Development of a Mobile Health Application with Real-Time Caffeine Monitoring System for Preventing Negative Effects of Caffeine Overdose

In partial fulfillment for the requirements in

Thesis Writing

Alvarez, Jonel Panesa

Clamor, Jomar Otrera

Diasanta, Michelle Marie Andres

Revelo, Richard John Falogme

October 2024

CHAPTER 1: INTRODUCTION

In today's fast evolving world, one staple of a beverage have stayed perfect since its creation first described in the 18th century by the Swedish botanist, Carolus Linneausan, an intricate mixture of more than a thousand chemicals and has a number of benefits that are more difficult to detect. It is a stimulant that works by blocking a inhibitory neurotransmitter called adenosine in the brain, meaning that it boosts brain function, has a high number of antioxidants, and may also Improve your mood and help fight depression. of course we are talking about coffee, but in our research coffee is not the main topic of our thesis, but a natural stimulant that resides in coffee commonly, called "Caffeine". But caffeine is not only found in coffee but found in tea, cola, cocoa, guarana, yerba mate, and over hundreds of other products like energy drinks and as previously stated chocolate that comes from cocoa.

caffeine has been associated with numerous daily needs. A drink when you wake up, a drink before you play a game, or a drink so you can stay awake and study better, but there is little research and exploration on what caffeine can do to our cognitive abilities and performance in the long term. Although caffeine is generally safe in low-to-moderate amounts, high levels of consumption can cause unpleasant and even dangerous side effects, being a very high consumer of caffeine is a predictor of high levels of stress, anxiety, and depression it can also interfere with sleep when consumed as long as six hours before bedtime, reducing sleep by an hour and interfering with sleep efficiency and REM patterns, according to a study by Christopher Drake, PhD, of the Henry Ford Hospital in the *Journal of Clinical Sleep Medicine* (2013). So time your intake accordingly.

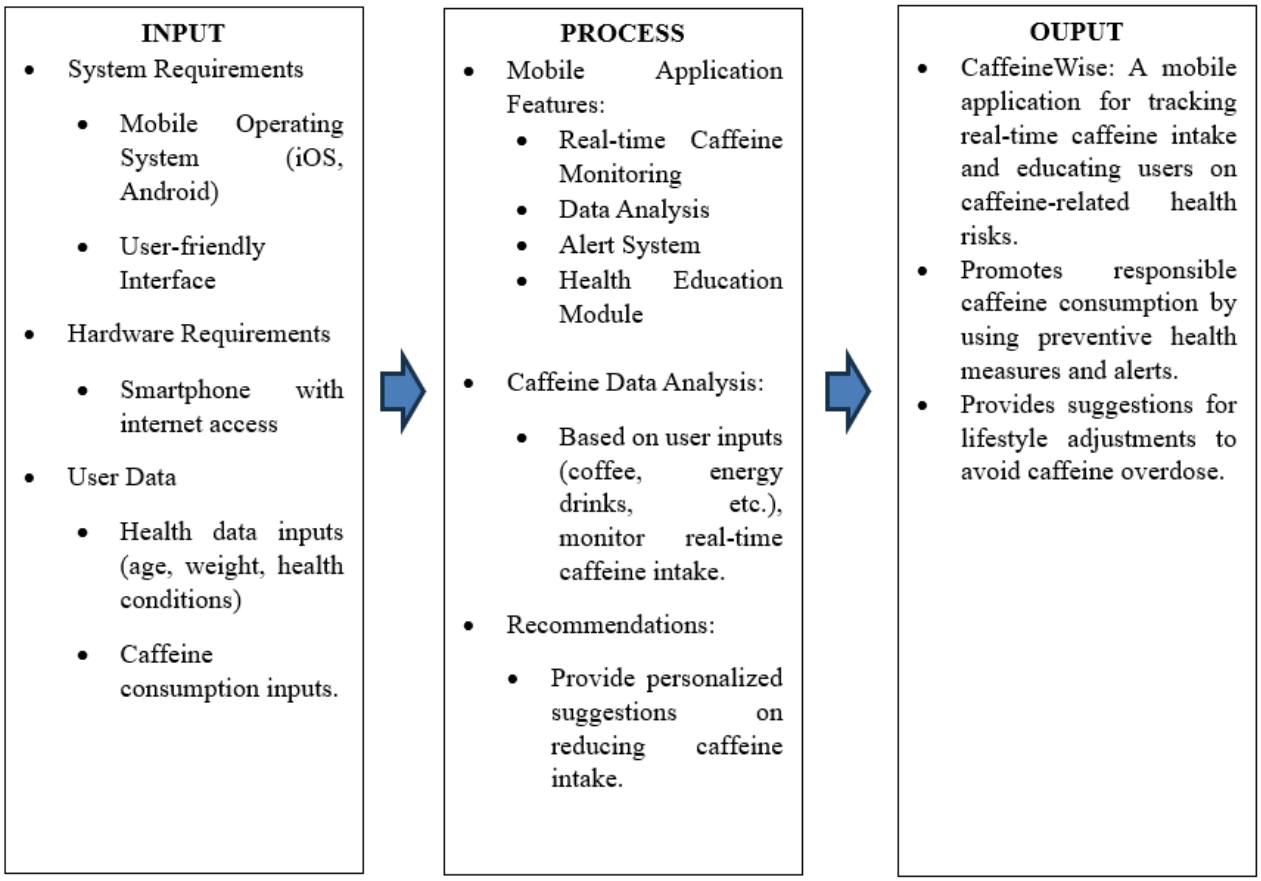
Objective of the Study

The objective of this study is to develop a mobile health application that can monitor the caffeine intake of the user so they can prevent the negative effects of caffeine overdose

Specific Objectives:

a) **Create an easy-to-use mobile app** that helps users track their daily caffeine intake and monitor it in real time to avoid overconsumption that can cause health problems like high blood pressure or heart issues.
b) **Develop a real-time caffeine tracking system** that alerts users when they are close to consuming too much caffeine, using data from different drinks like coffee and energy drinks, based on their health needs.
c) **To integrate health education and preventive measures into the application**, offering users information on the negative effects of caffeine overdose, tips for reducing intake, and recommendations for maintaining a balanced, healthy lifestyle while managing caffeine consumption.

Conceptual Framework



Significance of the Study

This study is significant as it addresses the growing concern over the widespread consumption of caffeine through many caffeinated beverages. With caffeine being a part of many individual daily lives, unregulated consumption can lead to health risks such as blood pressure, heart complications, and sleep disturbances. By developing a mobile health application that monitors caffeine intake in real time, this study offers a practical solution to prevent caffeine overconsumption and its associated health risks.

This study holds potential benefits for the broader public health domain by contributing to the reduction of caffeine-related health issues, thereby improving overall wellness in populations with high caffeine intake. The result of this study will benefit the following:

Individual Users

It will provide them with real-time tracking and personalized alerts, helping them manage their intake more effectively. This can lead to reduced risks of health problems such as high blood pressure, anxiety, unbalanced sleep, and cardiovascular issues.

Future Researchers/Developers

They can benefit from this study by gaining insights into how real-time health tracking systems can be developed and implemented.

Healthcare Professionals

Healthcare providers can recommend this application as a preventive tool for patients who are at risk of caffeine-related health complications. It will enable better patient self-management and may reduce the need for medical interventions related to caffeine overdose.

Scope and Limitations

This study focuses on creating a mobile health app that tracks caffeine intake in real time to help users avoid overconsumption and the related health risks. The app will monitor caffeine from drinks like coffee and energy drinks. The app will send alerts when the user reaches unhealthy levels.

The app depends on users who precisely record their caffeine intake for the app to function properly. The data may be inaccurate if people make mistakes. It doesn't precisely account for other sources, such as food or medications, and mostly measures caffeine from beverages. The app may not function properly without a stable internet connection because it requires internet to provide real-time alerts. Furthermore, everyone reacts differently to caffeine, the app's warnings may not be helpful to everyone.

The target audience for this study on a mobile health application designed to monitor caffeine intake in real-time is college students that rely on caffeine to manage intense study schedules, often leading to high levels of consumption that could result in sleep disturbances, anxiety, or cardiovascular issues.

Definition of Terms

Caffeine Intake - The amount of caffeine consumed by an individual from various sources such as coffee, tea, energy drinks, and certain foods or medications**.**

Caffeine Overdose - Occurs when an individual consumes an excessive amount of caffeine, leading to symptoms such as restlessness, rapid heartbeat, high blood pressure, nausea, or even more severe health issues

Real-time Tracking System - A technological system that collects and processes data instantly as events occur, providing immediate updates or feedback.

Medical Alerts - Notifications or warnings generated by a system to inform users or healthcare professionals about a potential health risk or emergency.

System Development - The process of designing, creating, testing, and maintaining a software system or application.

User testing - A process in which real users interact with a system or application to evaluate its functionality, usability, and overall user experience.

HSCL-25 - Hopkins Symptom Checklist-25, is a symptom inventory which measures symptoms of anxiety and depression It consists of 25 items: Part I of the HSCL-25 has 10 items for anxiety symptoms; Part II has 15 items for depression symptoms.

Review of Related Literature

Health Application

Mobile health (mHealth) applications have become increasingly popular for monitoring health metrics and enhancing patient engagement. However, assessing the quality and effectiveness of these apps presents unique challenges. Grundy, Wang, and Bero (2015) conducted a systematic review that examined common and innovative methods for evaluating mHealth app quality. Their findings indicate that many mHealth apps lack rigorous quality standards, leading to potential reliability issues in health monitoring tools. This review highlights the importance of developing standardized assessment criteria for health applications to ensure user safety and accuracy in health data, supporting the need for robust quality checks in mobile health app development (Grundy et al., 2015).

Mobile health (mHealth) applications have become widely used tools for tracking health behaviors and encouraging user engagement in health management. A study by Krebs and Duncan (2015) analyzed the trends and characteristics of mHealth app usage among U.S. mobile phone users, revealing significant interest in fitness and nutrition tracking. However, the study found that many apps lack advanced, evidence-based functionality and have high discontinuation rates due to data entry demands and concerns about data privacy. Younger, higher-income, and higher BMI individuals were more likely to use these apps, while users expressed a strong preference for apps that integrate with healthcare providers through features like appointment scheduling and secure data sharing. This study emphasizes the need for more user-centered and secure app designs to enhance adoption and sustained use in health management (Krebs & Duncan, 2015).

Mobile health (mHealth) applications are increasingly recognized for their role in improving disease management, particularly in underserved rural areas with limited healthcare resources. In a systematic review, Emeihe, Nwankwo, Ajegbile, Olaboye, and Maha (2024) examined the impact of mHealth apps on disease management in rural settings, noting substantial benefits such as improved healthcare access, remote monitoring, and timely medical interventions. The study highlights app features

like symptom tracking, medication reminders, health education, and telemedicine, which collectively enhance patient outcomes for chronic conditions like diabetes and hypertension. However, the authors identify barriers such as limited internet, low digital literacy, and privacy concerns, which constrain app effectiveness in these regions. The study underscores the importance of context-specific applications that address rural challenges and the need for integration into existing healthcare systems, affirming mHealth's potential to advance public health in underserved areas (Emeihe et al., 2024).

Caffeine Health Impacts

Overview of Caffeine Effects on Human Health and Emerging Delivery Strategies, comprehensively examines caffeine's diverse effects and the mechanisms by which it interacts with physiological processes, while exploring new delivery approaches that improve caffeine's health-related benefits. The review highlights caffeine's impact on inflammation, neuroprotection, and disease-specific conditions, such as neurodegenerative disorders, liver health, and cognitive function. Additionally, emerging delivery methods, such as targeted and sustained-release forms, are discussed for their potential to maximize caffeine's health benefits while minimizing side effects. This review emphasizes caffeine's therapeutic potential and the importance of innovative delivery systems to enhance its efficacy and safety in health management (MDPI, 2023).

Caffeine, Human Health and Sustainability. provides an in-depth look at the caffeine sources It highlights caffeine's widespread presence in foods and beverages, as well as its dual nature of health effects. Benefits include enhanced alertness and cognitive performance, while risks range from sleep disturbances to cardiovascular and gastrointestinal concerns. The review emphasizes individual differences in caffeine tolerance due to genetics and health factors. Additionally, it underscores coffee's

sustainability challenges, particularly in major coffee-producing countries, and advocates for environmentally responsible farming practices to combat deforestation and soil erosion. This review offers a holistic perspective on caffeine's health effects and sustainable coffee production practices, aiding stakeholders in making informed decisions on consumption and policy (Niazi, 2023).

Coffee and caffeine consumption are increasingly recognized for their associations with various health outcomes, driven by interest in their potential protective and adverse effects. Grosso, Godos, Galvano, and Giovannucci (2017) conducted an umbrella review synthesizing findings from 112 meta-analyses of observational studies and 9 meta-analyses of randomized controlled trials (RCTs). Their analysis examined the impact of coffee and caffeine on 59 distinct health outcomes. They observed a probable reduction in the risk of several chronic conditions, including breast, colorectal, colon, endometrial, and prostate cancers, as well as cardiovascular disease, mortality, Parkinson's disease, and type-2 diabetes in association with coffee consumption. While caffeine appears to increase blood pressure acutely. These findings underscore the broad health implications of coffee and caffeine, presenting coffee as a potentially beneficial component of a balanced diet when consumed with consideration of individual health profiles (Grosso et al., 2017).

Intake of Caffeine and Its Association with Physical and Mental Health Status among University Students in Bahrain

Stated However, intake of caffeine in high doses may lead to adverse effects on health [20]. A recent systematic review identified several unwanted symptoms associated with a high daily intake of caffeine; these include palpitations, headache, tremors, anxiety, agitation, restlessness, and sleep problems [21].

Research also shows that university students might be at a particularly high risk of adverse effects due to their high intake of caffeine [4]. For example, high caffeine use by university students is associated with sleep problems, particularly poor sleep duration and quality as well as excessive daytime sleepiness [22,23,24]. University students who are trying to control or lose weight are more likely to consume higher amounts of caffeine [25]. Binge alcohol drinking is also associated with the intake of energy drinks and other caffeinated beverages by university students [26].

Taking all of the above information collectively, it becomes clear that more research is necessary to study the overall intake of caffeine and its potential cumulative effects on physiology and behavior among populations vulnerable to its negative effects. Given the absence of previous research that focuses on the quantification of caffeine intake, its sources and its impact on health among Bahraini university students; the topic warrants further attention. The Bahraini student population consists mainly of Arab and Muslim individuals, which makes them different from other populations.

Data Collection And Analysis

Big data in healthcare: management, analysis and future prospects.

The advent of computer systems and its potential, the digitization of all clinical exams and medical records in the healthcare systems has become a standard and widely adopted practice nowadays. In 2003, a division of the National Academies of Sciences, Engineering, and Medicine known as Institute of Medicine chose the term “electronic health records” to represent records maintained for improving the health care sector towards the benefit of patients and clinicians. Electronic health records (EHR) as

defined by Murphy, Hanken and Waters are computerized medical records for patients any information relating to the past, present or future physical/mental health or condition of an individual which resides in electronic system(s) used to capture, transmit, receive, store, retrieve, link and manipulate multimedia data for the primary purpose of providing healthcare and health-related services"

Intake of Caffeine and Its Association with Physical and Mental Health Status among University Students in Bahrain

An Arabic language, self-administered questionnaire was used to collect the data. The questionnaire consisted of structured, closed-ended questions. There were no open-ended or continuing questions, making the questionnaire simple and quick to answer; the investigator estimated that it would take each participant around 7 to 10 min to complete their form based on a pilot test activity. The questionnaire was divided into three domains; socio-demographics and anthropometrics, daily caffeine intake, and the HSCL-25. The overall mean intake of caffeine from all dietary and non-dietary sources by university students was within levels considered to be acceptable by many dietary recommendations. About one-fifth of the students consumed more caffeine (over 400 mg/day) than is advised [7,36]. Levels of unsafe or maximum caffeine intake remain debatable, due to limited safety data. Our research shows that high caffeine use is associated with the following symptomatology: headaches, spells of terror or panic, feeling trapped or caught, worrying too much about things, anxiety and psychological distress. The present study is the first and largest to examine the association of daily caffeine intake from caffeine-containing products with symptoms among university students in Bahrain.

The U.S. Food and Drug Administration has cited 400 milligrams per day as a safe dose of caffeine [33]. Thus, to examine the association between high caffeine intake (≥400 mg/day) and the symptoms of the HSCL-25, logistic regression was performed, and odds ratio (OR) and 95% confidence intervals (95% CI) were computed, and significance was considered at p-value < 0.05. In the regression model, the independent variable was high caffeine intake (≥400 mg/day) or normal caffeine intake (<400 mg/day). The dependent variable was absence of symptoms (not at all) or the presence of symptoms (a little bit,

quite a bit, extremely) for the individual scores pf the symptoms of the HSCL-25; or a cut off of 1.75 for psychological distress, anxiety or depression scores.

Data Collection Mechanisms in Health and Wellness Apps: Review and Analysis.

The JMIR article discusses a study on the development and testing of the Digital Pain Management Solution (DPMS) for individuals experiencing chronic pain. The DPMS combines tailored digital therapeutics with an AI-based app that offers real-time monitoring, feedback, and personalized interventions. The study found the DPMS effective in managing chronic pain by promoting self-management and improving mental well-being. The article suggests that such digital interventions could complement traditional care, improving accessibility and empowering patients.

References:

Haitham Jahrami 1,2,*, Mana Al-Mutarid 2, Peter E Penson 3,4, Mo'ez Al-Islam Faris 5, Zahra Saif 1, Layla Hammad 1

Intake of Caffeine and Its Association with Physical and Mental Health Status among University Students in Bahrain

doi: 10.3390/foods9040473

Health Application:

Grundy, Q., Wang, Z., & Bero, L. (2015). Challenges in assessing mobile health app quality: A systematic review of prevalent and innovative methods. *JMIR mHealth and uHealth, 3*(4), e101. https://doi.org/10.2196/mhealth.4533

Krebs, P., & Duncan, D. T. (2015). Health App Use Among US Mobile Phone Owners: A National Survey. *JMIR mHealth and uHealth*, 3(4), e101. https://doi.org/10.2196/mhealth.4924

Emeihe, E. V., Nwankwo, E. I., Ajegbile, M. D., Olaboye, J. A., & Maha, C. C. (2024). Mobile health applications for disease management in rural areas: A systematic review. *International Journal of Academic Research in Social Sciences*, 1423. https://doi.org/10.51594/ijarss.v6i8.1423

Caffeine health impacts:

MDPI. (2023). *Overview of Caffeine Effects on Human Health and Emerging Delivery Strategies*. *Pharmaceuticals, 16*(8), 1067. https://doi.org/10.3390/ph16081067

Niazi, P. (2023) Caffeine, Human Health and Sustainability. Scientific Research Reports (pp.97-111) https://www.researchgate.net/publication/383256964_Caffeine_Human_Health_and_Sustainability

Grosso, G., Godos, J., Galvano, F., & Giovannucci, E. L. (2017). Coffee, caffeine, and health outcomes: An umbrella review. *Annual Review of Nutrition, 37*, 131–156. https://doi.org/10.1146/annurev-nutr-071816-064941

Haitham Jahrami, Mana Al-Mutarid, Peter E Penson, Mo'ez Al-Islam Faris, Zahra Saif, Layla Hammad *Intake of Caffeine and Its Association with Physical and Mental Health Status among University Students in Bahrain*

doi: 10.3390/foods9040473

Data Collection and Analysis:

Haitham Jahrami, Mana Al-Mutarid, Peter E Penson, Mo'ez Al-Islam Faris, Zahra Saif, Layla Hammad *Intake of Caffeine and Its Association with Physical and Mental Health Status among University Students in Bahrain*

doi: 10.3390/foods9040473

Ben Joseph Philip, MIT, Mohamed Abdelrazek, PhD, Alessio Bonti, PhD, scott Barnett, PhD, John Grundy, PhD

Data Collection Mechanisms in Health and Wellness Apps: Review and Analysis.

doi: http://dx.doi.org/10.2196/30468