

Tracking Usage Patterns of a Mobile Application for Dementia Risk Assessment in Elderly Individuals

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Abstract. Among elderly individuals, dementia stands as a prominent contributor to disability. However, multidomain lifestyle interventions have emerged as a promising approach for enhancing cognition. Taking a progressive step, integrating digital elements such as a mobile intervention application for elderly participants becomes crucial. Hence, it's crucial to identify the usage patterns of intervention features. Our aim was to implement a usage tracking mechanism and analyze usage trends and feature preferences over the initial six months of a clinical trial across various clinical sites, comparing intervention and control groups. Our findings reveal the differences in usage between the groups and highlight the most used features.

Keywords. Usage Patterns; Mobile Application; Medical Informatics; eHealth; Clinical Trial

1. Introduction

Dementia comprises a range of conditions marked by a decline from an individual's previously attained cognitive level, impacting daily activities and social functioning. It is a leading cause of disability in older people, affecting 50 million people in 2015 and is predicted to triple by 2050 [1]. Approximately 40% of cases stem from 12 modifiable risk factors addressed across various life stages [2]. Research indicates that multidomain interventions yield notable improvements in cognition [3].

The LETHE randomized controlled trial (RCT) seeks to build upon the FINGER study (Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability) [4] by integrating digital intervention techniques [5]. The LETHE RCT (ClinicalTrials.gov NCT05565170) spans two years and encompasses 160 participants at risk of cognitive decline evenly distributed across four centers: Austria (Medical University of Vienna), Finland (Finnish Institute for Health and Welfare), Sweden (Karolinska Institutet) and Italy (University of Perugia). Participants are randomized 1:1

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to either intervention or control group. Primary objectives involve assessing participant retention, adherence and engagement in the intervention, along with monitoring changes in dementia risk using validated scores such as LIBRA [6] and CAIDE [7]. The LETHE App collects digital biomarkers, providing tailored activities and lifestyle interventions for one group and questionnaires, a calendar and educational materials for all users.

While previous studies have explored mobile-based multidomain interventions [8] [9], including task monitoring, LETHE aims to surpass these by tracking user navigation paths in the app to identify frequently utilized features. Although app review trackers can highlight issues, they may not be able to capture the overall usage patterns or the need for features [10]. Another study [11] which conducted measurements on diverse metrics related to app usage has corroborated these findings. These metrics encompass factors like session duration and frequency across app categories. Their approach has similarities with ours but is broader in scope to track the initiation of multiple applications rather than specifically tailoring to screens and events within a single application.

The study outlined above [11] has a broader scope compared to our study where we've developed a usage tracking system for the LETHE App specifically for elderly users. This system objectively assesses feature usage and overall app engagement among intervention and control groups, aiding in optimizing interventions for effectiveness.

2. Methods

After creating the LETHE App, we devised a tracking system to monitor participant usage, identifying frequently used features and retention rates. Twenty different events were identified across the app's screens. These events correspond to specific actions or when the displayed screen changes. When a participant initiates the LETHE App, a session ID is assigned. Changes on the screen or opening external resources prompt an event recorded with a timestamp and session ID. This enables reconstructing a participant's path and calculating time spent on screens and throughout sessions.

Usage tracking analysis spans the initial six months post-randomization for each participant, excluding data beyond this point. LETHE App usage was recorded daily as 0 (no usage) or 1 (one or more screens opened). Analysis was conducted separately for each study group due to differing app features. Session duration was calculated by the difference between the first and last timestamps of a session ID, including only sessions with at least two distinct events. Sessions where external resources were accessed but the user returned to the LETHE App within 10 minutes were treated as a single session. Data analysis was carried out using Python [12] utilizing the pandas [13], Matplotlib [14] and SciencePlots [15] packages. Data is depicted as mean and SD or as median with 25th and 75th percentile depending on normality assessed via visual inspection of histograms. An unpaired t-test compared daily app usage between groups, while a Mann-Whitney U test analyzed session duration. Differences in usage between countries were assessed with a one-way ANOVA and post hoc Tukey HSD. To evaluate the association between the educational content and study group, a Chi-Square (χ^2) Test of Independence was used.

3. Results

The mean age of the participants was 68.80 years (SD=4.44), with 101 women (64.74%) and 55 men (35.26%). During the initial six months of the clinical trial, the intervention

group (M=50.51%, SD=7.45) compared to the control group (M=27.45%, SD=6.69) has shown a significantly higher daily app usage ($t(362)=-31.077, P<.0001$). A comparison is illustrated in Figure 1. Overall, 38.98% (SD=6.06) of the participants accessed the LETHE App per day. Peak usage for the intervention group was on day 50 post-randomization (69.23%), while for the control group, it was on day 36 (54.49%). The highest monthly average usage rate occurred in month 2 for both the intervention group (M=58.16%, SD=5.88) and the control group (M=35.21%, SD=4.36). The lowest monthly average usage rate was observed in month 4 for the intervention group (M=45.85%, SD=4.96) and in month 5 for the control group (M=21.88%, SD=3.42). The intervention group had a longer session duration in seconds with a median of 42.08 (IQR 15.64-115.49) compared to the control group with a median of 30.85 (IQR 11.68-94.74) and a Mann-Whitney U test has shown that there was a significant difference ($W=13141925, P<.0001$) in the session duration among the groups. The longest session recorded was 2013 seconds, involving educational resources and cognitive training.

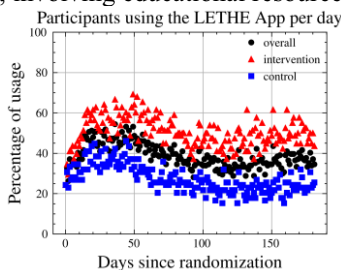


Figure 1. Daily usage rates of the LETHE App among intervention and control study groups, as well as overall, over a six-month period, expressed as percentages.

Additionally, a comparison was made among participating countries in the LETHE trial, as shown in Figure 2. Austria showed the highest LETHE App usage (M=44.45%, SD=8.58), followed by Finland (M=43.01%, SD=10.48) and Italy (M=37.45%, SD=10.36). Sweden has the lowest daily usage rate (M=30.14%, SD=9.70). Using a one-way ANOVA, it was observed that there was a statistically significant difference in the usage rates between the countries ($F(3,724)=39.34, P<.0001$). Pairwise comparison using the Tukey HSD test showed that there is a significant difference in the usage of the LETHE App between Austria and Finland ($P<.0001$), Austria and Italy ($P=0.0042$), Austria and Sweden ($P<.0001$), Finland and Sweden ($P<.0001$), Italy and Sweden ($P<.0001$). There is no significant difference in the usage between Finland and Italy ($P=.0850$). Interestingly, unlike participants from other countries, Italians showed peak usage in the first month, followed by a decline. Notably, across all countries, the intervention group consistently exhibited higher usage rates compared to the control group.

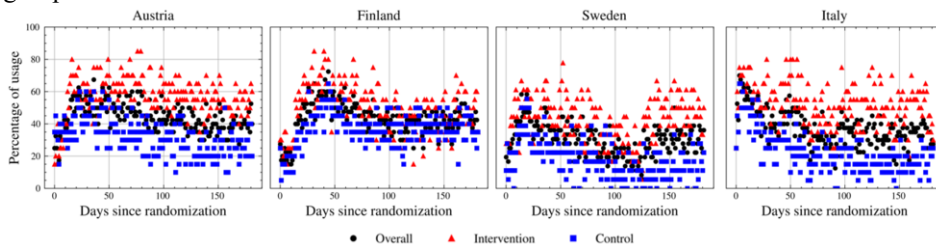


Figure 2. Daily usage rates of the LETHE App across intervention and control study groups, as well as overall, across multiple study centers, over a six-month period, expressed as percentages.

For the intervention group, the most frequently opened features in the LETHE App include personalized activities (opened 7644 times), followed by the list of available questionnaires (6870) and cognitive training (4442). Among the less utilized features, apart from settings, are social activities leading to a WhatsApp group (535), educational content (717) and physical activity videos (1376).

The intervention and control groups both track questionnaires, calendar visits and educational material but only the educational material is compared due to increased involvement in questionnaires and calendar visits within the study protocol. Here, the intervention group opened a total of 816 educational URLs, while the control group accessed 1971 URLs, resulting in a 41.40% lower engagement with educational material compared to the control group. All URLs are categorized into lifestyle domains, as detailed in Table 1. Physical activity content is the most accessed domain for both groups. Cognitive training is second in popularity for the control group but fourth for the intervention group. There is a significant relationship between the opened educational lifestyle domain URLs and the study group of the participants ($\chi^2(5)=185.27$, $P<.0001$).

Table 1. Comparison of opened external educational resources between intervention and control groups, categorized by lifestyle domains, with rankings showing group preferences.

Lifestyle Domain	Intervention		Control	
	Count	Rank	Count	Rank
Physical Activity	390	1	777	1
Nutrition	178	2	226	3
Sleep/Relaxation	85	3	219	4
Cognitive Training	82	4	609	2
Social Activity	46	5	120	5
Management of vascular/metabolic risk factors	35	6	20	6

4. Discussion and Conclusions

In this study, we examined usage patterns of a mobile app for elderly individuals in a multi-center European RCT after the first six months. We assessed app usage for both study groups, duration of use and popular features to understand user preferences. This work aims to identify improvements and prioritize features for enhancing the effectiveness of digital tools when developing applications for elderly individuals.

Low initial usage in both groups may stem from delayed technical support visits and by clinical professionals, meant to precede app usage. Usage increased in the second month but declined until the fifth month, with a spike in the sixth month due to follow-up clinical visits. The intervention group's higher usage is attributed to its comprehensive features, like the lifestyle program and mandatory tasks. Despite lower overall usage, the control group utilized educational resources 41% more than the intervention group.

Our study's limitations include not adjusting for seasonal variations as participants begin at various times throughout the year. Country differences remain uncertain, potentially influenced by the low participant numbers or other unknown factors.

Future efforts will concentrate on examining the outcomes beyond the one and two-year milestones, delving deeper into variances among various groups and countries as well as the assessment of different usage phenotypes.

Declaration

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