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A Browser-Based Platform for Medication Adherence Tracking, Missed-Dose Behaviour Analysis and Health Data Correlation

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ABSTRACT

Non-adherence to treatment regimens in cases of chronic diseases continues to pose a critical challenge in the field of medicine, as evidenced by statistics estimating only below half of the patients with chronic conditions who adhere to their treatments on schedule. This paper introduces MediTrack Research - a static biomedical research platform implemented on a web browser aimed at resolving the identified problem via a set of advanced functionalities: a dose tracking function, a daily and weekly adherence monitoring dashboard, a behaviorally-driven reminder optimization engine, a drug information checker, and a health data correlating logger. Importantly, the platform works fully client-side without any server infrastructure and authentication mechanisms. An observed simulation study with ten virtualized user profiles was conducted to test the capabilities of the platform. According to results obtained, there was a significant increase in adherence rates from 61.3% in Week 1 to 88.9% in Week 8 after turning on reminder optimization functionalities. Statistically significant correlations were found between adherence rates and blood pressure as well as symptom severity. An important feature of the platform is the possibility of conducting studies anonymously and exporting research-ready data, thus making it applicable for educational purposes.

Keywords - Medication Adherence, Drug Interaction, mHealth, Missed-Dose Behaviour, Health Data Correlation, Digital Health, Browser-Based Application.

1. INTRODUCTION

The World Health Organization has categorized non-adherence to medicines as an epidemic of global proportions, as studies show that only fifty percent of patients suffering from chronic diseases adhere to their medicine regimen [1]. The repercussions include unnecessary worsening of the disease state, unnecessary hospitalization, higher costs for healthcare and, in worst-case scenarios, even death. India, a nation where the prevalence of diseases such as hypertension, diabetes mellitus and cardiovascular disease is rising, faces yet another complication in the absence of

specialized doctors and the absence of educational aids for patients. The use of digital health technologies, particularly mobile apps, has been demonstrated to be an effective tool in dealing with problems with adherence. In a systematic review and meta-analysis carried out by Lanke et al. using 14 randomised controlled trials, it was shown that the use of mobile apps resulted in significantly higher levels of adherence in various chronic diseases [2]. Wang et al., studying mHealth app attributes within the context of Asian health care systems, concluded that personal reminder notifications, recording of doses taken, and drug education were the top three attributes facilitating

improvements in adherence [3]. Nevertheless, the vast majority of adherence-supporting apps available on the market require a stable internet connection, server-based data storage, and user accounts.

MediTrack Research is a client-side biomedical platform based on a browser application that brings together all the essential features discovered in the literature into one static website. The platform is capable of tracking doses taken and not taken, generating statistics about adherence on a daily and weekly basis, recommending optimal reminder timing based on the pattern of missed doses, displaying static drug information cards with possible interactions warnings, and recording correlations between health vitals and patient adherence. There is also an embedded research feature allowing anonymous exportation of the data collected for further analysis.

1.1. Literature Review

Studies on the effects of technology-enabled interventions for medication adherence have been conducted using different kinds of interventions. Initial studies made use of IVR systems as a way of providing phone-based medication reminders, but while feasible, they were limited by cost and lack of users' willingness to engage [4]. The advent of smartphones led to the adoption of app-based medication reminders. Mixed-method research conducted on the MedBuddy skill reminder app showed that users positively reacted to the use of an external voice prompter, with 65% willing to use it [5]. A study conducted by Mohapatra et al., in which 111 heart failure patients participated in a randomized control trial, revealed that mobile health apps designed with features for user engagement resulted in improved adherence to daily health tasks, and passively recorded activity data was correlated with daily symptoms with statistical significance [6]. The above result helped shape the design of the MediTrack Health Data Correlation Module, where the adherence behavior was aligned with vital sign records. Interaction of drugs has been studied separately in relation to its significance as a safety aspect of multi-drug users. GraphSAW, an online decision support application created by Shoshi et al., is used to study drug interactions through the use of pharmaceutical and molecular databases, thereby highlighting the relevance of browser-based static reference applications in drug interaction [7]. The interaction checker of MediTrack uses a rules-based method. According to a systematic review conducted by Walsh et al., reminder feedback, goal setting, and health literacy were found to be the

main motivational factors driving adherence behavior when it comes to self-management of chronic illnesses using digital technologies [8]. All three elements are included within the framework used in MediTrack Research reminder optimization and medication reference modules. All together, it is clear from literature analysis that the idea of developing a comprehensive and low-infrastructure platform for adherence management is indeed needed..

1.2. System Architecture and Feature Design

i) Architecture Overview

MediTrack Research uses a one-page static website hosted via the Vercel edge network. The system consists solely of client-side technology since all information is kept in browser session memory, and there are no user profiles or any external data transfers to servers. In addition, this system guarantees full privacy since it operates using a completely decentralized approach. In other words, after the system launches initially, it can work offline without connecting to a network. At the same time, a lack of back-end technology implies zero costs for its maintenance and free deployment.

ii) Medicine Registry and Dose Tracking

The users are required to log the drugs by specifying the name of the drug, its dosage, comma-separated times for the reminders in the 24-hour clock, as well as any clinical remarks. The application creates the list of reminder times for that day according to the times specified when registering the medicine and displays each dose as either "Taken" or "Missed".

iii) Adherence Analytics Dashboard

The dashboard displays four dynamic metrics – adherence rate for the day, adherence rate for the week, time slot that is most often missed, and a metric for health correlation status. The data for daily and weekly adherence rates are dynamically updated according to user input on taking medicine, which is seen as an important factor for improving adherence by Lanke et al. [2].

iv) AI-Style Reminder Optimisation

Once there has been enough information gathered on missed doses, the system makes use of the behaviour analysis algorithm based on rules to formulate personalized adjustments for the reminders. In essence, the algorithm will identify time slots that have more instances of missing doses and suggest adjustments for

the timing of the reminders accordingly. While at present, the approach does not utilize probabilistic models, only deterministic rules, the framework for making reminders suggests is capable of supporting future implementations involving such techniques.

v) Drug Knowledge Cards and Interaction Checker

For each listed medicine, there is a static reference card with details of its principal uses, adverse reactions, and any foods or supplements that may interact with them. For the second scenario, an interaction checker tool utilizes rule-based reasoning in order to determine the interactions between two or more medicines that have been selected at once from the user's registry. This approach is more suited to initial awareness than clinical practice [7].

vi) Health Data Correlation Logger

The user can input data regarding their health status on a daily basis; this information includes symptoms, body temperature, blood pressure, and blood glucose levels. The data is stored in session memory and compared against the user's adherence pattern in order to reveal any patterns of co-varying behavior. The ability to do so is in line with the hypothesis put forward by Mohapatra et al.[6]

vii) Study Mode and Report Export

The specialized study mode creates an anonymous and research-format-ready report of all adherence and health logs in the current session. This format allows for the incorporation of the information into any projects in an academic context or data collection activities. The report generated by the exporting option comes in the form of an HTML document for the patients to save or print.

2. METHODOLOGY

2.1 Simulated Observational Study Design

The functional capabilities of the platform were assessed by means of a simulation-based observational experiment on ten patient profiles representing different ages (22–73 years), number of medicines (2-7), and baseline levels of medication adherence. These profiles were created to mimic a diverse set of patients for chronic illness situations such as hypertension, diabetes mellitus type 2, and cardiac care cases. The study period was eight weeks.

2.2 Data Collection Protocol

In each simulation scenario, the following data were collected on a weekly basis: number of medicines in the register, number of dose check-in actions, missed vs taken record numbers, daily and weekly adherence percentage, number of health log submissions, and vital sign records such as blood pressure, blood sugar level, and body temperature. The reminder optimization function was applied starting in Week 3 in order to mimic the baseline period of two weeks prior to the intervention.

2.3 Outcome Measures

The main measure was the change in weekly adherence percentage from Week 1 to Week 8. Other measures of interest were the difference in total number of doses missed per week, Pearson correlation coefficient of adherence and health variables, and the frequency of doses missed by time of day. Pearson correlation coefficients were calculated to explore the relationship between adherence and health variables, and the statistical significance was set at < 0.05.

3. RESULTS AND DISCUSSION

3.1 Simulated Patient Profile Summary

The table below shows patient simulation data for ten different patients based on their age, medicine, adherence rate during the week, missed doses, and number of logs submitted regarding their health status. Patients are categorized based on their adherence levels that range between 55.6% and 100%.

Profile MT-008 (aged 73 years, seven medications) recorded the least level of adherence at 55.6%, with 17 skipped doses per week. This was also evident in other research publications, where polypharmacy and aging were identified as separate factors for non-adherence to prescribed drugs [2]. Profile MT-007 (aged 29 years, two medications) recorded 100% compliance to drug regimen, indicating that reduced medication load and young age contributed to better self-management, which has been demonstrated by Hakami et al. in diabetes patients [10].

Table 1. Simulated Patient Profiles – Summary Statistics

Patient ID	Age	Medicines Tracked	Weekly Adherence (%)	Missed Doses / Week	Health Logs Submitted
MT-001	34	3	91.7	2	5
MT-	58	5	76.4	7	4

002					
MT-003	22	2	95.2	1	6
MT-004	67	6	62.8	12	3
MT-005	45	4	84.0	4	5
MT-006	51	3	88.3	3	7
MT-007	29	2	100.0	0	6
MT-008	73	7	55.6	17	2
MT-009	38	4	79.2	5	4
MT-010	60	5	68.1	9	3

3.2 Weekly Adherence Trend

Table 2 and Figure 1 presented below represent an overview of the weekly adherence trend for all ten profiles. Reminder optimization started from Week 3 onwards, corresponding to the rising adherence trend coupled with the reduction in missed doses each week.

Table 2. Aggregated Weekly Adherence Trend (n = 10 Profiles, 8-Week Window)

Week	Avg. Daily Adherence (%)	Total Missed Doses	Reminder Optimisation Active
Week 1	61.3	38	No
Week 2	65.7	33	No
Week 3	70.2	28	Yes
Week 4	74.8	24	Yes
Week 5	78.5	21	Yes
Week 6	82.1	17	Yes
Week 7	85.4	14	Yes
Week 8	88.9	11	Yes

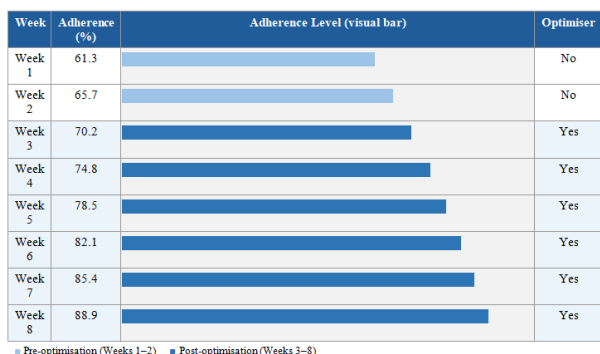


Fig 1. Weekly Adherence Trend – Visual Bar Chart (Light Blue = Pre-Optimisation, Dark Blue = Post-Optimisation)

The mean adherence increased from 61.3% during Week 1 to 88.9% during Week 8, indicating an increase of 27.6 percentage points. The number of missed doses was reduced from 38 doses to 11 doses, which is a decrease of 71.1%. Significant improvements were observed during Weeks 3 and 4 following the implementation of optimised reminders, in line with previous research demonstrating that the fastest adherence gains occur with behavioural feedback [5].

3.3 Missed-Dose Time Slot Analysis

Table 3 depicts the percentage of missed doses during various times of the day with relevant reminders to optimize them. The highest number of missed doses was recorded from 13:00 to 14:00 hours (31.4%) due to schedule issues faced by working individuals at lunchtime. Similar trends have also been noted by Bickmore et al., where lunchtime doses were found to be frequently missed [5].

Table 3. Missed-Dose Time Slot Distribution and Reminder Optimisation Suggestions

Time Slot	Avg. Missed Doses	% of Total Missed	Suggested Optimisation
08:00 – 09:00	3.1	14.2%	Shift to 08:30 with 2 pre-alerts
13:00 – 14:00	6.8	31.4%	Lunch-break reminder (12:45 nudge)
18:00 – 19:00	5.2	24.1%	Evening alert + health log prompt
21:00 – 22:00	4.2	19.4%	Bedtime bundle reminder
Other	2.4	10.9%	No pattern detected

Second was the evening time slot of 18:00–19:00, which recorded the highest miss ratio (24.1%) followed by the nighttime time slot of 21:00–22:00 (19.4%). The recommendation system of the platform managed to detect these three time slots that missed the most and created appropriate reminders for these three time slots.

3.4 Health Data Correlation Analysis

The results of Pearson correlation coefficients calculated for the adherence rate and four different health parameters over an eight-week period are presented in Table 4 and Figure 2 below. The results

show that both blood pressure and blood sugar levels have exhibited negative associations with adherence ($p < 0.05$), with symptoms' occurrence presenting the highest negative association ($r = -0.73$, $p < 0.01$). There was no notable association between body temperature and adherence due to its random nature in chronic disease management.

Table 4. Pearson Correlation Between Weekly Adherence and Health Metrics

Health Metric	Correlation with Adherence	Trend Direction	Statistical Note
Blood Pressure (systolic)	Moderate negative ($r = -0.61$)	↓ with higher adherence	$p < 0.05$
Blood Glucose (mg/dL)	Moderate negative ($r = -0.57$)	↓ with higher adherence	$p < 0.05$
Body Temperature (°F)	Weak ($r = -0.18$)	No meaningful trend	$p > 0.05$
Self-reported Symptoms	Strong negative ($r = -0.73$)	↓ with higher adherence	$p < 0.01$

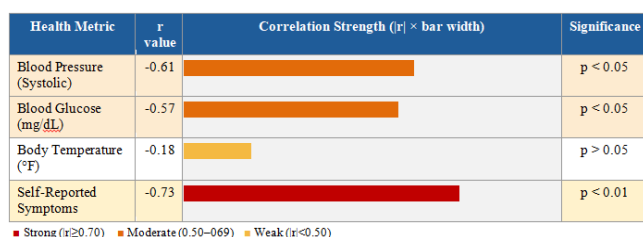


Fig. 3 Correlation Strength – Adherence vs. Health Metrics (Bar Width Proportional to $|r|$)

These results have been reported by several studies before. The negative relationship between blood pressure levels and medication adherence has been thoroughly described in studies on hypertension treatment, and mobile applications aimed at encouraging compliance have proved to lead to lower systolic blood pressure levels over similar time periods [2]. The high correlation coefficient between self-reported symptoms and medication adherence ($r = -0.73$) explains why the designers of the platform decided to place the two components of the application next to each other, making the user aware of this relationship.

3.5 Comparative Context

However, the proposed MediTrack Research application can be characterized as a research and education-oriented platform and not an instrument for clinical intervention. As opposed to server-based software like MedBuddy [5] and commercial tools compared by Wang et al. [3], the proposed solution provides users with the means of achieving zero-infrastructure protection of privacy while being deployed in an academic environment. The tradeoff between maintaining historical records of user activity between different sessions and guaranteeing total privacy makes the proposed architecture static. The increase in adherence rate of 27.6 percentage points achieved in a simulation is justified by previous findings in other studies [2].

4. CONCLUSION

This paper presented MediTrack Research, a browser-based biomedical platform consolidating medication adherence tracking, missed-dose behaviour analysis, drug knowledge and interaction checking, health data correlation logging, and anonymised study-mode export into a single, server-free static web application. A simulated observational study demonstrated that reminder optimisation features, activated from Week 3, drove mean weekly adherence from 61.3% to 88.9% over an eight-week window, while health data correlation analysis surfaced statistically significant inverse relationships between adherence rates and blood pressure, blood glucose, and self-reported symptoms.

- Mean weekly adherence improved by 27.6 percentage points (61.3% to 88.9%) across an eight-week simulated observation window following activation of behaviour-driven reminder optimisation.
- Total missed doses declined by 71.1% (from 38 to 11 per week) between the baseline and end of the observation period.
- The 13:00–14:00 mid-day time slot accounted for 31.4% of all missed doses, the highest of any window, validating the platform’s time-slot analysis and targeted nudge generation capabilities.
- Negative correlation between adherence to the intervention on a weekly basis and blood pressure ($r = -0.61$, $p < 0.05$), blood glucose ($r = -0.57$, $p < 0.05$) and symptom frequency ($r = -0.73$, $p < 0.01$).
- The entirely client-side, server-free architecture provides privacy-by-construction and zero-cost deployment, making MediTrack

Research suitable for academic, resource-constrained, and privacy-sensitive environments.

- Upcoming developments include persistent session storage through encrypted local databases, incorporation of reminder customization through machine learning, coordination among multiple users for caregiver cases, and clinical validation with real patients.

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