SUPPLEMENTARY DATA

A Randomized Controlled Trial to Evaluate the Effects of a Smartphone App-based Lifestyle Coaching Program on Gestational Weight Gain, Glycemic Control, Maternal and Neonatal Outcomes in Women with Gestational Diabetes: The SMART-GDM Study

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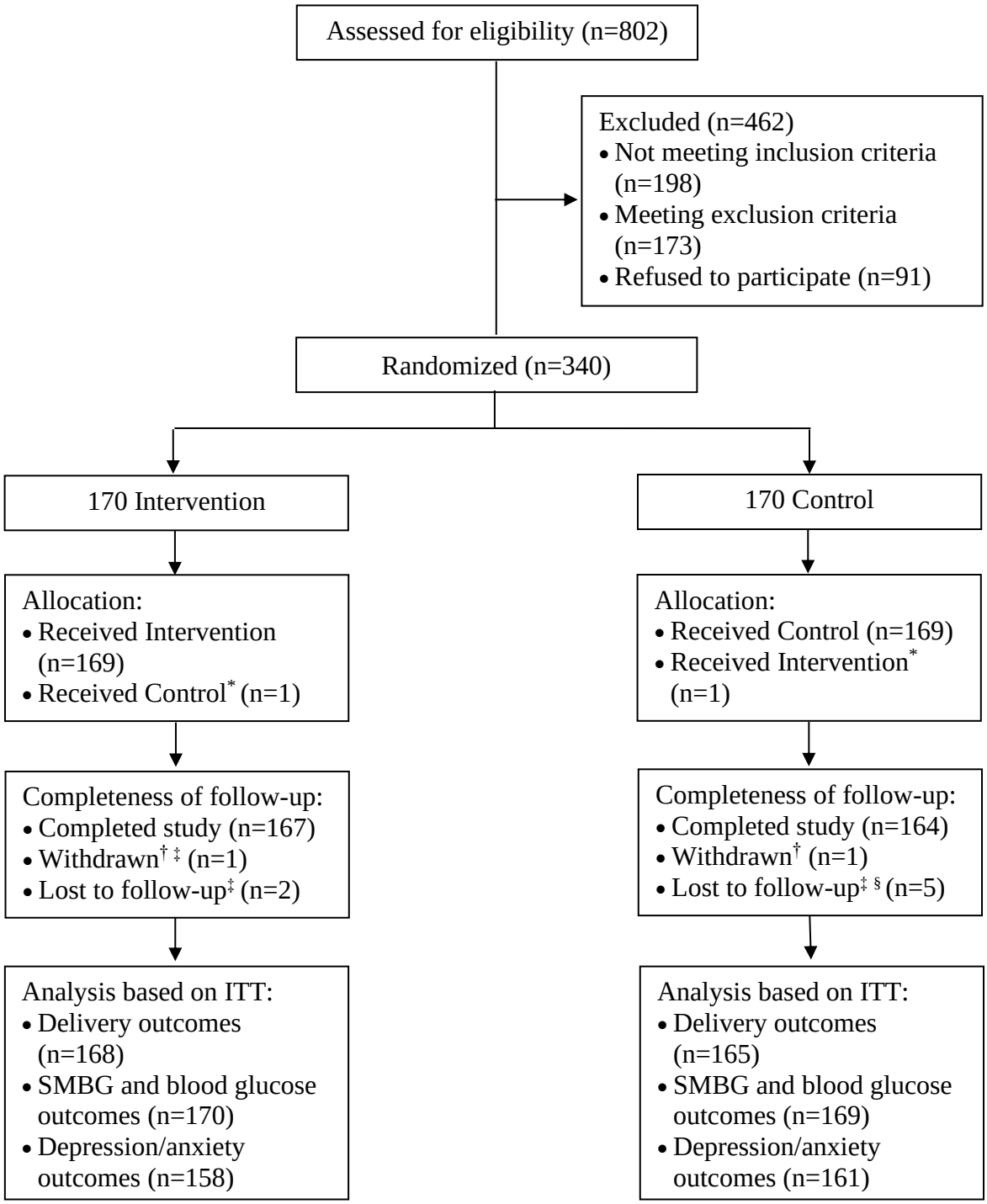
Supplemental Figure S1. Study flow diagram



* One participant in the control group was wrongly allocated to Intervention. Therefore, the allocation of one participant in the Intervention group was swapped due to previous error. † Contributed information towards the delivery outcomes. ‡ Contributed information towards frequency of SMBG and average blood glucose readings. § One contributed to the depression/ anxiety outcomes

Supplemental Information S2. Detailed description of Habits-GDM mobile app.

The Habits-GDM app was co-developed with Jana Care, the creators of Habits Diabetes Coach, a readily available and accessible smartphone app developed for the management of diabetes (http://www.habitsprogram.com). It was specifically designed for gestational diabetes mellitus (GDM). The app targets behavior changes by providing personalized GDM management program which consists of three main elements: lessons, tracking and coaching/ feedback.

1. Lessons

This section comprised 12 interactive lesson modules which provided patient education on GDM, delivered by a virtual coach. Participants were prompted by "push" automated messages to go through one lesson per day once they start using the app. Each lesson took approximately 5-10 minutes. Participants had the flexibility of scheduling their lessons by indicating the time they would like to receive the push messages. Lessons could be delayed and completed at a later time if the participant was unable to do so when a push message is received. Participants could also choose to revisit lessons after they have completed them.

Contents of the lessons were jointly developed by a multidisciplinary team of experts including endocrinologists, obstetricians, dietitians, and diabetes specialist nurses at a large tertiary hospital in Singapore, and Jana Care. The 12 topics, their respective duration to complete, and a few key messages for each modules were as follow:

i. Basics of GDM (4 minutes)

- General introduction of what is GDM
- Big picture of managing GDM – diet, physical activity, SMBG, weight

- Introduction to the app

ii. Understanding GDM (5 minutes)

- Will my baby be affected?
- Causes and symptoms of GDM
- GDM treatment basics

iii. Why treat (6 minutes)

- Neonatal complications: macrosomia, shoulder dystocia, neonatal hypoglycemia, jaundice, respiratory distress etc.
- Maternal complications: cesarean section, hypertensive disorders etc.

iv. Healthy eating (7 minutes)

- How to eat: eating at consistent times, avoid overeating, eating slowly
- What to eat: healthy plate, food preparation methods, types of food, avoiding sugary drinks, limiting extra sugar
- Vitamins and minerals

v. Carbohydrates (4 minutes)

- What are carbohydrates, types of carbohydrates
- Tracking carbohydrate amount
- Common foods with carbohydrate

vi. Glucose monitoring (7 minutes)

- How to test
- Target glucose range
- Avoiding low blood glucose

vii. Weight gain in pregnancy (6 minutes)

- Weight gain during pregnancy in each trimester
- Optimal weight gain range

- Contributions to excessive weight gain and calories
- Tracking weight

viii. Managing stress (6 minutes)

- Stress and its causes
- Recognizing stress, in relation in GDM
- Reducing stress in life
- Methods to managing stress effectively

ix. Being active (3 minutes)

- Why exercise?
- Practical tips to get active in pregnancy
- Workout basics, safety

x. Eating out (4 minutes)

- Planning ahead
- Choosing the right food: content, cooking methods, portion sizes, sauce and dressings, various courses
- Behavioral tips when eating out: when making orders, buffet, recognizing high caloric food in the menu, healthy alternatives to go for

xi. Nutrient dense food (3 minutes)

- Enjoying meals and avoid overeating
- Feeling full while keeping within calorie requirement
- Add fiber and suitable options of fluid
- Avoiding excessive fat

xii. Looking ahead (4 minutes)

- Screening postpartum
- Maintaining healthy lifestyle postpartum to lower future risk of diabetes

2. Tracking (Figure A)

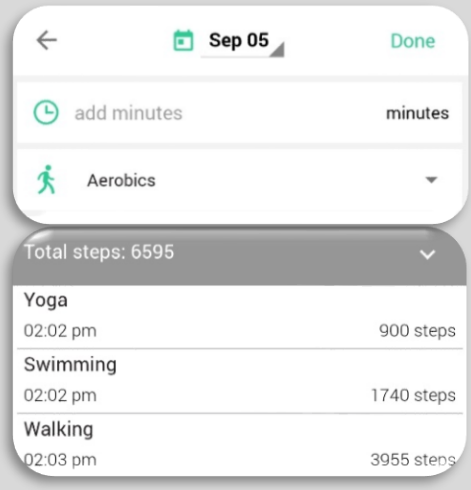
The following information was recorded and tracked by the Habits-GDM app:

i. self-monitoring of blood glucose (SMBG) – linked to the Aina or Aina Mini glucometer, a novel hardware sensor that can be plugged into any smartphone to measure blood glucose.
ii. weight (linked to a Bluetooth weighing scale)
iii. physical activity (physical activity tracking function on the app)
iv. food (self-reported and input into the app). A database of foods commonly eaten in Singapore (*Energy and Nutrient Composition of Food*. Singapore, Health Promotion Board, 2011. Available from https://focos.hpb.gov.sg/eservices/ENCF/ Accessed 27 Apr 2020) was incorporated into the program. To keep things simple and to avoid overloading the users with information, only key nutritional information specifically relevant to blood glucose such as calories and carbohydrate content were provided.

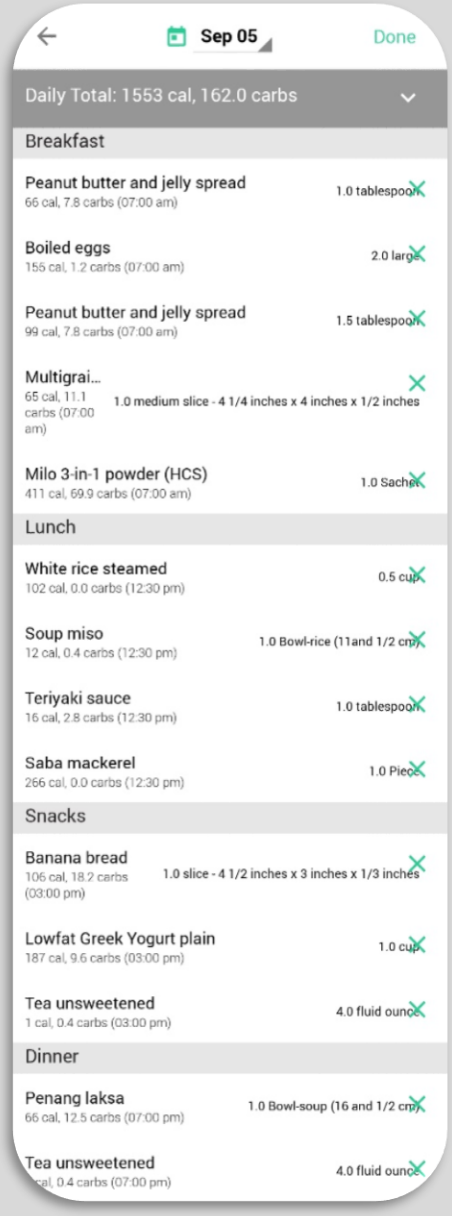
Participants had the option of viewing this information visually on a graphical, chart or report format on their phone. The app generated weekly report from these readings.

Figure A–Screenshots of the various tracking interfaces on Habits-GDM

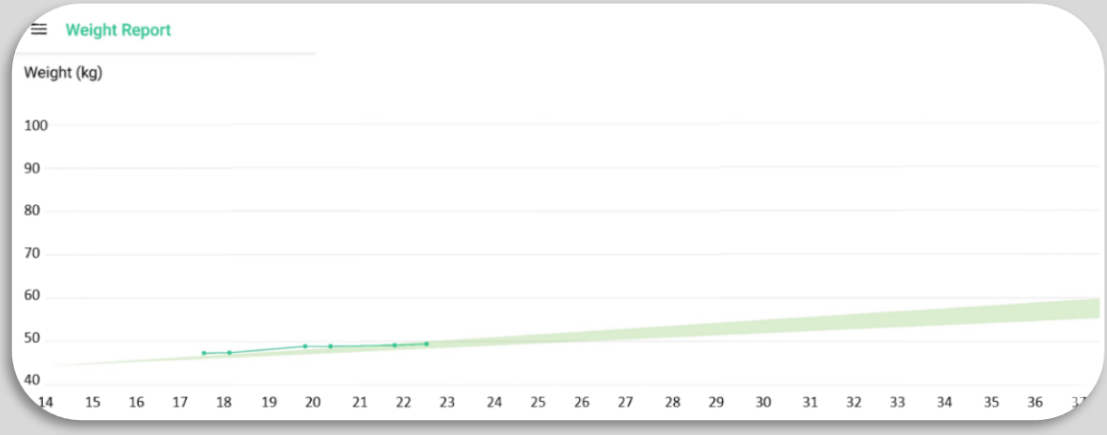
a. Screenshot of SMBG tracking



b. Screenshot of physical activity tracking



c. Screenshot of food tracking



d. Screenshot of weight tracking

3. Coaching/ feedback

An interactive messaging platform was used for coaching. Generic automated text messages on tips as well as customized automated messages from a virtual lifestyle coach to encourage and motivate participants towards healthy behavior beneficial for GDM, focusing on weight, SMBG, physical activity and diet were sent to participants. Purpose and content of messages include:

i. Weight:

- Initial automated push messages were sent to remind participants to weigh themselves once a week. They also received automated feedback on their weekly gestational weight gain (GWG).
- Automated messages were also sent to remind participants of their weekly maximum GWG and to weigh themselves daily in the following circumstances:
  - when weekly GWG exceeded the upper limit of the recommendation for two consecutive weeks, or
  - if their GWG corrected for the gestational weeks was already excessive at the start of study

The information on the optimal GWG by the end of pregnancy, recommended GWG range, and recommended ranges of weekly weight gain was conveyed to the participant through the lesson module on weight gain.

ii. SMBG (Figure B):

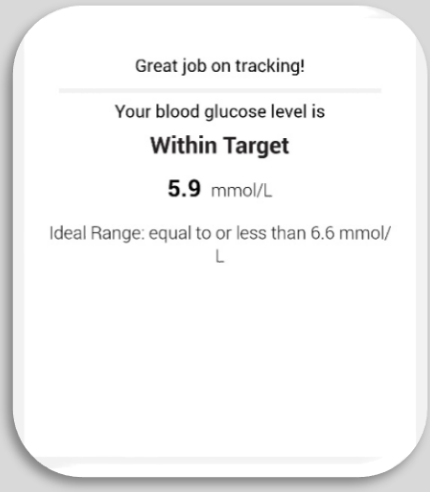
- For 2-hour post-meal glucose readings:
  - If the reading was >6.6 mmol/L, an automated message would be triggered to prompt participants to record or reflect on their diet in the preceding 2-4 hours.

- If the reading was between 6.4 – 6.6 mmol/L, an automated message would be sent to remind them that they were just at the upper limit of target glucose levels.
- If the reading was ≤6.3 mmol/L, an automated message would be sent to affirm them and to prompt them to reflect on the good self-management.

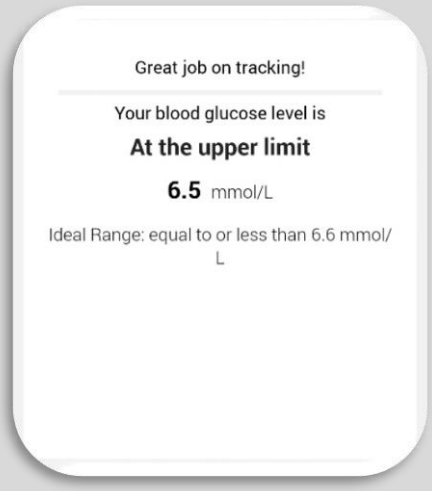
• For fasting readings, an automated message would be sent to affirm their effort to perform SMBG.

• For pre-lunch, pre-dinner or bedtime glucose readings:
  - If the reading was >5.5 mmol/L, an automated message would be triggered to check on the possible causes: carry on effect from preceding post-meal reading which was high, or participant had just had a snack.
  - If the reading was ≤5.5 mmol/L, a message would be sent to affirm their effort to perform SMBG.

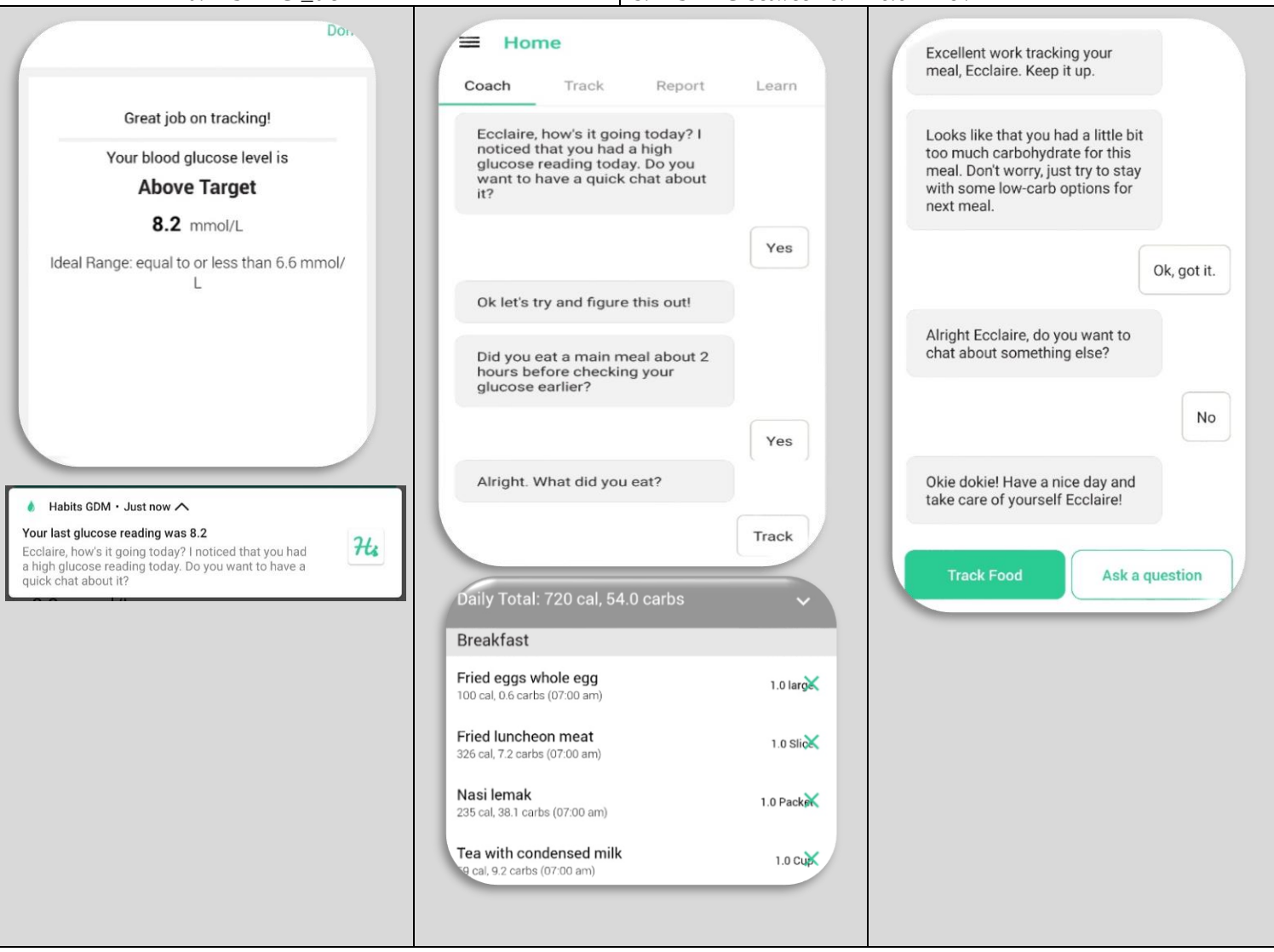
Figure B–Screenshots of automated messages sent post entry of SMBG readings



a. If SMBG ≤6.3 mmol/L



b. If SMBG between 6.4 – 6.6 mmol/L



c. If SMBG >6.6 mmol/L

iii. Physical activity:

- Generic automated messages were sent to remind participants to remain active with 150 minutes of moderate intensity aerobic activities e.g. brisk walking.

Participants could also pose specific questions related to GDM via the manual chat function on the messaging platform. The questions are directed to the relevant healthcare provider e.g. diabetes specialist nurse or dietitian to address within 24 hours. If the questions were related to obstetric issues, an automated message will be sent to ask them to encourage them to speak with their primary obstetrician. The healthcare providers did not reach out proactively through this function as the coaching were designed to be mostly automated.

Supplemental Table S3. Adjusted analyses of Excessive GWG and absolute GWG

	Estimate*	95% CI	*P* value
Primary outcome			
Relative odds of Excessive GWG†	1.87	0.88; 3.95	0.102
Secondary outcomes			
Mean difference in absolute GWG, kg†	0.47	-0.35; 1.28	0.260

GWG, gestational weight gain. *The effect estimate is expressed in terms of OR for the primary outcome which is binary, and difference in mean for the secondary outcomes as it is continuous. †These models are adjusted for insulin treatment for gestational diabetes mellitus and baseline Excessive GWG.

Supplemental Table S4. Subgroup analyses of Excessive GWG and absolute GWG by baseline Excessive GWG

Subgroup	Estimate	95% CI	*P* value
Relative odds of excessive GWG			
Had excessive GWG at baseline	1.21	0.46; 3.18	0.705
Did not have excessive GWG at baseline	3.73	0.99; 14.07	0.052
Mean difference in absolute GWG, kg			
Had excessive GWG at baseline	0.77	-0.98; 2.52	0.382
Did not have excessive GWG at baseline	0.38	-0.55; 1.31	0.422

GWG, gestational weight gain. These models are adjusted for insulin treatment for GDM.