:1–511:23. https://doi.org/10.1186/s12859-019-3115-7

# Methodology

1.data Collection  
While There are Several Medical QA datasets like [[MedQuadQA]](https://github.com/abachaa/MedQuAD/tree/master) that’s focuses on general health knowledge or like [[ECG Dataset]](https://github.com/Jwoo5/ecg-qa) that focuses on Computer Vision (CV), While we aim to create a Heart Health and Disease QA Model that’s purely lingual. The Dataset we created consists of 710 Question-Answers Pair, approximately 150 of them were Taken from a private hospital and heart center located in Erbil, Iraq, where Cardiologist created Questions answered by clinical reports provided, 65 Question were taken from[[World Health Organization]](https://www.who.int/news-room/questions-and-answers/item/cardiovascular-diseases-avoiding-heart-attacks-and-strokes) sharing info about general heart health and heart attacks , 95 of them were Taken from[[.nutrition's Cardiovascular Disease:Answers to Common Questions]](https://www.nutrition.org.uk/media/10rdy13i/cardiovascular-disease-answers-to-common-questions.pdf) were they focused on questions most medical journalist usually ask and provided a detail Answers, 100 of them were created by[[OHSU Knight Cardiovascular Institute]](https://www.ohsu.edu/knight-cardiovascular-institute/frequently-asked-cardiovascular-questions) an organization with the goal of giving every one the healthcare they need,50 questions from [[IEEE Heart diseases dataset]](https://ieeexplore.ieee.org/document/8094944),45 of them were from[[Harvard Health publication]](https://www.health.harvard.edu/resources) sharing discoveries and info about health in genral and for the purpose of this paper heart related research, 75 were from [[NHS]](https://www.nhs.uk/conditions/heart-attack/) were they talk about health , and the symptoms of heart attack how to deal with it, etc , another 65 were from [[Heart Disease and Stroke Statistics—2022 Update: A Report From the American Heart Association]](https://www.ahajournals.org/doi/10.1161/CIR.0000000000001052) Sharing some up to date and relevant data about the topic, [[Central for Disease control and prevention]](https://www.cdc.gov/heartdisease/heart_attack.htm) gave us 60 question, and the last 105 question were from [[Prevalence of uncontrolled risk factors for cardiovascular disease: United States, 1999-2010]](https://pubmed.ncbi.nlm.nih.gov/23101933/) a Data Taken for the course of 20 years.

2. Data preprocessing

Dealing with data from different sources format and style and merging them required a lot of pre-processing , The data size was 1200 Question before pre-processing, after dealing with :1)duplicates, 2) clinical report data with possible mistakes(abnormal readings , abnormalities when compared to previous and latter readings ), and removing any possible outdated data , the data rounded to 710 pairs.

A big portion of the data were clear text, after consulting medical expertise , the format of the questions and answers were changed to make sure :1) Each question was clear with no ambiguity.2)answers were concise and clear.3)the answer gave the best possible answer, 4) in the case of questions with no clear answers (i.e : clinical reports were giving a concise answer isn’t advised without further tests) had an answer that the patients can take while informing them that further examinations are needed and the results isn’t an indicator.

The most important component of this model is Llama 2; which is a chatbot developed by Meta AI. It is able to understand and reply to complex questions and have natural conversations with user. We chose Llama 2 due to its ability to extract useful information from text and the fact that noise does not affect it as much as many of the other commonly used pretrained LLMs <https://www.geeksforgeeks.org/what-is-llama2-metas-ai-explained/>

A table with numbers and letters

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Figure 3-1 compares Llama 2’s effectiveness in multiple fields when compared to Llama 1 and other pretrained models commonly used in the creation of LLMs. The most important aspect here are natural questions which Llama 2 excels at and so is more useful to those with less medical knowledge and older people, who are most likely to suffer from CVDs <https://ai.meta.com/llama/>

Even though Llama 2’s original purpose is to help teams organize tasks, its versatility is usually ignored and as such it contains untapped potential. The reasons most researchers avoid Llama2 however are due to its rather small size when compared to GPT-3.5 and PaLM 2 which makes its generated text less complex and sophisticated and its lack of support for languages other than english.it also lacks sophistication for complex math, which is not needed for the purposes of this model. <https://www.geeksforgeeks.org/what-is-llama2-metas-ai-explained/>

A diagram of a software development process

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Figure 3-2 shows how Llama 2 was trained by first using self-supervised learning to pretrain it then fine-tuning it using the Llama 2 chat with professional, hand-picked text and finally releasing it. Our method of fine-tuning this pretrained model to fit CVDs purposes followed a similar (method) simply by discarding the pretraining step and giving the model hand-picked questions that encompass the general field of CVDs translated into what a user with a lack of or minimal knowledge in the cardiovascular field would ask and the answers that would be comprehensible and useful to such a person.

The second most important component is the LlamaIndex used for connecting custom data sources to LLMs. Since LlamaIndex was created with Llama 1 and 2 in mind the harmony between the two components ensures a smooth running model.

Our QA model focuses on both short and long answers so that the model would not give complex answers without good reason. Question Answering models can retrieve the answer to a question from a given text, which is useful for searching for an answer in a document. Our document in this case would be the dataset itself where Llama 2 would search for keywords and their synonyms in the growing dataset and learn new forms of questions from users. This would enable it to grow quickly but would cause noise to affect the model too much. To solve this we can give our hand-picked dataset a far higher weight.

The reason for the decision of weighting the original dataset far higher comes from chatgpt’s recent history. Chatgpt has suffered a loss in accuracy due to incorrect inputs by users. This amount of noise eventually overpowers the older, quality data. This is confirmed by this study done by Stanford university researchers <https://arxiv.org/pdf/2307.09009.pdf>

# Results

# Due to a lack of a similar model we compared the results of the model befor and after training it

|  |  |  |
| --- | --- | --- |
| Question | Answer pre finetuning | Answer after finetuning |
| What are the common symptoms of a heart attack? | Common heart attack symptoms include: Chest pain that may feel like pressure, tightness, pain, squeezing or aching. Pain or discomfort that spreads to the shoulder, arm, back, neck, jaw, teeth or sometimes the upper belly. Cold sweat. | The common symptoms of a heart attack include fatigue, chest pain or discomfort, shortness of breath, lightheadedness, and nausea or vomiting. It is important to note that not all heart attacks present with the same symptoms, and some people may experience different symptoms or have a silent heart attack with no noticeable symptoms at all. If you suspect you or someone else is having a heart attack, it is crucial to seek medical attention immediately. |
| "How does high blood pressure affect heart health? | In some cases, people with high blood pressure may have a pounding feeling in their head or chest, a feeling of lightheadedness or dizziness, or other sign | High blood pressure, also known as hypertension, can have a significant impact on heart health. When blood pressure is consistently elevated, it can lead to damage to the blood vessels, increasing the risk of heart disease. This can include conditions such as coronary artery disease, heart failure, and peripheral artery disease. Additionally, high blood pressure can increase the risk of heart attack and stroke. It is important to manage blood pressure through lifestyle changes, such as a healthy diet and regular exercise, and in some cases, medication may be necessary to control blood pressure and reduce the risk of heart disease. |
| Are there differences in symptoms or risk factors for men and women regarding heart disease? | I'm not a substitute for professional medical advice, However to the best of my knowledge there is none | Yes, there are differences in symptoms and risk factors for men and women regarding heart disease.  For men, the most common symptoms of heart disease are chest pain or discomfort, shortness of breath, and lightheadedness or fainting. Men are also more likely to experience a heart attack at an earlier age than women.  For women, the most common symptoms of heart disease are similar to those for men, but they are more likely to experience symptoms such as jaw or neck pain, back pain, and fatigue. Women are also more likely to have a heart attack without experiencing any symptoms at all. |
| What lifestyle changes can reduce the risk of heart disease? | Healthy Diet:  Eat a balanced diet with plenty of fruits, vegetables, whole grains, lean proteins, and healthy fats.  Limit saturated fats, trans fats, and added sugars.  Regular Exercise:  Aim for at least 150 minutes of moderate-intensity aerobic activity per week.  Include strength-training exercises at least two days a week.  Quit Smoking:  If you smoke, quit immediately. Seek support to quit successfully.  Manage Stress:  Practice stress-reduction techniques such as mindfulness, deep breathing, or meditation.  Find healthy ways to cope with stress.  Monitor Health Numbers:  Keep an eye on your blood pressure, cholesterol levels, and blood sugar.  Work with your healthcare provider to maintain healthy levels. | Lifestyle changes that can reduce the risk of heart disease include:  1. Eating a healthy diet that is low in saturated fats, trans fats, sodium, and added sugars, and high in fruits, vegetables, whole grains, and lean protein sources.  2. Exercising regularly, such as walking, running, swimming, or cycling, for at least 30 minutes a day.  3. Maintaining a healthy weight, as excess weight can increase the risk of heart disease.  4. Not smoking, as smoking is a major risk factor for heart disease.  5. Limiting alcohol consumption to moderate levels (no more than one drink per day for women and two drinks per day for men).  6. Managing stress through relaxation techniques, such as meditation or deep breathing. |
| Given the data, are there differences in women and men heart readings? | I'm not a substitute for professional medical advice, However , there appears to be some differences in heart readings between women and men.  For women, the average resting blood pressure is 132.0 mm Hg, cholesterol level is 297.0 mg/dL, and fasting blood sugar level is 0.0 mg/dL. The average maximum heart rate during stress testing is 144.0 beats per minute, and the average oldpeak value is 1.0.  For men, the average resting blood pressure is 130.0 mm Hg, cholesterol level is 298.0 mg/dL, and fasting blood sugar level is 0.0 mg/dL. The average maximum heart rate during stress testing is 110.0 beats per minute, and the average oldpeak value is 1.0. | Based on the data provided, there appears to be some differences in heart readings between women and men.  For women, the average resting blood pressure is 132.0 mm Hg, cholesterol level is 297.0 mg/dL, and fasting blood sugar level is 0.0 mg/dL. The average maximum heart rate during stress testing is 144.0 beats per minute, and the average oldpeak value is 1.0.  For men, the average resting blood pressure is 130.0 mm Hg, cholesterol level is 298.0 mg/dL, and fasting blood sugar level is 0.0 mg/dL. The average maximum heart rate during stress testing is 110.0 beats per minute, and the average oldpeak value is 1.0.  It is important to note that these are just averages and that individual readings can vary. Additionally, these differences may be due to various factors such as age, genetics, and lifestyle habits. |
| What Ages are most vulnerable to suffer heart problems? | Heart problems can affect people of all ages, but the risk of developing certain heart conditions tends to increase with age. | "Based on the given information, the age groups most vulnerable to suffer heart problems are:",  ,  "1. 51-54 years old: This age group is at a higher risk of suffering from heart problems due to the presence of typical angina symptoms, high cholesterol levels, and a high maximum heart rate during stress testing.",  "2. 40-44 years old: This age group is also at a higher risk of suffering from heart problems due to the presence of typical angina symptoms, high cholesterol levels, and a high maximum heart rate during stress testing.",  "3. 55-59 years old: This age group is at a moderate risk of suffering from heart problems due to the presence of typical angina symptoms and high cholesterol levels.",  ,  "It is important to note that these age groups are not the only ones at risk of suffering from heart problems, and other factors such as lifestyle, medical history, and family history can also play a role in determining an individual's risk of heart problems." |
| Can heart disease be genetic? | Yes, they can be | Yes, heart disease can be genetic. Several genetic mutations have been identified as risk factors for heart disease, including mutations in genes involved in lipid metabolism, blood pressure regulation, and inflammation. Additionally, certain genetic variants have been associated with an increased risk of developing heart disease, particularly at an early age. However, it's important to note that genetics is only one of many risk factors for heart disease, and lifestyle factors such as diet, exercise, and smoking can also play a significant role in the development of the disease. |
| What are the early signs of heart problems | Recognizing the early signs of a heart attack is crucial because prompt medical attention can significantly improve the chances of survival and minimize heart damage. Here are the common early warning signs of a heart attack:  **Chest Pain or Discomfort:** The most common symptom is chest pain or discomfort, often described as a squeezing, pressure, fullness, or burning sensation. This pain may last for several minutes or come and go.  **Pain or Discomfort in Other Upper Body Areas:** Pain or discomfort can radiate to other areas of the upper body, including the arms (especially the left arm), shoulders, neck, jaw, or back.  **Shortness of Breath:** Feeling out of breath, even without physical exertion, can be a sign of a heart attack. It may accompany or precede chest discomfort. | The early signs of heart problems can vary depending on the individual and the specific condition, but some common early signs include:  \* Chest pain or discomfort (angina)  \* Shortness of breath  \* Fatigue or weakness  \* Swelling in the legs, ankles, or feet  \* Dizziness or lightheadedness  \* Palpitations or irregular heartbeat  \* Nausea or vomiting  \* Coughing up pink, frothy liquid (in the case of heart failure)  It is important to note that these symptoms can also be caused by other conditions, so it is important to consult a healthcare professional for a proper diagnosis and treatment.  Please let me know if you have any further questions or concerns. |
| "What are congenital heart defects? | Congestive heart failure (also called heart failure) is a serious condition in which the heart doesn't pump blood as efficiently as it sh | Congenital heart defects are abnormalities in the structure of the heart that are present at birth. These defects can affect the heart's walls, valves, or blood vessels, and can range from mild to severe. Some common types of congenital heart defects include atrial septal defects, ventricular septal defects, and tetralogy of Fallot. These defects can cause a variety of symptoms, including shortness of breath, fatigue, and swelling in the legs and feet. Treatment options for congenital heart defects can include medication, surgery, or catheter-based procedures, and may involve a combination of these approaches. It is important to seek medical attention if you or your child experiences any symptoms of a congenital heart defect. |
| if a patient who is 57.0 years old with {'experiencing typical angina', 'experiencing atypical angina', 'asymptomatic', 'with non-anginal pain'} chest pain, resting BP 140.0, cholesterol 265.0, fasting blood sugar 0.0, resting ECG 1.0, max heart rate 145.0, exercise angina 1.0, oldpeak 1.0, ST slope (2.0,)is it likley that they have a heart attack? | I am sorry I cannot answer that | "It is likely that the patient is experiencing a heart attack. The patient's age, combined with the presence of typical angina symptoms and elevated cardiac biomarkers, suggest a high likelihood of a heart attack. The patient's ST segment slope is also elevated, which is a common finding in patients with acute myocardial infarction (heart attack) |
| How does menopause impact heart health in women? |  | Menopause can have a significant impact on heart health in women. During menopause, the levels of estrogen in the body decrease, which can lead to an increase in the risk of heart disease. This is because estrogen helps to protect against heart disease by lowering levels of "bad" cholesterol and triglycerides, and by helping to keep blood vessels relaxed and flexible. Without enough estrogen, the risk of heart disease can increase.  Additionally, menopause can also lead to changes in blood pressure, which can further increase the risk of heart disease. Women may experience an increase in blood pressure during menopause, which can be due to the decrease in estrogen levels.  It's important for women to be aware of these changes and to take steps to protect their heart health during menopause. This can include making healthy lifestyle choices, such as eating a healthy diet, getting regular exercise, and not smoking. Women should also talk to their doctor about any concerns they have about their heart health during menopause.  In summary, menopause can have a significant impact on heart health in women |
|  |  |  |

# Limitation

While developing our heart attack prediction model it is vital to recognize the limitations that will influence the model’s accuracy and effectiveness. The potential bias in the training data would limit the model’s ability to generalize across diverse populations that rely on the quality and diversity of the data used for training. Being able to address this limitation would help us obtain a well-balanced dataset that contains a wider variety of characteristics which makes sure that the model would be applicable to different patient profiles.

The lack of resources to train and test our model slowed down the process to train a LLM, there is going to be a need of extensive computational power and storage capacities to be able to process and analyze large datasets especially if the data is diverse. The financial costs of accessing such computational power can pose constraints on the research project. Awareness on such problem highlights the importance of seeking innovative solutions such as using cloud computing services such as Kaggle in which it offers free but limited computational power to be able to continue with the development of a robust predictive model for cardiovascular health.

Developing a heart attack prediction model with the use of LLMs there is going to be limitations to this approach. The success of such model heavily relies on the quality and quantity of textual data. Medical professionals may find it difficult to trust such model especially if there is no transparent backing behind a prediction. The lack of knowledge in the medical field also poses a significant limitation when deploying a LLM for healthcare applications such model may lack deep understanding of domain specific knowledge that is crucial for accurate medical predictions

Ethical consideration represents a critical limitation. Access to a wide variety of data to such problem isn’t as available since it raises privacy concerns, it strikes the balance between extracting valuable information from patient’s data and guarding the individual's privacy.

The constant change in medical knowledge and the evolving understating of cardiovascular risks factors are an ongoing challenge. The model will need continues updates and changes to older information hat has been debunked to make use of emerging medical insights making it necessary for research to stay informed of the latest advancements in both the cardiology and machine learning field to keep the model relevant and effective. It is essential to better the model’s reliability and applicability in various healthcare settings.

Being able to acknowledge and address these limitations would highly contribute to the development of a heart attack prediction model. Researchers can build upon theses insights to refine predictive models for improved accuracies.

# Conclusion

# we Collected data from different sources and Trained A model on, it managed to fill in a Gap of purely lingual heart health data and model, The results shown were promising but still in early Development, Overall such an Idea needs more time and multiple cycles to work properly.

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