**DoseBuddy - Survey Report**

**Mobility in Aging II**

**Madeline Rao Shishis**

**Melvin Mokhtari**

**Nnamdi Nnake**

**Edward Chu**

# **Introduction**

Non-adherence to treatment has been identified as a major source of danger to patients [1]. This problem is more acute amongst older adults, whose population is increasing and estimated to reach 2.1 billion in 2050, or 1 in every 5 persons [2]. One popular approach for dealing with the issue of medication non-adherence is the use of automatic pill dispensers which are designed to ensure the right drugs are taken in the right quantity at the right time [3]. Olaleye et al. (2025) estimate the value of the automated drug market at $2.5 billion in 2020 and project the figure would double to $5.4 billion in 2030 [4]. This report surveys the current state of automatic pill dispenser research and design, to guide the development of DoseBuddy, our innovative pill dispensing solution. The survey assesses different approaches that have been adopted in automatic pill dispenser design, the needs of users, the variety of features offered by different products, as well as the attributes and limitations of our proposed device.

**Literature Review**

In assessing the mechanical features and mechanisms of commercially available home pill dispensers, Marmaglio et al. (2024) assert that the functional principles of these products fall into three macro categories. These are envelope roll dispensers, which deliver doses in sealed sachets, compartment-style dispensers, where required dosages are split into multiple compartments, and container-type dispensers, which are devices with several containers to hold pills. They argue that the most important roles dispensers should play are controlling and tracking drug administration [3]. *Automatic pill dispensers are therefore electronic medication management devices*. Patel et al. (2020) report that Canadians could purchase more than 80 of such products for their medication needs in 2016. Yet, they observe that despite the proliferation of automatic pill dispensers, extant research has not studied their usability, which is described as the “facility with which users can use a technological artefact to achieve a particular goal” [2].

However, with regards to the usability of automatic pill dispensers, Bhandari’s (2022) prototype was tested for its market and financial potential in Portugal, and reports that a simple user interface would influence a client’s willingness to purchase one, if it suited their budget [1]. Buono et al. (2018) adopted a modular approach to design a system that combined a pill dispenser with a mobile application and web server to respectively control the device and store information. In usability tests of the model, they reported an average success rate of 84%, and stated that scheduling tasks were the most problematic for volunteers when interacting with the automatic dispenser [5].

Similarly, a proof-of-concept study by Zilp, Touw and Bowen (2020) for a Smart Pill Bottle Prototype, also managed via an app and a web-platform, recorded a mean System Usability Scale score of 79.3 and an adherence rate of 88% amongst volunteers [6]. On the other hand, Stip et al. (2013) suggested that live monitoring would be valuable as a standardized objective measure of adherence to medication, following randomized tests for DoPill, a 28-compartment smart pill dispenser that combined manual controls, alarms and sensors to track consumption of medication by schizophrenia patients [7].

# User Needs

DoseBuddy, our proposed automatic pill dispenser, seeks to fill important gaps that available interventions do not address, and to do so in a cost-effective way. Based on the literature, one of the key concerns of users is the simplicity of the product and in particular, the user interface [8]. People neither want to feel stigmatized by their age, nor to be digitally excluded [7, 5]. Ease-of-handling was also identified as an important usability factor. Hence, pill dispensers should be easy to move around and the format in which medication is dispensed should not be cumbersome [6]. Here, our approach of CAD modelling and modular 3D prototyping will be beneficial to our overall design. Added to these desirable features of functionality, usability and aesthetics, is the users need for security to protect access to the device, its contents, and any app used for control where applicable [8].

# **Comparison of C**ompeting Products

There are several automatic medication dispensers available on the market, five of which will be compared in this section. The first example of a current product is Hero. This automatic medication dispenser contains 10 compartments for each unique pill per container. The dispenser automatically dispenses one pill based on the programmed set of medication for each time period. The dispenser includes a display screen that provides information on the next dose and current time, and there is one button with 4 arrows for the user to interact with. Once the user presses the button, the medication is dispensed. The dispenser also has an audio alarm to remind the user to take medication. This solution is accompanied by an app, which is discussed in the next section. Hero is available to users for a monthly fee of $44 with a minimum commitment of 1 year ($528). The device cannot be purchased, and is therefore very expensive. However, this solution provides 24/7 live support, and users can easily connect to licensed clinical professionals.

The second example of a current product is MedaCube, which includes 16 containers for each unique pill. The display screen allows the user to program their medication dispensing schedule, and includes medication images. There are also tilt sensors that detect when the dispenser has been tampered with or when medication has spilled, thereby locking the system for safety purposes. This device underwent clinical trial testing, and reports having 48-97% of users comply with their medication routine. A unique feature of this device is that it includes a barcode scanner to directly input pill information from the original bottle. This solution is accompanied by an app, which is discussed in the next section. MedaCube is available for purchase at $1999, which is very costly. It must be plugged into an outlet, however if there is no power, there is a 24-hour battery backup. This dispenser also supports the use of narcotics, given that it has emergency locking capabilities when tampered with.

The third competing product is LiveFine, which consists of a simple rotational setup with 28 compartments. This product does not provide automatic sorting, and therefore requires the user to pre-load each compartment. There are 9 different dose ring labels for the user to choose from to track their medication schedules. The LCD screen displays the alarm volume, battery level, current time, next alarm, and wifi connection. While the dispenser does not require wifi to operate, it is required to set up the medication dispensing schedule. The dispenser provides 3 tone options for alarms, and lights flash when medication needs to be taken. The device operates on rechargeable batteries. LiveFine does not indicate device dimensions, but it appears to fit in the palm of a large hand. The cost for this solution is $280.

The fourth competing product is Lifeline, which uses 60 Solo Cups provided by Lifeline to be dispensed at particular times. The cups must not be damaged, cracked or crushed, otherwise the dispensing may be interrupted. These cups require very specific manual loading procedures, as each cup is meant to contain the medications for one time point. Cups are placed on trays, which hold up to 7 days of medications at 6 doses per day. Trays are loaded into the dispenser in a specific order. This requires manual labelling for each cup lid to assist with organization. The dispenser also requires a phone line for proper operation, and will send voice messages as reminders to take medications. The user therefore must ensure that no 1-800 numbers are blocked.

The fifth product that is currently on the market is the e-Pill Voice Pro. This dispenser has 28 compartments in a rotational setup. The product comes with two keys to lock the lid, and a filling guide for manually placing medication in the small compartments. The display screen blinks and includes a voice-based notification, where users can select from 9 different voice note options. The device is battery-operated, and can be recharged. This product costs $400. A size is not provided, however it appears to be the size of a coffee machine. The device requires to be plugged into an outlet, and costs $90. There is an additional monthly fee to subscribe to the app, although costs are not provided.

**Table 1: Summary of Competing Products**

| Competing Product | # of Containers | Automatic Sorting? | Size | Power Supply | Cost | Interactions with User | Connections required? |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Hero [9] | 10 | Yes | 9 in x 9 in x 15 in | Plugged in  Emergency Safety Key | $44/month  1 year minimum | Display Screen (next dose, current time)  Audio Reminder of next dose  One Button to dispense medication | Wifi |
| MedaCube [10] | 16 | Yes | 10in x 10in (depth not provided) | Plugged in  24-hour battery backup | $1999 | Display Screen (touch to dispense)  Barcode Scanner  Tilt sensors | N/A |
| LiveFine [11] | 28 | No | N/A | Chargeable battery | $280 | LCD screen (current time, next dose)  Audio alarm (3 tones)  Blinking Lights | N/A |
| Lifeline [12] | 60 (dose cups) | No - manual is very confusing | N/A | Plugged in  Battery backup | $90 + monthly app subscription | Phone line voice messages | Phone line |
| e-Pill Voice Pro [13] | 28 | No | 9 inch diameter x 2 inch | Chargeable battery | $400 | 9 daily alarms with voice notifications  Blinking Lights | N/A |

# **Comparison of Co**mpeting **Apps**

There are several apps that assist with medication taking, and most are provided by the same companies that design the automatic medication dispenser. Firstly, Hero’s app allows for medication scheduling and reminder setting. The app connects users to providers, healthcare professionals, and live support. The app provides text and audio reminders, and provides real-time reports on medication use and adherence. The app will also alert the user when pills are low and need to be refilled. The app includes HIPAA-compliant security, and is password protected.

Secondly, MedaCube’s app provides scheduling for medication taking and reminder settings. The app provides reports including recent doses, adherence, pill inventory, and pill dispensing times. The recent doses are particularly useful for caregivers to check if the most recent dose has been taken. The app allows healthcare professionals to access these reports, with the permission given by the user. Caregivers receive alerts for missed doses, when prescriptions need to be refilled, internet outages, and power outages, which are particularly useful when they are not present at the user’s location. Every dose can be viewed and authorized by the caregiver through the app if internet connection is available. The app sends notifications to the user to take their medications, and provides a followup notification if the dispenser has not been used within 10 minutes of the first notification.

Thirdly, LiveFine’s app provides information regarding the next dose, number of doses remaining for the day, refill dates, and number of remaining doses. This app allows the user to connect to multiple family members. Medical professionals and caregivers can also access the app. Additionally, the scheduling of the medication dispensing is created through the app, and provides notifications on dosage reminders.

Fourthly, Lifeline’s app “My Lifeline” is a general app used for all of Lifeline’s products. The details of the app do not provide information regarding medication scheduling or reports, however this does not mean the app does not include these features. This app provides emergency contacts to be set up, allows connections to caregivers and technical assistance, and allows GPS tracking. The app sends push notifications, and sends alerts when battery-backup is low on the device (in this case, the dispenser). Family members and caregivers are also able to share photos, reactions, and trends with users to stay connected.

Lastly, e-Pill’s app is very basic. It connects to the dispenser via bluetooth, and therefore requires the phone to be within 33 feet of the dispenser in order to use the app’s capabilities. The app allows for setting alarms on the dispenser, formatting the device time and volume, sending text notifications, and notifying when the battery is low. The app also provides records for medication taking history. It is unknown whether the e-Pill app provides connections to caregivers, as this information is not provided in the website.

**Table 2: Summary of Competing Apps**

| Competing App | Scheduling | Reports | Additional Connections | Reminders |
| --- | --- | --- | --- | --- |
| Hero [9] | Medication Taking  Reminder Setting | Medication use  Adherence  HIPAA-compliant security | Providers  Health care professionals  24/7 Live Support | Text  Audio |
| MedaCube [10] | Medication Taking  Reminder Setting | Recent Doses  Adherence,  Pill inventory  Pill dispensing times | Share reports with healthcare professionals  Caregiver alerts (e.g., missed dose, power interruptions) | Text  Email  Phone |
| LiveFine [11] | Medication Taking  Scheduling Dosages | N/A | Nurses  Caretakers  Family members | Text  Audio |
| Lifeline [12] | Unknown | Unknown | Emergency contacts  Caregivers  Technical Assistance  GPS  Share photos | Text  Audio |
| e-Pill Voice Pro [13] | Medication Taking  Reminder Setting | Dosage record | Unknown | Text |

# **Gaps in Existing Prod**ucts

The significant volume of research on automatic pill dispensers is indicative of the continuous growth in the field and the great variety in product design signifies efforts to meet user needs with suitable devices. The literature however suggests that some gaps remain unresolved. These may arise from the design, operations or integration of the various components that make up the automatic medication dispensing system. Tracking the dosage of pills and the time they are dispensed remains a major concern [14, 3]. In systems that combine a dispenser with an app and a web server, one reason tracking can be difficult is the reliability of the network connection linking all three. With wireless connectivity for instance, loss of signal may not only lead to inability to track, but may also disable the alarm/alert system [5].

In addition to tracking and reminder systems, the power source may also constitute a challenge. This issue may be more acute in the Global South or places where power supply is inconsistent. Hence, the call for more international collaboration between researchers is apt [4]. One interesting study of a smart pill dispenser for hospitals in Uganda explored user perceptions of its usefulness for achieving medication adherence. This study outlined the benefits and potentials of the technology, but noted that it could not address the dosage risks posed by herbal remedies which some patients consumed alongside or in replacement of the pills to be dispensed [15]. Such research is indicative of the gaps that exist in research which could begin to explore dispensing solutions for herbal treatments.

With respect to app-based control systems, users have expressed desires for simplified user interfaces, but more broadly, the financial requirements of owning a smartphone and maintaining monthly subscriptions remain a constraint [2]. Security-wise, the control mechanisms for the dispensers surveyed are typically physical or app-based, but rarely both. Furthermore, dispensers for home use are usually designed for single users, but multi-user functionality has been identified as a path research should explore [5].

# **Our Proposed Device**

Our proposed device, DoseBuddy, consists of several stackable (modular) layers of medication dispensing units. On one unit, there is a rotational device that dispenses medication down a spiraling slide. The dispensing action is powered by a stepper motor, which rotates a specific number of steps to allow the desired compartment medication to fall into the release slide. This motor will be controlled through an arduino microcontroller. With the addition of a clock module, these components will control what time the medication will be dispensed. Each unit contains one motor, one microcontroller, and one clock module, which allows each layer to be controlled individually. The layers stack on top of each other via a snap and quick-release mechanism on the slide, as well as a support structure that fits between each layer. This unique design feature of DoseBuddy allows for modular compartment setup, depending on medication needs, which offers a competitive advantage over currently available dispensers on the market. In this regard, households that have multiple users may only need one device.

Each layer can be detached for simple loading and unloading of medication. The base dispensing layer leads to an exit door that locks and unlocks at specified time points. This locking feature is controlled through an app. The locking mechanism will be controlled via wifi modules, which will enable communication through the app to provide more control to the caregiver even if they are not at the location of the dispenser. This unique feature of locking and unlocking of the dispenser through an app provides better remote support and safety from the caregiver in the event that the user is not taking medication during the designated times. This is another competitive advantage over products on the market, as there is no known app that controls the locking of the physical device.

DoseBuddy will also offer dual-operation, where the dispenser can be manually unlocked. This feature allows caregivers to have more control through the app, but does not require users taking medication to use the app if they do not wish to. The dispenser will also contain an LCD display which will allow interaction with the user to display messages, including last dose, next dose, and the current time. The dispenser will include text, audio and visual alerts when medication needs to be taken. It will need to be plugged into an outlet, however, it will also provide up to 4 hours of battery back up. In the event of a power outage, there will also be a physical key for accessing medications. The app that accompanies the dispenser will have features such as setting reminders, alarms, and interacting with caregivers. History checks and reports will be available for caregivers to ensure that medications are being taken. If the user has not taken their medication after 15 minutes, a notification will be sent to the caregiver.

# Limitations of DoseBuddy

With every device, there are limitations that should be acknowledged. One of the limitations that our device shares with many currently available devices is when power outages or wifi outages occur. Our device requires it to be plugged into an outlet, and while there is battery backup, this has a finite lifetime. With longer battery backup, the cost of the device increases, and is therefore not cost-efficient to have long battery backup time. Additionally, the device does not provide any solution if the wifi connection is lost, besides sending a notification to the caregiver. This may be an area of further research. For example, it may be possible to employ systems of temporary data storage which can subsequently be synchronized with a database.

An additional limitation is evaluating the cost of our design. Our initial goal was to provide a more cost-effective solution than dispensers that are currently available on the market. However, it is challenging to predict research & development costs, production costs, and marketing costs, which will ultimately impact our selling price. Ideally, we would want our device to be sold for less than $90, as this is cheaper than most automatic dispensers available. However, this is a challenge to achieve at the current progress of our product.

# **Conclusion**

DoseBuddy is a project we are excited about. Whereas automatic pill dispenser research and design is extensive, this survey indicates that our prototype has the potential to address existing gaps. We propose a modular design for the dispensing machine, and our objective for the first prototype is to create the base module. In the long run, we anticipate a prototype that comprises multiple modules operating concurrently. Our CAD design and 3D printing approach will give us the flexibility to make changes to the dispenser’s components as required. The multifunction feature of this modular product is a key feature that stands out. In conjunction with our co-designers our finalized design will include a limited test of the prototype to assess functionality, usability, aesthetics and security..

# References

1. L. Bhandari, “Assessing the Market and Financial Potential of Selfmed Pill Dispenser: a Start-Up Aiming to Eradicate Medication Non-Adherence in Portugal,” ProQuest Dissertations & Theses, 2022.
2. T. Patel *et al.*, “A Prospective Study of Usability and Workload of Electronic Medication Adherence Products by Older Adults, Caregivers, and Health Care Providers,” *Journal of medical Internet research*, vol. 22, no. 6, pp. e18073–e18073, 2020, doi: 10.2196/18073.
3. P. Marmaglio *et al.*, “Home Pill Dispenser Operating Technologies: Automation Mechanisms Comparison,” in *Advances in Italian Mechanism Science*, vol. 164, Switzerland: Springer, 2024, pp. 529–537. doi: 10.1007/978-3-031-64569-3\_60.
4. S. A. Olaleye, O. E. Olubunmi, B. W. Atsbeha, and M. N. Wodaje, “Unveiling the complementariness of robotic tablet dispensing machines for elderly care: A bibliometric data analysis,” *Exploratory research in clinical and social pharmacy*, vol. 17, pp. 100545-, 2025, doi: 10.1016/j.rcsop.2024.100545.
5. P. Buono *et al.*, “A Modular Pill Dispenser Supporting Therapies at Home,” in *Current Trends in Web Engineering*, vol. 11153, Switzerland: Springer International Publishing AG, 2018, pp. 71–82. doi: 10.1007/978-3-030-03056-8\_7.
6. T. R. Zijp, D. J. Touw, and J. F. M. van Boven, “User Acceptability and Technical Robustness Evaluation of a Novel Smart Pill Bottle Prototype Designed to Support Medication Adherence,” *Patient preference and adherence*, vol. 14, pp. 625–634, 2020, doi: 10.2147/PPA.S240443.
7. E. Stip, P. D. Vincent, J. Sablier, C. Guevremont, S. Zhornitsky, and C. Tranulis, “A randomized controlled trial with a Canadian electronic pill dispenser used to measure and improve medication adherence in patients with schizophrenia,” *Frontiers in pharmacology*, vol. 4, pp. 100–100, 2013, doi: 10.3389/fphar.2013.00100.
8. O. Lima, Terroso, M., Dias, N., L.Vilaça, J., Matos, D, “Development of a Pill Dispenser: System Requirements and Product Architecture,” in: Martins, N., Brandão, D. (eds) *Advances in Design and Digital Communication III*. Springer, 2023, Cham. https://doi-org.libaccess.lib.mcmaster.ca/10.1007/978-3-031-20364-0\_29
9. “Individuals.” Hero. https://herohealth.com (accessed Feb 3, 2025).
10. “How the MedaCube Works.” MedaCube. https://www.medacube.com/pages/usage (accessed Feb 3, 2025).
11. “Smart WiFi Automatic Pill Dispenser.” LiveFine. https://www.livefineproduct.com/products/smart-wifi-automatic-pill-dispenser (accessed Feb 3, 2025).
12. “Automated Medication Dispensing Service Support.” Lifeline. https://www.lifeline.com/support/dispenser/ (accessed Feb 3, 2025).
13. “MedTime Voice Pro.” E-pill: Medication Reminders. “https://www.epill.com/medsmartvoice.html (accessed Feb 3, 2025).
14. A. Sandhu, P. Singh, S. Kaur, P. K. Jindal, and S. Singh, “Automatic pill dispenser with personal health care monitoring,” in *AIP conference proceedings*, Melville: American Institute of Physics, 2024. doi: 10.1063/5.0222308.
15. G. A. Mugisha *et al.*, “Usability Evaluation of Low-Cost Smart Pill Dispenser by Health Care Practitioners,” in *Proceedings of the Future Technologies Conference (FTC) 2020, Volume 3*, vol. 1290, Switzerland: Springer International Publishing AG, 2020, pp. 17–29. doi: 10.1007/978-3-030-63092-8\_2.