Use of a mobile application to raise diabetes risk awareness: Reaching the Chinese population

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Acknowledgement

This project was funded by:

**HKU/China Medical Board Grants, 2011-12**

**Knowledge Exchange (KE) Funding Exercise for Impact Project, the University of Hong Kong, 2013-14. (project no.: KE-IP-2013/14-41)**

Generous support from:

Mr. Miguel Cheng, Versitech, HKU

Mr. Vincent Lau, App Designer

Mr. WC Shum, Director (community service), SKH Holy Carpenter Church Community Centre

Anonymous reviewers from SKH Holy Carpenter Church Community Centre

Mr. Benjamin Kwok, Research Assistant, School of Nursing, HKU
Background

• 1/10 of the world population (346 million) have diabetes, and the number is likely to be doubled by 2030\textsuperscript{1}.

• In Hong Kong, there are about 700,000 diabetic patients. The prevalence of diabetes (10\%) in Hong Kong is comparable to the world average figure.\textsuperscript{2}

• The incidence of diabetes keeps on increasing, unfortunately more than half of the patients being undiagnosed.\textsuperscript{2}

• Lifestyle modification interventions have been evidenced to prevent progression of pre-diabetes to diabetes\textsuperscript{3}.

• The importance of early identification of people with diabetes and proposed to adopt a risk-based approach to screen for diabetes\textsuperscript{4}.
Diabetes Risk Score (DRS)

- To increase the acceptability of diabetes screening, Diabetic Risk Score (DRS) has been developed and considered as a practical tool to predict type 2 diabetes risk\(^5\).
- DRS is used to estimate the chance of having diabetes either \textit{at the current moment} or \textit{in the next few years}.
- DRS is a good tool for clinical practice due to its \textit{simple, fast, inexpensive and non-invasive features}\(^5\).
- FINDRISC predicts the 5-year risk of diabetes\(^5\)
  - has good sensitivity (\(=0.78\))
  - specificity (\(=0.77\))
  - positive predictive value (\(=0.13\))
Finnish Diabetes Risk Score (FINDRISC)$^5$

- age
- BMI
- waist circumference
- use of blood pressure medication
- history of high blood glucose
- physical activity less than 4 hours per week
- daily consumption of vegetables or fruits
A free mobile software application has been developed to:

1) increase awareness of the risk of diabetes
2) support self assessment of the risk of diabetes
3) promote change of healthy lifestyles
4) identify the at-risk group and follow-up
Objectives

There are 2 phases in the study. The objectives are:

**Phase I:**
1. To test out the feasibility of using this DRS app in the community of Chinese population;

**Phase II:**
1. To test the feasibility of approaching the high-risk app users;
2. To test the validation of FINDRISC in Chinese population.
Target Population

- HKUDRS targets for:
  1) Chinese aged 18 or above;
  2) Hong Kong residents;
  3) Those who are able to use a smartphone to download the HKUDRS app;
  4) Those who are able to key in the information by himself/herself

- Can be downloaded from by searching “HKUDRS” as keywords
  - Google App Store
  - Apple App Store
Features of the HKUDRS app

BMI
21.7

身高: 160 厘米

在過去的七日內，你進食了多少個生果（例如蘋果或橙；10粒提子=1個生果）?

- 沒有進食任何生果
- 1 至 3 個
- 4 個或以上
Features

• Risk of having diabetes in the next 5 years will be calculated;
  – DRS score ≥ 9: high diabetic risk
• Provide tailor-made health educational advice
• Users could share the risk score with friends and relatives through Facebook
HKUDRS (Phase I)  
(2014 Aug-Oct)

<table>
<thead>
<tr>
<th>Data</th>
<th>Number of users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input data</td>
<td>6,905</td>
</tr>
<tr>
<td>Valid data*</td>
<td>5,169</td>
</tr>
<tr>
<td>Device used: Android</td>
<td>2,829 (54.7%)**</td>
</tr>
</tbody>
</table>

* Valid input refers to the input to body height, weight and waist circumference which are not outliers
** Percentage calculated based on the number of valid cases (n=5169)
Age distribution (n=5,169)

- 159 (3%) Aged <45
- 793 (15%) Aged 45-54
- 1325 (26%) Aged 55-64
- 2892 (56%) Aged 65 or above

Female: 1798 (35%)
Male: 3371 (65%)
Education Level (n=5,169)

- Primary: 195, 4%
- No formal Education: 372, 7%
- Certificate/Diploma: 498, 10%
- Degree or above: 1940, 38%
- Secondary: 2059, 41%
Table 1: Descriptive statistics of DRS risk score (N=5169)

<table>
<thead>
<tr>
<th>Value of interest</th>
<th>Median</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRS risk score (0-20)</td>
<td>3</td>
<td>4.26</td>
<td>3.264</td>
</tr>
</tbody>
</table>

Figure 1: Histogram of DRS risk score (Red line represents DRS risk score = 9)

12.8% had high risk DRS≥9
High risk vs low risk (n=5,169)

Table 2: Comparison of DRS risk scores between those who didn’t give emails and those gave emails for follow up

<table>
<thead>
<tr>
<th></th>
<th>Emails</th>
<th>No emails</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk</td>
<td>183 (22.4%)</td>
<td>478 (11.0%)</td>
</tr>
<tr>
<td>Low risk</td>
<td>633 (77.6%)</td>
<td>3875 (89%)</td>
</tr>
</tbody>
</table>

$\chi^2 = 1289, p<0.0001$
Discussion (Phase 1)

• Mobile software application is attractive to Chinese adults
  ✓ A large number of app users (>6900) within a short period of time (2 months)

• Mobile software application is a user-friendly, non-threatened self-assessment tool
  ✓ A large number of app users agreed to provide e-mails or phones for follow up
  ✓ High-risk group had greater intention to be followed up by professionals.
Implications and Conclusion (Phase I)

• Implications in research
  ✓ Use of mobile app in data collection
  ✓ Use of mobile app in behavioral modification intervention

• Implications in clinical practice
  ✓ Encourage patients’ self-assessment and self-monitoring, develop self management in chronic illness
  ✓ Promote the concept of health literacy and preventive care in general public
HKUDRS Phase II
(Jun – Aug 2015)

• Inclusion Criteria of the subjects:
  ✓ All inclusion criteria in Phase I
  ✓ Left emails or phone numbers in the app
  ✓ Claimed to be undiagnosed in type-II diabetes in Phase I

• Procedures:
  ✓ Blood test (HbA1c and lipid profile)
  ✓ Senior Fitness Tests
  ✓ Diabetes Empowerment Scale (self-efficacy) (Shih, 2003)
  ✓ Lifestyle: Diet, physical activities,
  ✓ Medicine, history of chronic illnesses
HKUDRS Phase II (2015 Jun - Aug)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>No diabetes in Phase 1</td>
<td>162</td>
</tr>
<tr>
<td>Diagnosed as diabetes in Phase 1</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>210</td>
</tr>
</tbody>
</table>
HKUDRS Phase II (Jun – Aug 2015)

Age
- 12, 7%
- 4, 3%
- 13, 8%
- 70, 43%
- 63, 39%

Education Level
- No formal Education
- Primary
- Secondary
- Vocational School
- Tertiary Education
- <=34
- 35-44
- 45-54
- 55-64
- 65-74
- 9.90%, 10%
- 38.30%, 38%
- 49.40%, 50%
- 1.20%, 1%

Sex
- Male
- Female
- 59, 36%
- 103, 64%
Distribution of diabetes risk score

- 124 (76.5%): DRS < 9
- 38 (23.5%): DRS ≥ 9

Score Frequency
Risk score vs HbA1c

ROC Curve

Area under the curve (AUC)

<table>
<thead>
<tr>
<th>Area</th>
<th>Standard deviation</th>
<th>Asymptotic p-value</th>
<th>95% CI lower</th>
<th>95% CI upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>.714</td>
<td>.051</td>
<td>.000</td>
<td>.614</td>
<td>.813</td>
</tr>
</tbody>
</table>

- AUC=0.714 > 0.7 represents that HKUDRS and HbA1c are having reasonable sensitivity and specificity.

 ROC curve coordinates

<table>
<thead>
<tr>
<th>Cut-off point</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>.643</td>
<td>0.634</td>
</tr>
<tr>
<td>8</td>
<td>.607</td>
<td>0.731</td>
</tr>
<tr>
<td>9</td>
<td>.429</td>
<td>0.806</td>
</tr>
<tr>
<td>10</td>
<td>.393</td>
<td>0.858</td>
</tr>
<tr>
<td>11</td>
<td>.250</td>
<td>0.925</td>
</tr>
<tr>
<td>12</td>
<td>.107</td>
<td>0.948</td>
</tr>
</tbody>
</table>

- When cut-off score equals 8, COHEN'S KAPPA =0.25, represents that HKUDRS score and HbA1c are having a fair agreement.
Implication and conclusion (Phase II)

Implications in research

✓ Feasible to approach the app users after one year.
✓ One-quarter of the app users who left their contacts in the app were able to be followed up after one year.

Implications in clinical practice

✓ Use the app for initial screening: DRS score and HbA1c were associated
Challenges

• **Sustainability of the use of app in subsequent self-reported change of behavior**
  - Prop-up menu for reminding change of behavior
  - Delete of apps after some time: incentive to keep on using this app
  - Increase the scope of service, e.g. check other chronic illness
  - Modify the formula to suit Chinese population

• **A small proportion of elderly users had used this mobile software application**
  - Digital disparity does exist in aging population
  - Only 3% of the users are aged 65 or above
  - There is room for developing elder-friendly mobile app as the next cohort of older adults (soon-to-be-aged adults) are more educated and have higher competence in digital device
Conclusion

• HKUDRS app is **feasible** to identify the high-risk group
  ✓ the first health-related web-based tool developed by HKU multidisciplinary team - endocrinologist, family medicine expert and nursing/health literacy faculty
  ✓ Used by thousands of Chinese adults
  ✓ App users could be approached after one year
  ✓ Adjust the cut-off point of risk score

• Further investigation:
  ✓ adding other variables to develop a diabetic risk score tailor-made for Chinese population.
  ✓ Longer follow up (e.g. 3 years)
  ✓ Provide health advice to users
  ✓ Do users change their behaviour?


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Welcome your comment

谢谢!  THANK YOU!
欢迎您的意见!
## Association between demographics and HbA1c

At risk of diabetes:
- HbA1c ≥ 6.0
- 28 (17%)

Chi-square tests
* p-value > 0.1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Levels</th>
<th>A1c &lt;6 (n=134)</th>
<th>A1c ≥=6 (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Age*</td>
<td>&lt;=34</td>
<td>4</td>
<td>3.0%</td>
</tr>
<tr>
<td></td>
<td>35-44</td>
<td>12</td>
<td>9.0%</td>
</tr>
<tr>
<td></td>
<td>45-54</td>
<td>50</td>
<td>37.3%</td>
</tr>
<tr>
<td></td>
<td>55-64</td>
<td>57</td>
<td>42.5%</td>
</tr>
<tr>
<td></td>
<td>65-74</td>
<td>11</td>
<td>8.2%</td>
</tr>
<tr>
<td></td>
<td>75-84</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Highest Education Level*</td>
<td>No Formal</td>
<td>2</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>2</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>64</td>
<td>47.8%</td>
</tr>
<tr>
<td></td>
<td>Vocational</td>
<td>13</td>
<td>9.7%</td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>53</td>
<td>39.6%</td>
</tr>
<tr>
<td>Sex*</td>
<td>Male</td>
<td>88</td>
<td>65.7%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>46</td>
<td>34.3%</td>
</tr>
</tbody>
</table>
### Risk score vs HbA1c

#### DRS score vs HbA1c

<table>
<thead>
<tr>
<th>DRS Score</th>
<th>HbA1c</th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 6</td>
<td>&gt;= 6.0</td>
<td></td>
</tr>
<tr>
<td>&lt; 9</td>
<td>108 (66.67%)</td>
<td>16 (9.88%)</td>
<td>124 (76.54%)</td>
</tr>
<tr>
<td>&gt;= 9</td>
<td>26 (16.05%)</td>
<td>12 (7.41%)</td>
<td>38 (23.46%)</td>
</tr>
<tr>
<td>Total</td>
<td>134 (82.72%)</td>
<td>28 (17.28%)</td>
<td>162 (100%)</td>
</tr>
</tbody>
</table>

Cut-off score:
- **DRS ≥ 9**:  
  \[\text{chi-square} = 7.096, \ p = .008\]

- **DRS ≥ 8**:  
  \[\text{chi-square} = 12.055, \ p = .001\]