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Using mobile technology to self-monitor and -manage diabetes and hypertension

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Acknowledgements

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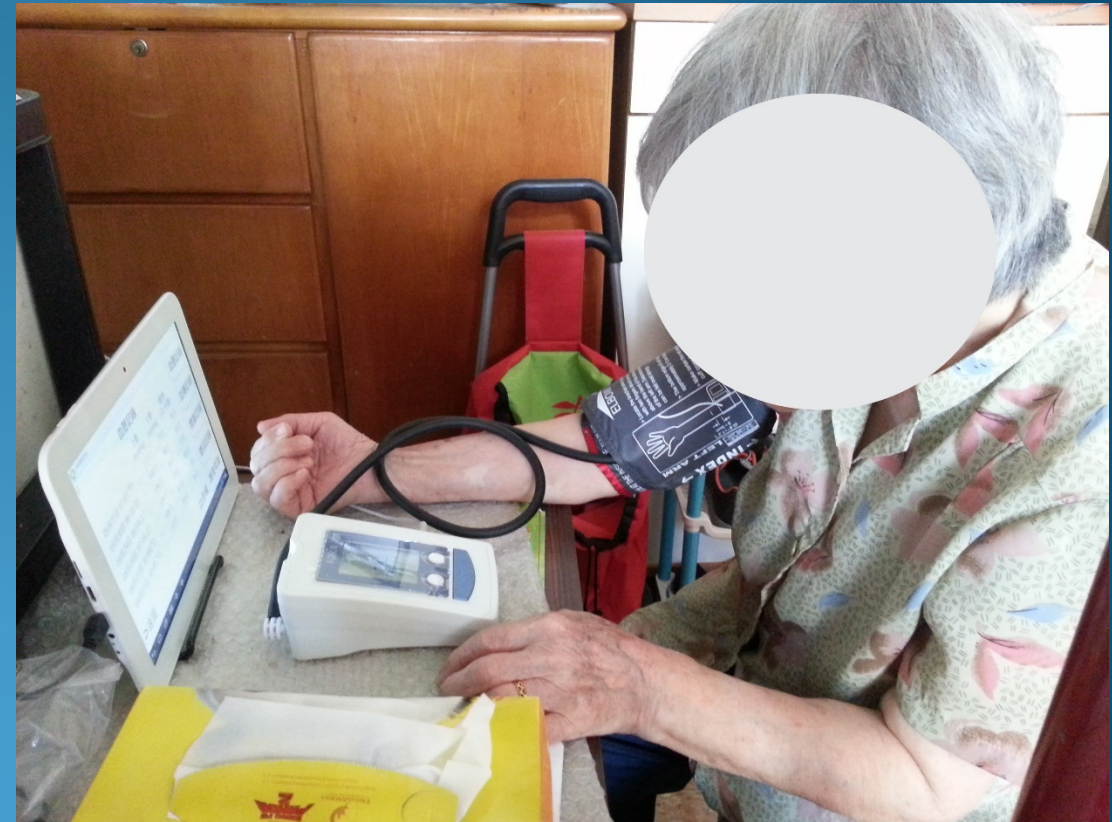
- Hup-chun Cheng, Tung Wah Eastern Hospital
- Bernard Man-yung Cheung, HKU
- Grace Hui, Tung Wah Eastern Hospital
- Emmy Lau, PYNEH
- Tracy Lau, PYNEH
- Mike K P So, HKUST
- Joseph Tan, McMaster University, Canada
- Aggi Tiwari, Hong Kong Sanatorium & Hospital
- Loretta Yam, PYNEH

Funding support:

- Health and Medical Research Fund (HMRF) of Food and Health Bureau, The Government of HKSAR (Grant #: 12133231)
- General Research Fund, University Grants Council of Hong Kong (Grant #: 716211)

Study

- ❑ Use of mobile technology to perform disease self-monitoring and self-management in patients with coexisting diabetes and hypertension
- ❑ To examine whether the use of a mobile technology-based self-monitoring intervention would improve glycemic and blood pressure control and some other relevant outcomes in patients with coexisting diabetes and hypertension





Introduction

- The coexistence of type 2 diabetes and hypertension is a major health problem affecting many individuals worldwide
 - 422 million adults had diabetes globally in 2014, and the majority of them were type 2 diabetic patients ¹
 - 20%-60% of patients with type 2 diabetes also had hypertension ²

1. The World Health Organization. Global report on diabetes. 2016. http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf

2. Arauz-Pacheco C, Parrott MA, Raskin P. The treatment of hypertension in adult patients with diabetes. Diabetes Care. 2002;25(1):134-47.



Introduction

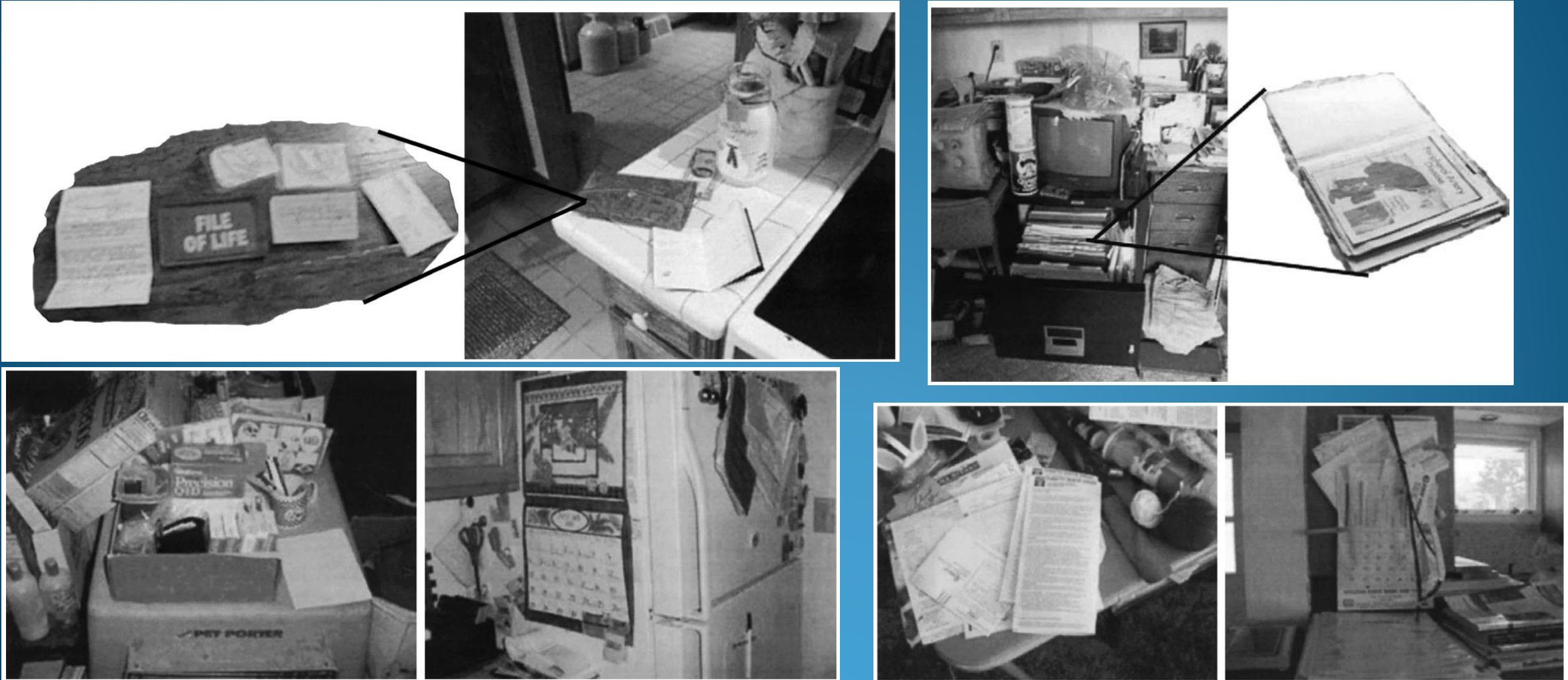
- ❑ To achieve control of the two conditions, patients need to assume greater responsibility for self-care and health information management
- ❑ However, patients' self-management can be inadequate, highly variable, and disorganized



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Methods of self-management and health information management *(see Moen and Brennan 2005)*





Introduction

- ❑ Information technology (IT) has become an integral part of health care
 - Electronic patient records
 - Computerized physician order entry systems
 - Barcode medication administration systems
 - Telemedicine systems



Introduction

□ The use of mHealth can

- complement traditional self-care as they can help empower patients to care for themselves
- bridge the data-sharing gap among care stakeholders to ensure the timely availability of patient health data for decision making



Introduction

- ❑ DialBetics – *a smartphone-based system for diabetes self-management through which diabetic patients could report their blood glucose and diet for monitoring purpose*¹
- ❑ CollaboRhythm – *a tablet-based system to provide self-care support to hypertensive patients*²
- ❑ A few previous studies have evaluated the efficacy of mHealth interventions in self-care, but the results have been mixed and the focus has been on single-disease populations

1. Waki K, Fujita H, Uchimura Y, Omae K, Aramaki E, Kato S, et al. DialBetics: A novel smartphone-based self-management support system for type 2 diabetes patients. *Journal of Diabetes Science and Technology*. 2014;8(2):209-15.

2. Moore J, Marshall MA, Judge D, Moss F, Gilroy S, Crocker J, et al. Technology-supported apprenticeship in the management of hypertension: A randomized controlled trial. *JCOM*. 2014;21(3):110-22.



Methodology: Study design

□ 24-week RCT

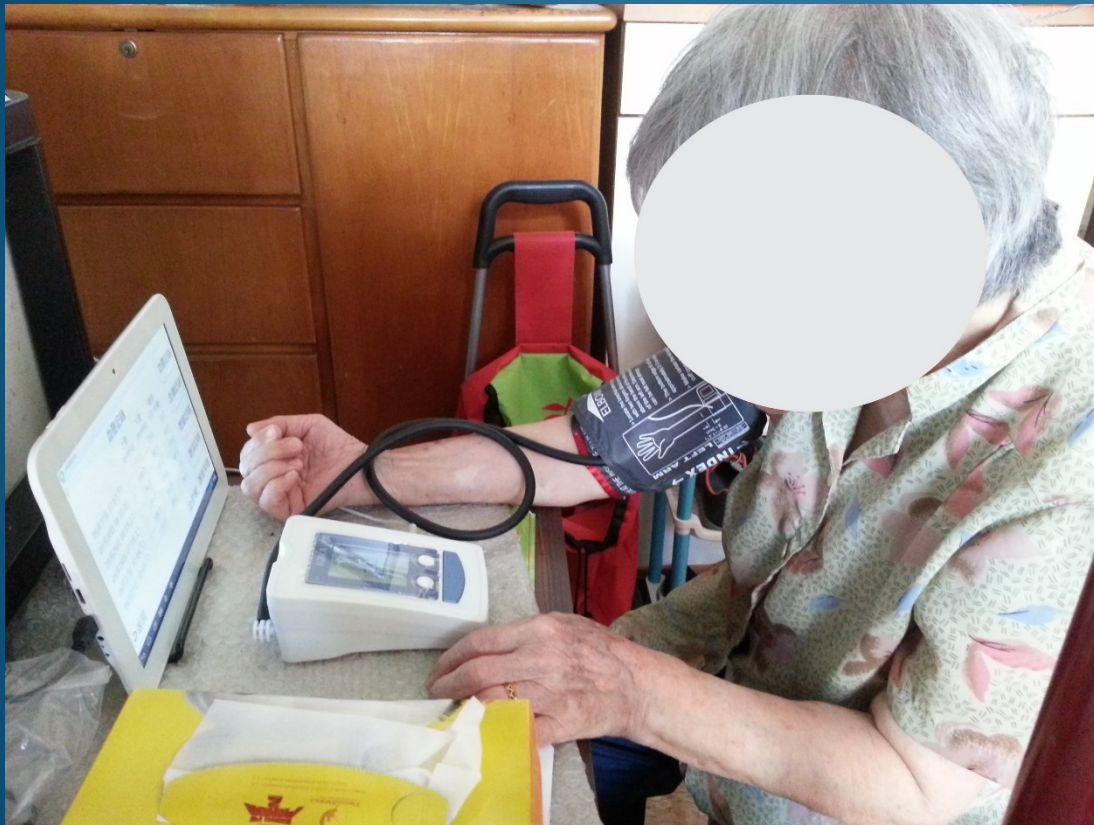
- Participants were randomly assigned to either an intervention group or a control group
 - Intervention group: using tablet-based self-monitoring system
 - Control group: using conventional self-monitoring devices
- Follow-up visits: 8, 12, 16, and 24 weeks after randomization



Methodology: Participants

- ❑ Participants were recruited from two public hospitals in Hong Kong
- ❑ Inclusion criteria:
 - aged 18 years or older
 - with a physician-confirmed diagnosis of type 2 diabetes and hypertension of at least one-month duration
 - taking oral medications for the diseases
 - able to perform disease self-monitoring and self-management
 - able to understand written Chinese

Methodology: The tablet-based self-monitoring system



- ❑ 2-in-1 blood glucose and blood pressure monitor
- ❑ Tablet-based application:
 - Blood glucose measurement module
 - Blood pressure measurement module
 - Text-based materials for diet, exercise, self-monitoring, use of blood pressure monitors, and use of blood glucose meters
 - Video-based materials for a home-based exercise
 - Medication reminder function
- ❑ Web portal: for other carers to (remotely) review and monitor the measurement records



Methodology: The tablet-based self-monitoring system

測試 Test account

血糖記錄 Blood glucose records

日期 Date and time	餐前 Before meal (mmol/L)	餐後 After meal (mmol/L)	小時 Hours
2017年06月27日 07:15(下午)	5.9		
2017年06月27日 07:14(下午)	5.9		
2017年06月27日 07:07(下午)	6.4		
2017年06月27日 07:06(下午)	3.9		
2017年06月27日 07:04(下午)	6.4		
2017年06月07日 10:06(上午)	6.1		

血壓記錄 Blood pressure records

體重記錄 Weight records

血氧記錄 Blood oxygen saturation records

護理常識 Health knowledge

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測試 Test account

血糖記錄 Blood glucose records

日期 Date and time	餐前 Before meal (mmol/L)	餐後 After meal (mmol/L)	小時 Hours
2017年06月27日 06:55(下午)	118	80	112
2017年06月07日 11:19(上午)	118	80	112
2017年06月07日 10:05(上午)	102	76	108
2017年06月07日 10:04(上午)	105	72	104
2017年06月07日 10:01(上午)	115	67	108
2017年06月05日 04:59(下午)	102	68	95

血壓記錄 Blood pressure records

上壓 (mmHg)	下壓 (mmHg)	脈搏 Pulse(BPM)
118	80	112
118	80	112
102	76	108
105	72	104
115	67	108
102	68	95

體重記錄 Weight records

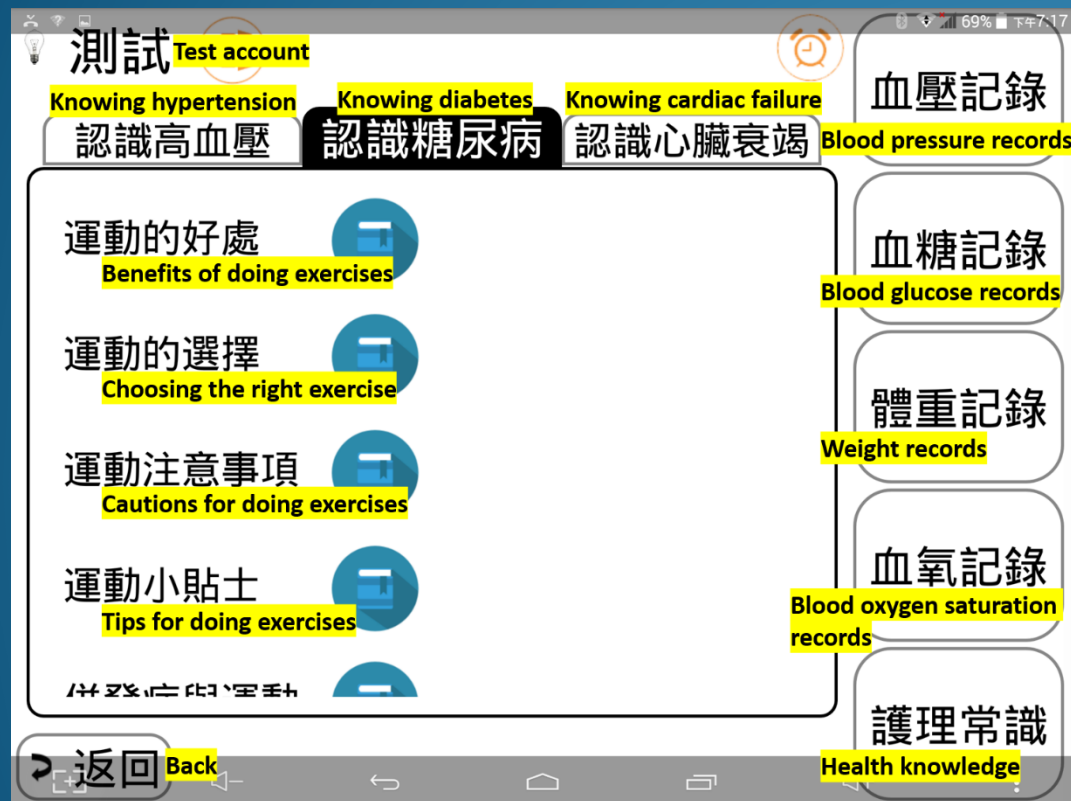
血氧記錄 Blood oxygen saturation records

護理常識 Health knowledge

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Methodology: The tablet-based self-monitoring system





Methodology: Outcomes

	Baseline	8-week	12-week	16-week	24-week
<u>Primary outcomes</u>					
HbA _{1c} (%)	√		√		√
Systolic blood pressure (mm Hg)	√	√		√	√
Diastolic blood pressure (mm Hg)	√	√		√	√
<u>Secondary outcomes</u>					
Medication adherence	√	√		√	√
General adherence to treatment	√	√		√	√
Adherence to disease-specific activities	√	√		√	√
Diabetes knowledge	√	√		√	√
Hypertension knowledge	√	√		√	√
Self-efficacy in coping with chronic disease	√	√		√	√



Methodology: Statistical analysis

- ❑ T-tests or Chi-squared tests to compare the characteristics of the two groups at baseline
- ❑ Linear mixed model to examine the differences between baseline and follow-ups for the outcome measures



Results: Baseline characteristics of the study sample

- ❑ Total 299 patients participants (intervention = 151 patients, control = 148 patients)
 - Mean HbA_{1c} = 8.0%
 - Mean blood pressure = 137.5/75.4 mm Hg
 - Mean age = 63.8 years
 - 64.2% were male
 - Mean duration of type 2 diabetes = 16.1 years
 - Mean duration of hypertension = 12.9 years
 - 87.3% lived with families
 - 59.9% had completed secondary school
 - 5.0% had experience in using computer-based self-management system

- ❑ Baseline characteristics were generally well balanced between the two groups except sex ($p=0.09$), education ($p=0.09$), and experience in using computer-based self-monitoring system ($p=0.02$)

Results: HbA1c (%)

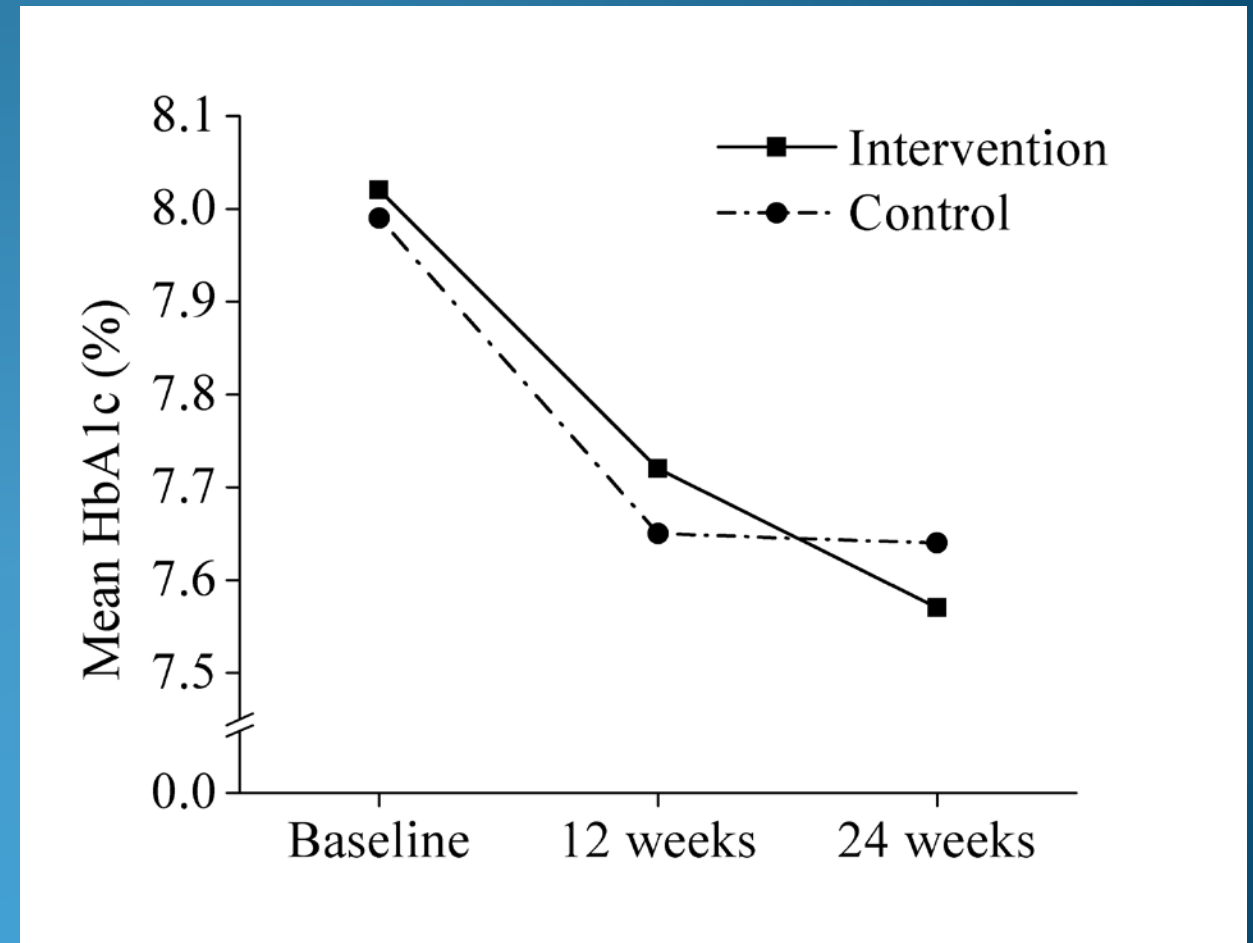
12-week vs. baseline

- Intervention group: -0.29%
(95% CI, -0.52 to -0.07, $p=0.008$)
- Control group: -0.34%
(95% CI, -0.57 to -0.11, $p=0.002$)

24-week vs. baseline

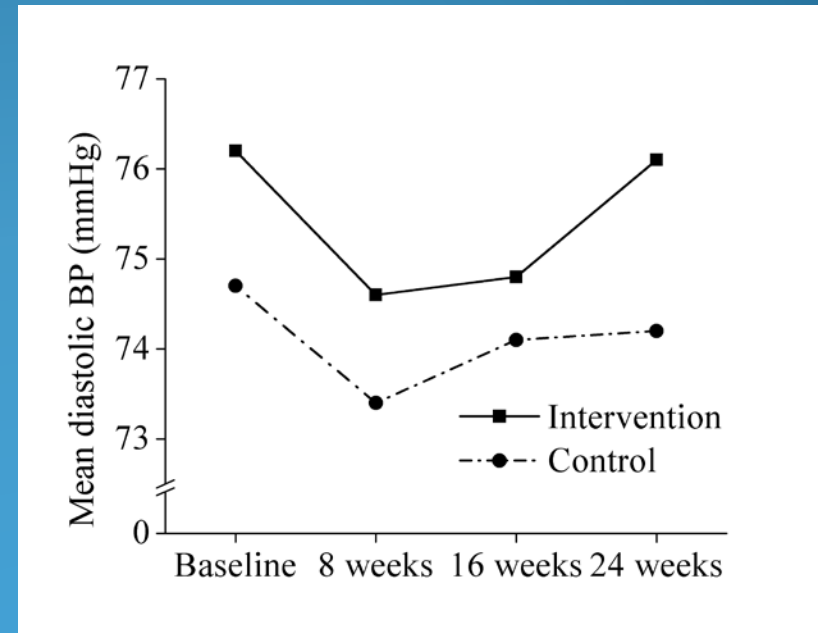
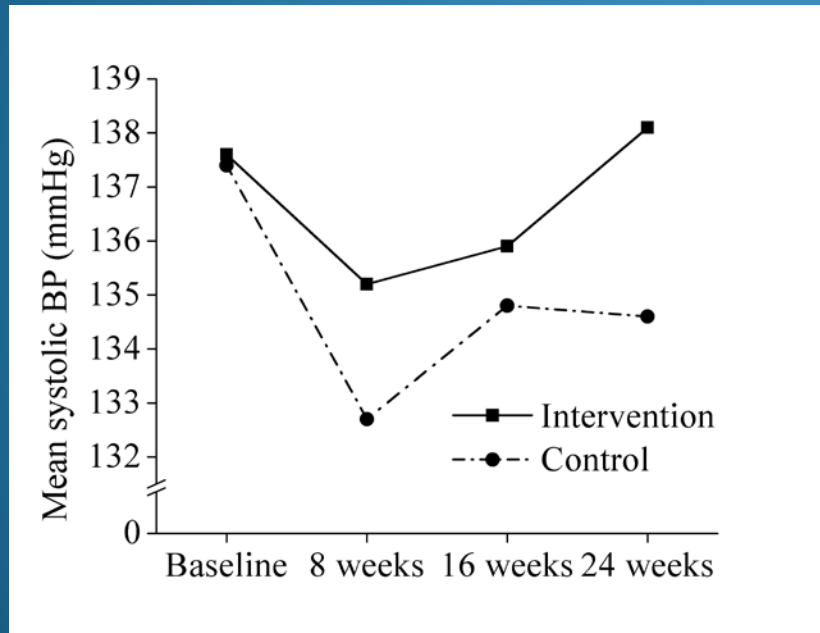
- Intervention group: -0.44%
(95% CI, -0.67 to -0.22, $p<0.001$)
- Control group: -0.35%
(95% CI, -0.58 to -0.13, $p=0.001$)

- Reduction in HbA1c was similar for both intervention and control groups.



Results: Blood pressure (mm Hg)

- ❑ Significant improvement in blood pressure was only seen in the control group at 8 weeks (systolic blood pressure, -4.65 mm Hg; 95% CI, -8.20 to -1.10; $p=0.01$)
- ❑ Changes from baseline in both systolic blood pressure and diastolic blood pressure remained similar between the two groups over time





Results: Secondary outcomes

- ❑ We observed significant improvements in both groups after 24 weeks for
 - adherence to specific activities
 - diabetes knowledge
 - hypertension knowledge
- ❑ Improvement in medication adherence was only seen in the intervention group at 8 weeks
- ❑ Improvements in self-efficacy in coping with chronic diseases were only seen in the control group at 16 weeks and 24 weeks
- ❑ No beneficial effect of the intervention over the control group was observed



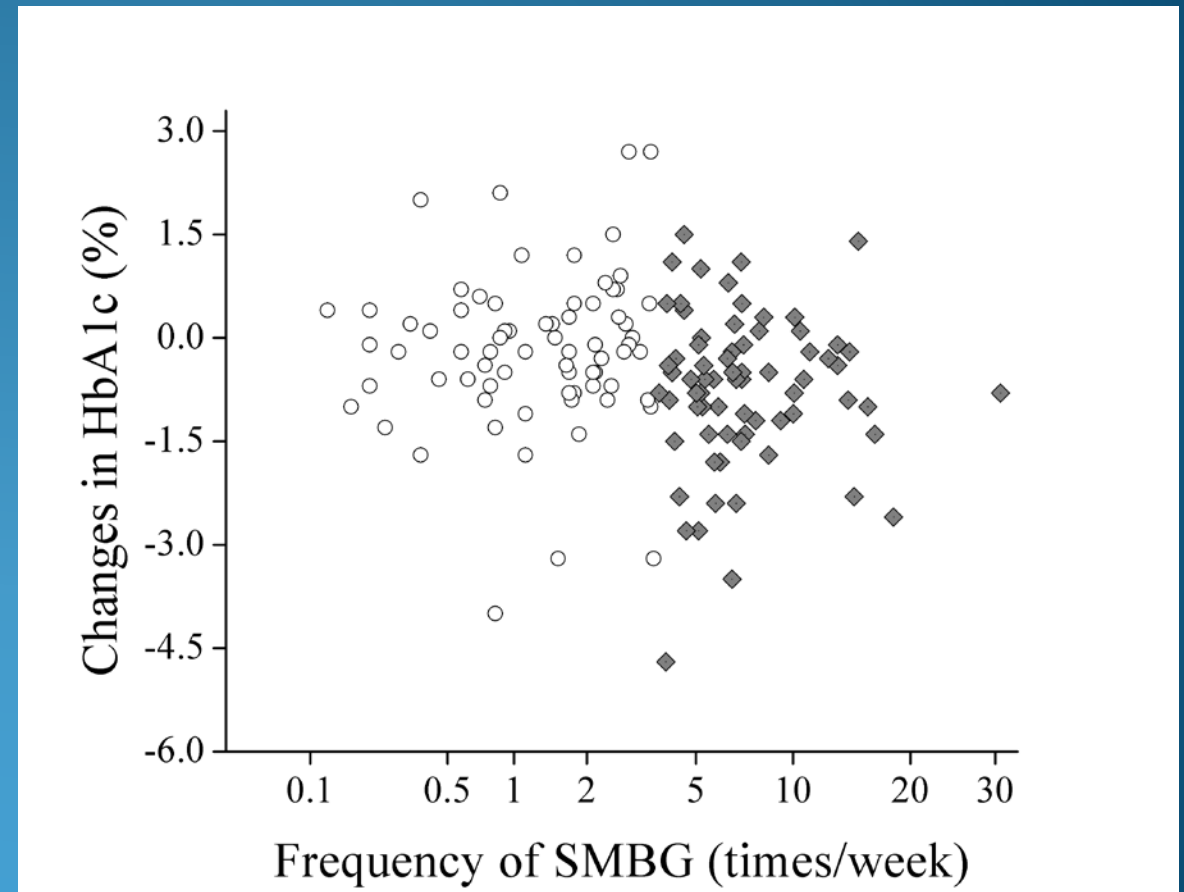
Results: Use frequency

- ❑ Patients in the two groups had similar frequency of SMBG ($p=0.94$) and SMBP ($p=0.14$) during the 24-week study period
 - SMBG (median): Intervention = 3.65 times/week, Control = 3.60 times/week
 - SMBP (median): Intervention = 3.46 times/week, Control = 3.15 times/week
- ❑ Other features, such as medication reminder function, exercise videos, and information for diet and self-monitoring, etc. (for intervention group only)
 - About 2/3 of the patients had used the education module, half of them only read the materials or watch the videos less than five times during the 24 weeks
 - More than 2/5 of the patients never used the medication reminder function
 - 4/5 of the patients and their families or healthcare providers never log in the web portal

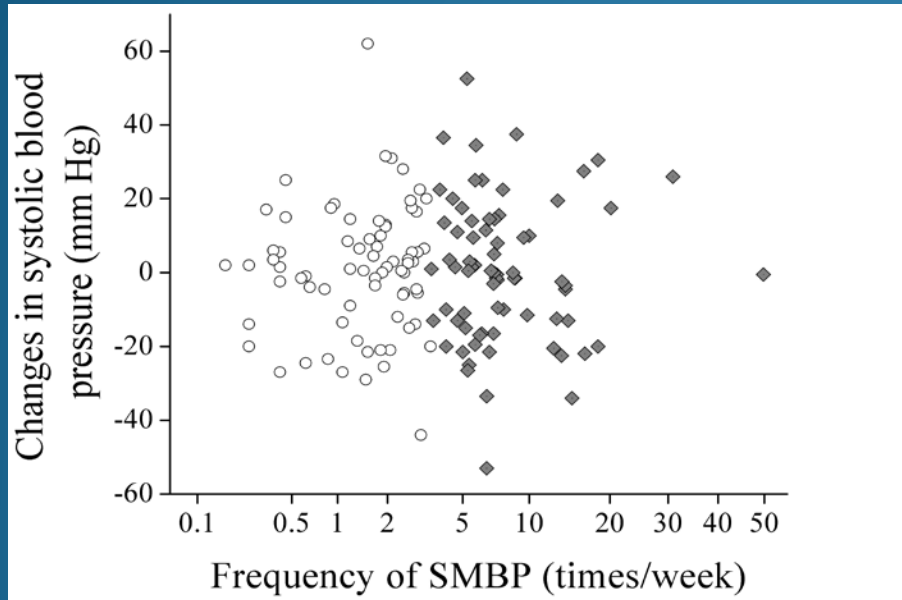
Results: Impact of frequency of SMBG (Intervention group only)

□ 24-week vs. baseline

- High frequency (>median): -0.75%
(95% CI, -1.01 to -0.49)
- Low frequency (\leq median): -0.16%
(95% CI, -0.42 to 0.10)
- Between group $p=0.002$

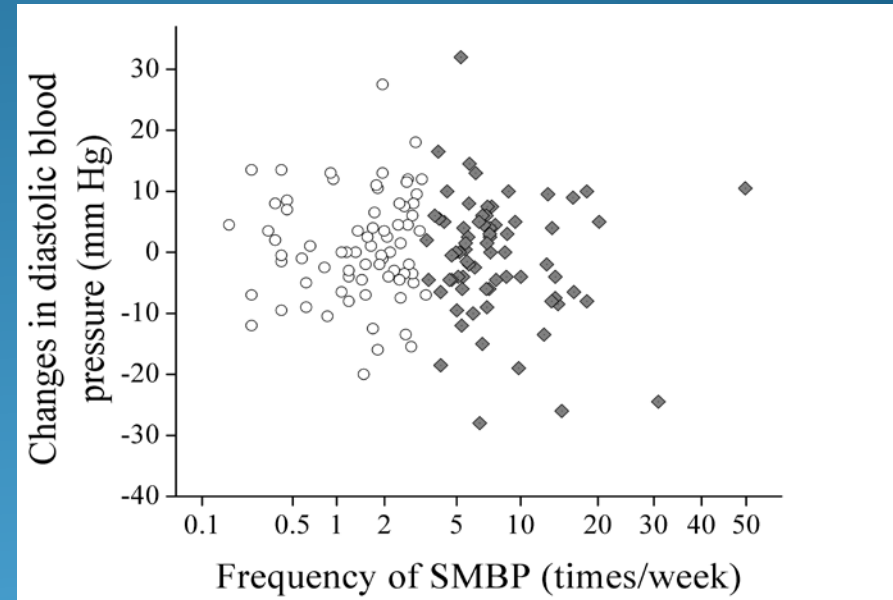


Results: Impact of frequency of SMBP (Intervention group only)



□ 24-week vs. baseline

- High frequency (>median): 0.5 mm Hg
(95% CI, -3.7 to 4.1)
- Low frequency (\leq median): 0.7 mm Hg
(95% CI, -3.5 to 5.0)
- Between group $p=0.93$



□ 24-week vs. baseline

- High frequency (>median): -1.1 mm Hg
(95% CI, -3.3 to 1.1)
- Low frequency (\leq median): 0.9 mm Hg
(95% CI, -1.3 to 3.1)
- Between group $p=0.20$



Conclusions

- ❑ HbA_{1c} and some of the secondary outcomes significantly improved over time for both the two groups. However, the study failed to show a beneficial effect of the intervention over the control group
- ❑ An improvement in the fidelity of intervention could lead to larger positive effect.
- ❑ Attention should be given to improve the acceptance and implementation of the intervention



Conclusions

❑ Implications for future research

- Longer study period is required
- Future research need to reach patients at higher risk of diabetes and hypertension (in this study, baseline HbA_{1c} = 8.0%, blood pressure = 137.5/75.4 mm Hg)
- Qualitative investigations are needed to understand the facilitators and barriers of implementation of a new mHealth intervention

Thank you!