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Field Testing of a Novel Holistic National Health Outcome Score: An Indicator of Health from Patient-Reported Outcomes

Yapp FCW[1], Tey JXY[1], Mohammad NA[2], Hamid B[3], Lam JJF[1], Kassim N[3], Lim HS[1]

1 EVYD Technology, Brunei Darussalam
2 Digital Health Transformation Unit, Ministry of Health, Brunei Darussalam
3 Health Promotion Centre, Ministry of Health, Brunei Darussalam

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ABSTRACT

The deployment of a health score module (health index) via a national mHealth application provides a platform for the population to contribute information on their health status. The tool aims to promote health-seeking behavior and guide policymakers to improve health outcomes through population segmentation for targeted interventions. A preliminary national exercise was conducted to obtain behavioral insights in completing self-reported questionnaires using the tool and yielded an initial indicator of population health status.

1,200 active users on a national mHealth application were randomly selected according to age, gender, and history of type 2 diabetes at a 1:1 ratio. Participants were sent periodic nudges to interact with the module. A personalized health score was generated based on patient reported outcomes from 5 sets of questionnaires, parameters and biochemical tests auto-populated using existing electronic health records. User behavior and subsequent health score results were analyzed.

13% of targeted users completed the questionnaires within 1 month. Nudges were most effective on weekends and after 6pm. Uptake in those aged 60 years and above was slow, while users diagnosed with type 2 diabetes mellitus were more likely to participate. 85% of all participants were in the 'At Risk' (31-81) category; 94% of participants diagnosed with diabetes were captured here. Analysis of health variables showed that body mass index (BMI) and diet put participants at risk in the physical health and specific domain category respectively.

Preliminary results showed great promise on user adoption. The final roll-out is projected to reach a target audience of approximately 440,000 users. An effective nudging strategy, including optimal nudging windows and customized nudges, may increase public interest to participate. The existing model can capture the holistic health status of participants while taking into consideration existing diagnoses. Further regression analysis will be conducted to identify localized lifestyle factors associated with health risks.

INTRODUCTION

The effectiveness of health promotion initiatives remains difficult to measure as targeted health outcomes are only observed 10 to 15 years following the initiatives. Nevertheless, increased uptake, adoption and engagement rates have been shown to improve health literacy and encourage health-seeking behaviors. This can then lead to positive, health outcomes such as weight loss and decreased fasting blood glucose, which has strong correlations to the prevention of non-communicable diseases.

Holistic approaches to health promotion generally still rely on independent assessments of various health domains to generate insights of an individual's health. To date, there are no validated instruments that can integrate multiple sources of data across different health domains and weigh the effect of each domain to create a synergic indicator of overall health status for individuals and their healthcare providers.

The Health Index is a composite health score that can serve as a robust indicator of health to provide insights on a granular, individual level or contribute to population level insights. It can be measured over time to track changes in health and monitor the effectiveness of interventions. In the Bruneian context, the Health Index was developed as a digital solution that allows users to understand their health state by incorporating data from electronic health records and self-reported questionnaires to create a 360 view of the user, with the aim of empowering the population with health management resources, increasing health literacy and promoting health-seeking behaviours to improve health outcomes.

The deployment of Health Index in Brunei is facilitated by use of a national mobile health application (mHealth app), BruHealth, which was mandatory COVID-19 pandemic surveillance tool that has been reworked into a health promotion app post-pandemic due to the health of healthcare data. The initial Health Index pilot was launched among a randomly targeted group of active users on BruHealth app to provide initial insights and assess user behaviors across different age groups.

METHODS

1,200 active users were randomly selected and categorised according to age, gender and previous diagnosis of type 2 diabetes. There were 12 groups in total (groups A to L) with 100 users per group. Under the assumption that conversion rate would be 10% across all target groups, the pilot was set to conclude when (1) at least 10 users from each group completed the questionnaires and generated their Health Index or (2) 30 days from the day of launch, whichever came first.

Users were nudged with targeted push notifications from BruHealth app at varying times and days of the week throughout the pilot. An adaptive strategy was deployed to increase adoption rate.

Users would then complete questionnaires in the Health Index module. The domains of health include (in order):
1) Basic demographic
2) Lifestyle
3) Physical Health
4) Frailty (FRAIL scale[1])
5) Mental Health (DASS-21[2])
6) Diet (SFFFQ[3])
7) Physical Activity (IPAQ-SF[4])

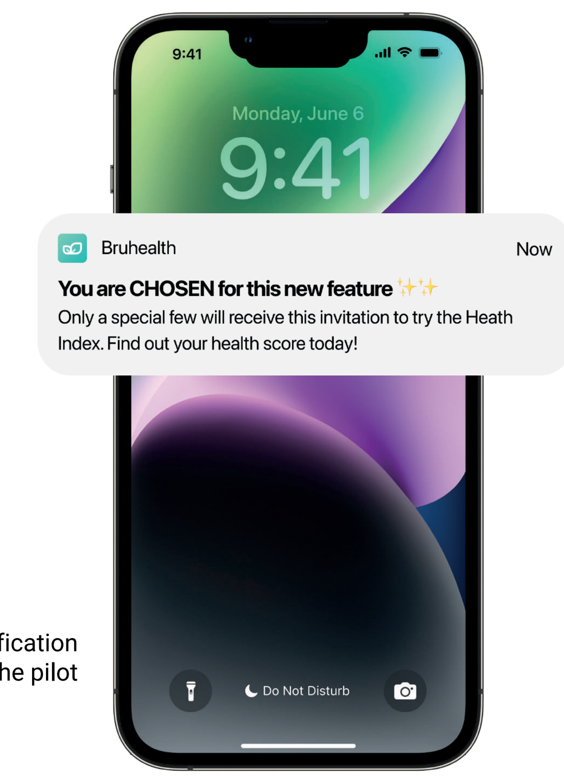

Fig. 1: Example of push notification deployed during the pilot

To calculate the health score, questionnaires utilise a scoreboard system to generate a severity score, and each domain is allocated a clinically verified weightage to contribute to the final score.

The Health Index also extracts medical data from the national electronic medical records, Bru-HIMS[5]. Demographic and physical health data are auto-populated based on the latest available data to improve user experience.

Engagement metrics such as completion rate, drop-off rate, drop-off point were tracked, along with click-through rates of the push notifications. Users who have completed and obtained their Health Index were stratified into 3 main categories: Healthy, At Risk or Poor Health for targeted population health management.

The Health Index module on BruHealth is available to users in 2 languages, English and Malay.

1 FRAIL Scale Frailty questionnaire will only be applicable to users aged 60 and above
2 DASS-21: Depression Anxiety and Stress Scales 21
3 SFFFQ: Short Form Food Frequency Questionnaire
4 IPAQ-SF: International Physical Activity Questionnaire-Short Form
5 Bru-HIMS: Brunei Health Information and Management System, a national e-health initiative by the Ministry of Health of Brunei where medical data from all government hospitals, outpatient services, treatment centres and clinics are consolidated under one Electronic Patient Record to achieve the vision of having One Patient One Record.

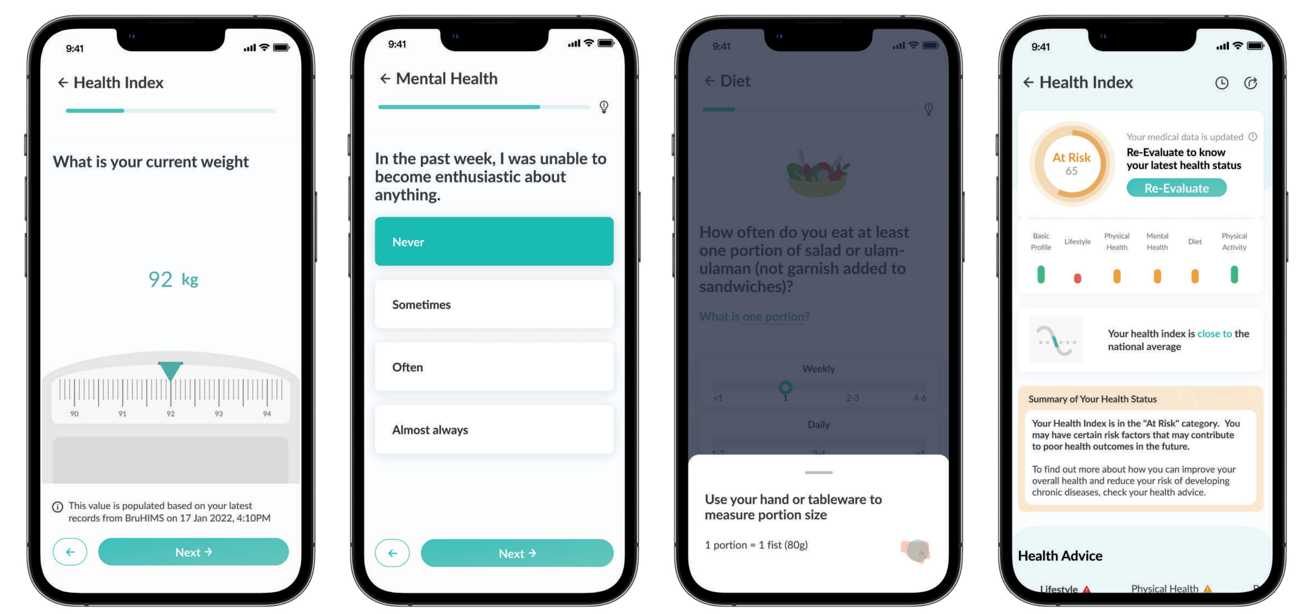

Fig. 2: Examples of screens from the Health Index module

RESULTS

The pilot took place over 30 days from November 2022 to December 2022, with an average conversion rate of 13% (156 out of 1,200 completed the questionnaires). Throughout the study, 6 nudges were deployed via push notifications at intervals depicted in Fig. 3. In the absence of nudges, there was little to no engagement with the module.

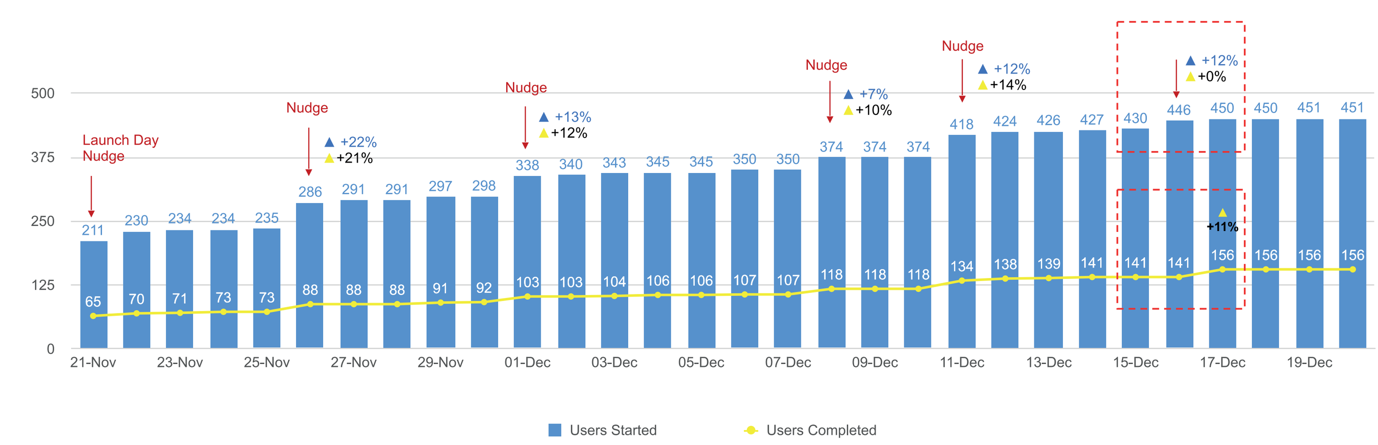

Fig. 3: Health Index completion daily progress

Out of 12 groups, 9 groups reached the targeted sample size of 10 user completion per group. The first groups to reach the desired number were users aged 18-40 years old and has records of type 2 diabetes, both male (G) and female (J) respectively. Interestingly, groups A and D (18-40 years old, no diagnosis of type 2 diabetes) saw a noticeably slower uptake.

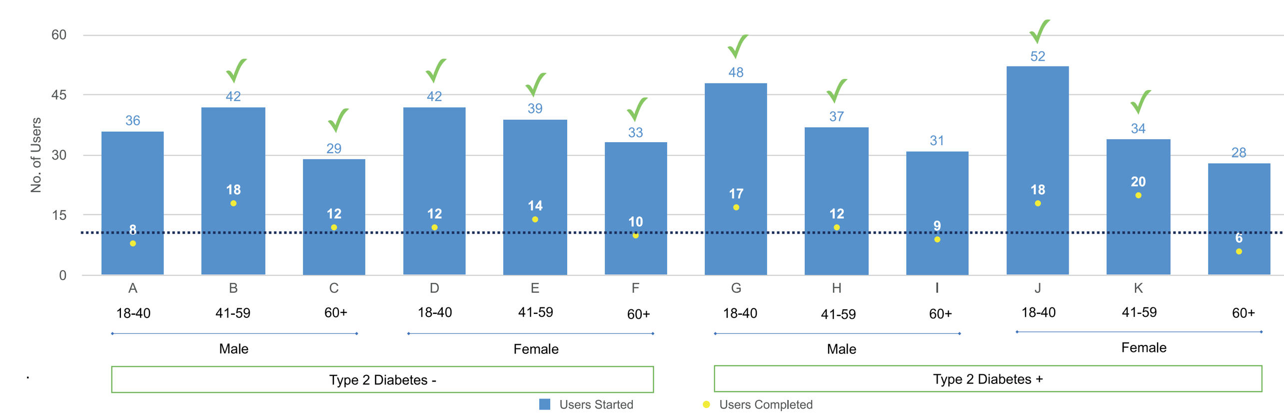

Fig. 4: Health Index completion by target groups at the conclusion of pilot

85% of all Health Index completion fell into the At Risk category. 77% (229 out of 296) of total users who completed the basic questionnaire reported a body mass index (BMI) outside of the normal range of 18.5 to 24.9 as recommended by WHO for adults over 20 years old. 82% (150 out of 184) who completed the diet questionnaire fell into 'Unhealthy Diet' label.

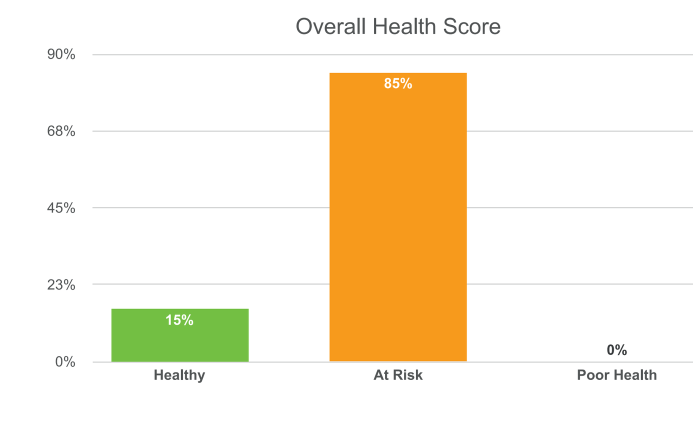

Fig. 5: Distribution of Health Index users by risk category

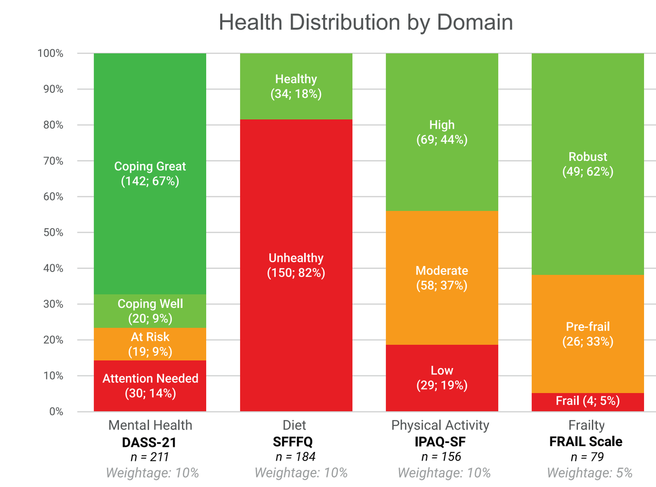

Fig. 6: Distribution of health labels by domain

22 out of 156 users attempted the Health Index more than once (re-evaluation rate 14%). 4 users (18%) scored lower at their second attempt, 3 users (14%) scored the same as their first attempt and 15 users (68%) scored higher at their second attempt. No users re-evaluated more than once.

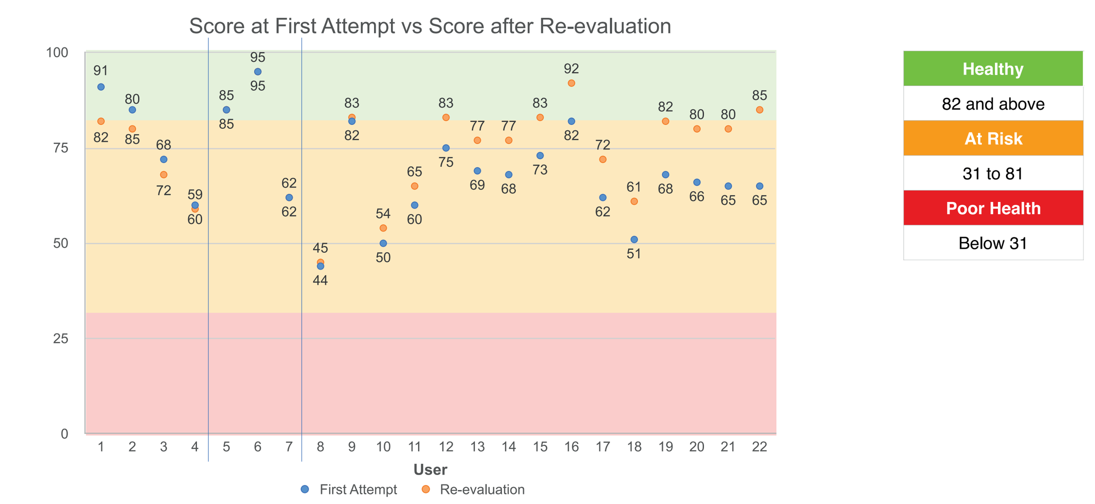

Fig. 7: Comparative analysis of scores at first attempt vs subsequent attempts

The click-through rates of the push notifications did not directly translate to the completion rates. Preliminary results suggest that nudges may be more effective after 6pm, especially on weekends, based on the engagement time of each domain i.e. time users start or submit each questionnaire.

CONCLUSION

The pilot study successfully generated insights to craft a strategy for user adoption. The full launch will capture up to 440,000 app users. In addition to push notifications, online and offline complimentary initiatives such as digital marketing, media campaigns and directives from healthcare providers will be deployed to increase user awareness of the initiative and drive uptake.

To further drive impact, completion of the Health Index provided users with relevant advisories and resources to improve their health based on their risk factors.

The personalization aspect of Health Index aims to provide targeted intervention and promote health-seeking behavior amongst users. The goal is for users to be empowered with knowledge and tools to make positive changes to their lifestyle towards a sustainable way of healthy living.

Over time, an increasingly robust Health Index resulting from planned retrospective and prospective studies aims to prompt users to conduct risk assessments for non-communicable diseases, allowing early disease detection and treatment of such diseases. Findings from Health Index can support policymakers in planning and allocating appropriate and adequate efforts and resources more effectively in the country.

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Florence Yapp | florence.yapp@evydtech.com