

# Cell phone–based health education messaging improves health literacy.

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## Abstract

**Background:** The ubiquity of cell phones, which allow for short message service (SMS), provides new and innovative opportunities for disease prevention and health education.

**Objective:** To explore the use of cell phone–based health education SMS to improve the health literacy of community residents in China.

**Methods:** A multi-stage random sampling method was used to select representative study communities and participants  $\geq 18$  years old. Intervention participants were sent health education SMSs once a week for 1 year and controls were sent conventional, basic health education measures. Health literacy levels of the residents before and after the intervention were evaluated between intervention and control groups.

**Results:** Public health literacy scores increased 1.5 points, from 61.8 to 63.3, after SMS intervention for 1 year ( $P < 0.01$ ); the increase was greater for males than females (2.01 vs. 1.03;  $P < 0.01$ ) and for Shenzhen local residents than non-permanent residents (2.56 vs. 1.14;  $P < 0.01$ ). The frequency of high health literacy scores was greater for the intervention than control group (22.03% to 30.93% vs. 22.07% to 20.82%). With health literacy as a cost-effective index, the cost-effectiveness per intervention was 0.54.

**Conclusion:** SMS may be a useful tool for improving health literacy.

**Keywords:** Health literacy, intervention, community residents, cell phone, short message service.

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## Introduction

Unhealthy lifestyle behaviors are major public health problems. Promoting health behavior is an ongoing challenge that warrants innovative solutions.<sup>1</sup> The use of new technologies, such as cell phones and the internet, has greatly increased in recent years. The effect of cell phones on health care delivery is of increasing inter-

est.<sup>2</sup> Health care interventions via short message service (SMS) based on cell-phone text messages are beneficial in medicine, for public health-related uses and administrative processes.<sup>3</sup>

SMS makes use of a text message that is storable; health-related knowledge can be sent to specific people, guiding medication and behavior, and encouraging self-health management. Because of its convenience, reliability, wide coverage, low cost, relevance and retransmission aspects, SMS is acceptable to many people, especially youth,<sup>4</sup> and has been used in medical treatment and public health in both developed and developing countries.<sup>5-7</sup> SMS has been used to promote a range of health behaviors, such as smoking cessation; weight loss; physical exercise; nutrition guidance; self-management of diabetes mellitus, asthma and hypertension; HIV prevention; and medication compliance.<sup>8-10</sup> In assessing the use of SMS as the main tool for health behavior intervention, many studies

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have shown that SMS plays a role in the main results.<sup>11-14</sup> As a simple and cost-effective tool for providing medication reminders, SMS has been used by several healthcare services.<sup>15</sup> However, some studies have shown no benefit of SMS in improving health behavior or promoting therapy.<sup>16,17</sup>

Health literacy is the degree to which individuals can obtain, process, and understand basic health information and services needed to make appropriate health decisions.<sup>18</sup> The consequences of inadequate health literacy include poor health status, lack of knowledge about medical care and medical conditions, decreased comprehension of medical information, lack of understanding and use of preventive services, poor self-reported health, poor compliance, increased hospitalization, and increased health care costs.<sup>19,20</sup> Many countries, such as the United States, Canada, and Australia, have used health literacy as an indicator of National health.

In 2008, to improve the level of National health literacy and health behavior, China issued the Chinese basic knowledge and skills of health literacy policy<sup>21</sup> and started a national health-literacy promotion plan. However, health education resources are limited, and more effective intervention measures are needed to promote health literacy. Every area in China uses many different forms of information dissemination to improve health literacy, but SMS is almost never used as an intervention.

The population of Shenzhen, adjacent to Hong Kong, has rapidly increased from 15,000 to 15 million people in past 30 years. The young people represent the majority, and traditional ways of health education are limited; exploring how to use SMS for health education and to improve health literacy in communities is of interest. Also, determining the cost-effectiveness of the SMS intervention in health literacy is needed to supply evidence to the government for policies to support SMS in health education and promotion.

This study aimed to explore the use of SMS for health education to improve the health literacy of community residents in China.

## **Materials and methods**

### **Participants and sampling**

In July 2012, 16 street districts were randomly selected from all 53 street districts in Shenzhen, then 32 com-

munities (2 communities were chosen from 1 street districts) were randomly allocated to 16 intervention and 16 control groups. The residential buildings were chosen by systematic sampling from each community, and the participants were chosen by cluster sampling from each building, until 200 participants ( $\geq 18$  years and lived in Shenzhen for at least 6 months) were chosen from one community. Health literacy levels were determined before the intervention in a random sample of 3,205 participants from the intervention group and 3,208 participants from the control group. After the 1-year intervention, health literacy levels were evaluated in cross-sectional samples of participants  $\geq 19$  years old: 3198 from the intervention group and 3202 from the control group. All study investigators and staff members were trained and certified. The study plan and all procedures were approved by the Life Sciences Ethical Committee of Shenzhen Health Education and Promotion Center. Written informed consent was obtained from all the community residents in the intervention group and participants who were used to evaluate the effects of health literacy level before and after the intervention from both intervention and control groups.

### **Intervention**

The intervention group received conventional, basic health education measures (such as bulletin boards, posters, and health lectures) and health education SMSs once a week for 1 year. The control group received the same conventional and basic health education measures as the intervention group but without SMSs.

### **SMS content**

According to the results of previous health literacy assessment for the Shenzhen population, the project team formulated a series of text messages. Message contents were designed in accordance with the basic principle of the conditioned reflex. All content was based on the public need for health literacy. The SMS was constructed as displaying evidence first by survey data, which would attract the participants; then explaining the reason, which would prompt learning about health, including consequences and influences; then listing the health behaviors, encouraging and intensifying them, so as to take action. The content was limited to 250-400 words.

### **SMS frequency**

The SMS involved texting from a group message-sending

system designed by an Internet company. The intervention lasted for 12 months, with one piece of SMS sent every week, and 60 pieces of SMS in total.

### Evaluation criterion

On the basis of systems theory, a rapid assessment of health literacy (RAHL) questionnaire<sup>22</sup> was designed to include the 3 dimensions of health knowledge, behavior and skill. Health knowledge represents basic sanitation, prevention of infectious diseases and chronic diseases, nourishment and diet, mental health, and the harmfulness of smoking. Health behaviors represent healthy habits, mental fitness, no smoking, safe medication, healthy check-up and physical exercise. Health skills represent safety, emergency treatment and correct methods of washing hands. The questionnaire had 20 items in total, with each item having a total score of 5. The RAHL is more convenient, flexible, and acceptable than traditional health assessment methods. The health literacy assessed by the RAHL was divided into three levels by the cutoffs 60% and 75%: low health literacy (LHL), high health literacy (HHL), and marginal health literacy (MHL).

The cost included the fee for the text messaging charged by the cell phone operator in China. The effectiveness was the level of health literacy assessed. The cost-effectiveness was the ratio of the cost divided by the effectiveness. The basic unit of money of the fee was the Chinese Yuan.

### Data analysis

Multi-stage random sampling and weighted calculation methods were used to obtain representative samples and data analyses. Because of possible overstimulation in both intervention and control groups, we included 2 groups (intervention vs. control) to complete pretests and post-tests to reduce the effects of reporting bias. Continuous data is shown as mean  $\pm$ SD, and Student t test was used to analyze differences in health literacy before and after the intervention as well as differences between groups before and after the intervention. Categorical data is represented as number (percentage) and chi-square test was used to assess differences in LHL, MHL, and HHL before and after the intervention. Statistical analysis involved use of SAS 9.10 for Windows (SAS Inst., Cary, NC, USA).  $P < 0.05$  (two-sided) was considered statistically significant.

### Results

Before the intervention, 89.33% of the 3,205 intervention participants indicated that they were willing to receive health education SMSs. Participants 18-24 years old (91.77%) and those older than 60 years (91.95%) were extremely willing to receive the education. The proportion of willingness did not differ for males and females (89.32 vs 89.34%) (Table 1).

**Table 1. Willingness to receive the health education short message service (SMS) among the intervention group before the intervention**

Variable	No. participants	of No. willing to receive SMS	%
<b>Gender</b>			
Male	1489	1330	89.32
Female	1716	1533	89.34
<b>Age (years)</b>			
18-24	632	580	91.77
25-39	1599	1427	89.24
40-49	561	494	88.06
50-64	326	282	86.50
65-	87	80	91.95
<b>Total</b>	<b>3205</b>	<b>2863</b>	<b>89.33</b>

### Change in health literacy

For the intervention group, the mean health literacy score was higher after than before the intervention (63.33 vs 61.84,  $P < 0.001$ ), with no significant difference before and after the intervention for the control group (61.43 vs. 61.37,  $P > 0.05$ ) (Table 2). After the intervention, health literacy differed by gender, age group, household register, and level of education ( $P < 0.01$ ). The male health literacy increased 2.01 points, from 60.16 to 62.17, and

was higher than for females: increase of 1.03 points, from 63.29 to 64.32. The health literacy increased 2.39 and 2.10 points for participants aged 25-39 and 40-49, respectively, and increased more for Shenzhen residents than non-residents (2.56 vs 1.15,  $P < 0.01$ ). The higher the education, the greater the increase in literacy. People with a university degree showed increased literacy (3.06 points) and those with a primary school degree decreased literacy (1.60 points). Change in health literacy did not differ by marital status.

**Table 2. Dimensions of health literacy among intervention and control groups**

variables	Intervention				<i>P</i> *	Control				<i>P</i> *
	Before		After			Before		After		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
<b>Gender</b>										
Male	60.16	12.49	62.17	13.42	0.001	59.76	12.71	59.97	12.32	0.66
Female	63.29	11.57	64.32	13.07	0.014	62.94	11.85	62.64	11.74	0.48
<b>Age group, years</b>										
18-24	61.14	11.78	61.95	12.96	0.280	60.07	12.57	60.53	11.96	0.57
25-39	62.22	11.95	64.61	12.76	0.001	62.22	12.02	61.96	11.83	0.52
40-49	61.40	12.76	63.50	13.39	0.007	60.47	12.85	60.31	12.27	0.83
50-64	61.82	11.79	61.32	14.47	0.600	61.09	12.53	61.30	12.55	0.82
65-	63.05	13.66	62.72	13.26	0.840	62.63	12.53	62.21	12.94	0.81
<b>Household register</b>										
Shenzhen resident	65.24	11.81	67.80	13.07	0.001	65.33	12.05	64.29	11.91	0.07
Nonresident	60.52	11.97	61.66	12.95	0.002	59.92	12.16	60.20	11.96	0.42
<b>Education level</b>										
< Primary school	59.34	11.88	57.74	14.39	0.240	57.28	13.76	58.07	13.41	0.54
Junior high school	58.24	11.86	59.27	13.19	0.080	58.26	12.05	58.07	12.10	0.75
Senior high school	61.86	11.54	63.90	12.00	0.001	61.48	11.77	61.27	11.51	0.66
> College degree	66.62	11.70	69.68	12.09	0.001	65.49	11.78	65.15	11.46	0.54
<b>Marital status</b>										
Not married	61.36	11.85	63.62	12.92	0.550	60.08	13.28	60.45	12.12	0.62
Married	62.00	12.13	63.29	13.32	0.001	61.87	11.99	61.73	11.98	0.69
Other	61.02	14.34	64.57	14.55	0.190	59.03	15.02	56.35	14.36	0.31
<b>Total</b>	61.84	12.48	63.33	13.67	0.001	61.43	12.75	61.37	12.46	0.12

Comparing before and after intervention

Before the intervention, the proportion of HHL in the intervention group was lowest (22.03%), LHL highest (46.23%), and MHL moderate (31.74%) (Table 3). After the intervention, the proportion of MHL became the lowest (29.04%), HHL increased (30.93%), and LHL decreased (40.03%). After the intervention, the 3 dimensions of health literacy differed in the intervention group ( $P=0.001$ ) but not in the control group ( $P=0.400$ ).

### Cost-effectiveness analysis

In total, 160,250 SMS messages with 11217.5 RMB (Yuan) were released during the 1-year intervention, so the cost per SMS with group messaging was 0.07 Yuan. Using health literacy as a cost-effective index, the cost-effectiveness per intervention was 0.54: with 1 Yuan invested in health education via SMSs, the level of health literacy would increase 0.54 points.

**Table 3. The composition of different levels of the 3 dimensions of health literacy**

Group	No.	LHL (%)	MHL (%)	HHL (%)	$\chi^2$ *	$P$ *
<b>Intervention group</b>						
Before intervention	3205	46.23	31.74	22.03	55.48	0.001
After intervention	3198	40.03	29.04	30.93		
<b>Control group</b>						
Before intervention	3208	45.64	32.29	22.07	1.82	0.400
After intervention	3202	45.73	33.45	20.82		

*Comparison before and after intervention*

*LHL, low health literacy; HHL, high health literacy; MHL, marginal health literacy*

### Discussion

There has been an explosion in the number of articles and studies on SMS use in health interventions; however, few studies have evaluated its use with health literacy. To our knowledge, this is the first study to use an SMS program to promote health literacy in a community-based population in China. We found that public health literacy scores significantly increased after SMS intervention for 1 year, and was greater for male than female. The frequency of high health literacy scores was greater for the intervention than control group. Using health literacy as a cost-effective index, the cost-effectiveness per intervention was 0.54, so for 1 Yuan invested in health education SMSs, the health literacy would increase by 0.54 points. SMS may be a powerful tool for improving health literacy because it is readily available and inexpensive.

According to government information, Shenzhen has more than 18 million cell phones, with an average of about 130% per 100 people.<sup>23</sup> We found that 89.3% of our intervention group was highly willing to receive

health messages, which suggests that education by cell phone is acceptable.

Public health literacy results from many factors, including policy, society, environment, education, culture, economy, and population characteristics. We found that public health literacy increased by 1.56 points in 1 year with an SMS intervention. These findings were similar to other research finding, that texting was easily accepted by subjects.<sup>24</sup> SMS was found to affect the promotion of health awareness,<sup>25</sup> health knowledge,<sup>26-28</sup> and changing unhealthy behavior or improving therapy.<sup>29-34</sup> SMS was more effective than pamphlets in improving knowledge, attitude, and practices, especially in promoting physical activity.<sup>35</sup> In the present study, we also found that SMS-delivered interventions had positive short-term behavioral outcomes.

SMS may work well because it is simple, well known, and delivered to a primary “inbox”. More consideration should be placed on the design of SMS content, message framing and timing of delivery.<sup>36,37</sup> The duration of

interventions range from 1 to 24 months, and the frequency of text messaging is from daily to twice weekly;<sup>38</sup> the frequency of SMSs sent once a week is acceptable to subjects.<sup>39</sup> The intervention can stimulate craving in some participants at some times but also provides emotional support and reinforcement at temporally appropriate moments.<sup>40</sup>

Text messages can increase self-health management in the public, especially in patients with chronic disease. For certain patients, SMSs may enhance chronic-disease management support and patient–provider communications.<sup>41</sup> One study found that SMSs changed behavior among older adults,<sup>42</sup> but we found that SMS was more valid for young people and those with higher education. Learning via SMS can be an effective and appealing method of knowledge acquisition in a population with a high level of education or young age.<sup>43</sup> Because the health condition of these people may be compromised due to pressure from both family and career, many people are in a physical state of sub-health, so health education SMSs may be beneficial and improve health literacy. However, the disadvantages of using SMS over the traditional method cannot be ignored. SMS is restricted in the quantity and quality of the message communicated. As well, with limited storage facility, it is not a good reference source.

Traditional means of communication such as pamphlets, publicity campaigns, and lectures have more reasonable costs than mass media, but the implementation process is relatively complicated and the coverage ratio is low. Mass communication by television, newspapers, and radio has good coverage, but the cost is high and sustainability is difficult because of the need to develop content. However, SMS represents easy management. SMS offers health promoters an exciting opportunity to engage personally with a large number of people at low cost.<sup>44,45</sup> We found that the cost-effectiveness of SMS per intervention was 0.54 in improving health literacy, which agrees with other research.<sup>46</sup> SMS complements traditional health education methods, which expands the means of multiple transmission. SMS for health literacy may have better benefit and lower the cost of health education. SMS was previously found more effective than pamphlets in improving knowledge, attitude and practices.<sup>47</sup> The cost is relatively low, its use is widespread, and it is applicable to every model of cell phone.<sup>48</sup>

Although the use of the SMS might have similar potential in developing and developed countries, this method is still not applicable globally. The potential overall effect of SMS-based programs is difficult to ascertain. Also, because of limited staff and funds, we did not investigate text interactivity and achieving targeted individualized guidance and intervention. The intervention time was not long enough to fully reveal the long-term effect of the intervention for public health literacy. The topic needs further research to explore the effect if SMS is implemented with a more refined, scientific, and professional personalized service.

## Conclusion

SMS may be a useful tool for improving health literacy.

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## Conflicts of interest

None declared.

## Abbreviations

SMS: short message service

LHL: Low health literacy

MHL: Middle health literacy

HHL: High health literacy

RAHL: Rapid assessment of health literacy

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