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A comprehensive assessment of health education and health promotion in non-communicable disease demonstration districts

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Manuscripts

A comprehensive assessment of health education and health promotion in non-communicable disease demonstration districts

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25 ABSTRACT

26 Objectives

27 Develop assessment indicators of health education and promotion for non-communicable
28 disease demonstration districts in China. Check status of the districts in Hunan province by
29 field assessment. Provide a framework or methodological reference for similar, future studies.

30 Methods

31 Between late 2013 and 2015 in Hunan province, China, three complementary techniques were
32 used to conduct this study. The Delphi technique was used to develop assessment indicators
33 with weights, followed by Rank Sum Ratio (RSR) to normalize weights through rank
34 conversion, and lastly a Technique for Order Preference by Similarity to Ideal Solution
35 (TOPSIS) was conducted to assess five random demonstration district samples, including one
36 national level district (Furong district) and four provincial level districts (Ziyang district,
37 Shaodong county, Shuangfeng county, Luxi county).

38 Results

39 A total of 24 assessment indicators were constructed, covering the following sections:
40 organizational management, fund support, personnel supplies, health education and promotion,
41 awareness of NCDs, management and control of NCDs patients, satisfaction with health
42 education and promotion, and civil health literacy. The sampling demonstration districts
43 launched an effective construction with better performances in health education and
44 promotion. However, performance varied from districts with national level district obviously
45 surpassed provincial level ones.

46 Conclusions

47 The evaluated NCD demonstration districts were proved to be effective with better
48 performances, and differed corresponding with their demonstration level. Our study could
49 provide both a methodological reference and an (assessment indicators) framework for other
50 community health studies.

51 **Keywords:** assessment; health education; health promotion; non-communicable diseases.

52

53 **Strengths and limitations of this study**

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3 54 First study to build assessment indicators for health education and promotion in NCD
4
5 55 demonstration districts in China.
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7 56 Three popular assessment tools were comprehensively used to set assessment indicators
8
9 57 both qualitatively and quantitatively.
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11 58 This study provide a framework or methodological reference for future similar studies.
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13 59 It's uncertain whether the sampling NCDs demonstration districts will sustain their
14
15 60 effectiveness on health education and promotion from now on.
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17 61 It's restricted to NCDs demonstration districts with no consideration for non NCDs
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19 62 demonstration districts.
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21 63

22 23 64 **INTRODUCTION**

24
25 65 China has undergone a swift health transition over the past two decades. The spectrum of
26
27 66 people's diseases are now dominated by NCDs or known as chronic diseases, such as
28
29 67 cardiovascular diseases, lung cancer, chronic obstructive pulmonary disease, and road
30
31 68 injuries,¹ instead of infectious diseases, along with a rapid incidence rise and heavy disease
32
33 69 burden. Currently, some 260 million Chinese, accounting for 19% of the nation's population,
34
35 70 suffer from NCDs, which contributed to 85% of the mortality rate and 70% of the disease
36
37 71 burden. China is now facing great challenges from NCDs.²
38

39 72 The National Health and Family Planning Commission of China (former the Ministry of
40
41 73 Health) has launched a nationwide community-based NCD demonstration districts (or
42
43 74 counties) campaign since late 2010, similar to widely known healthy cities occurred in many
44
45 75 countries from the late 1980s,³ to curb the surging NCDs across the country. Since then, a
46
47 76 series of NCD demonstration districts, aimed to play their demonstrational effects and
48
49 77 promote NCDs' control and prevention, has been set up either at national or provincial level.
50

51 78 Health education is defined as a systematic social activity of helping people improve their
52
53 79 health related behaviors, while health promotion is the process of enabling people to increase
54
55 80 control over, and to improve, their health.⁴ Integrated health education and promotion are both
56
57 81 the first priority policy and primary means of NCDs control and prevention, also play
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59 82 important roles in the construction of NCD demonstration districts, especially at community
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3 83 level. However, the work was young in China with rare systematic assessments have been
4 reported (none assessment indicators available). Thus, based on health education and
5 84 promotion in the districts, this study was conducted to develop their assessment indicators,
6 followed by evaluation on the sampled demonstration districts, to provide a framework or
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11 methodological reference for other community health studies.
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13 88 **METHODS**

14 89 **Study design**

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16
17 90 Three evaluation techniques were comprehensively followed in the study. Figure 1 showed
18 the flow diagram. A modified Delphi method originally developed by RAND/UCLA⁵ was
19 91
20 firstly used in the following steps (conducted between late 2013 and 2014) :
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22
23 93 1. Based on work manuals of NCD demonstration districts developed by the national
24 Center for Diseases Control and Prevention (CDC) and our own work experiences, thirty-nine
25 94
26 sub-sectional consultative items in seven sections were selected for the first Delphi round
27 95
28 (appendix table A1).
29 96

30 97 2. Experts nationwide were invited if they met the following demands: Working either in
31 NCDs control and prevention, health education and promotion, or other public health
32 98
33 professions; Working for provincial institutions and above. Had five years or more of work
34 99
35 experience; Showing an interest to participate in the study.
36 100

37
38 101 3. Following a two round Delphi process. In the first round, experts were asked to judge
39 whether items should be included, and were free to add items or make comments.
40 102
41 Additionally, they scored importance of each item with a 9 point Likert scale (1 to 9:
42 103
43 extremely unimportant to extremely important).⁶⁻⁸ Data were summarized, revised, and fed
44 104
45 back to experts for a second round conducting the same as the first round. After that,
46 105
47 assessment indicators were determined.
48 106

49 107 Secondly, the RSR method introduced by Tian FD⁹ was followed (conducted in 2015). The
50 basic theory behind the method is that a dimensionless statistical indicator (RSR) is calculated
51 108
52 from an $n \times m$ matrix using rank conversion. The subjects' status (worst/best) could be
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54 evaluated using the RSR order. All items were firstly ranked as R_{ij} ($i \leq n, j \leq m$), with the higher
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56 quality items ranked in ascending and the lower quality items descending. A weighted RSR
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112 was then calculated by equation $RSR_i = \frac{\sum_{j=1}^m R_{ij}}{m \times n}$.

113 Lastly, a TOPSIS technique¹⁰⁻¹² was employed to assess the sampling NCDs demonstration
114 districts (conducted in 2015). Prior to the technique, five out of twenty-eight NCDs
115 demonstration districts in the province, namely Furong district, Ziyang district, Shaodong
116 county, Shuangfeng county, Luxi county, were randomly sampled as evaluated target. They
117 were collected data in the term of the assessment indicator between 2014 and 2015. The
118 TOPSIS was then conducted by the following six steps:

119 1. The original values of items (X_{ij}) were converted as the high quality (X'_{ij}) ones. There
120 was no need to convert here because of their naturally high quality features.

121 2. Normalizing the mono-trended matrix as Y_{ij} and calculating by the equation

$$122 \quad Y_{ij} = X'_{ij} \div \sqrt{\sum_{i=1}^m (X'_{ij})^2} .$$

123 3. Based on weights by RSR, combined values of normalized matrix were calculated as Z_{ij}
124 by equation: $Z_{ij} = RSR_i * Y_{ij}$.

125 4. Determine the ideal solution ($A+$) and negative ideal solution ($A-$).

126 5. Calculate the distance of each alternative to ideal ($Di+$) and negative ideal ($Di-$) solution,
127 and relative similarities of an alternative to the ideal solution (Ci).

128 6. Ranking alternatives based on Ci . The larger Ci , the greater alternative was.

129 **Statistical analyses**

130 During the Delphi process, assessment items were excluded unless they simultaneously
131 reached experts agreement $\geq 70\%$,¹³⁻¹⁵ median scores ≥ 7 ,¹⁶⁻¹⁸ and coefficient of variation (CV)
132 < 0.25 .¹⁹⁻²⁰ Internal consistency of items was taken with a Cronbach's α coefficient test.
133 Cronbach's α of 0.7 or greater are regarded as reasonable reliability, of 0.8 or greater are
134 regarded as good reliability.²¹⁻²³

135 Data was analyzed from 2014 to 2015, when the variables of "Mean", Standard Deviance
136 (SD) and CV, along with Cronbach's α test, were analyzed with SPSS17.0 (SPSS Inc.,
137 Chicago). Other related data in the above methods were addressed by Microsoft Excel2010.

138 RESULTS

139 Totally nineteen experts (Figure 2) coming from national or provincial public health
 140 institutions completed the Delphi process. Most of them (68.42%) came from CDC. They had
 141 been working for a mean of 15.53±7.40 years, approximately 90% of whom awarded as
 142 senior doctors. Experts all got a bachelor degree (in public health), and 63% of whom also
 143 had a master's degree.

144 The two round Delphi process showed that (Table 1) fifteen items were removed, including
 145 fourteen in the first round and one in the second round. Twenty-four items were stayed as
 146 assessment indicators with scores defined as weights (appendix table A2), covering the
 147 following sections as organizational management, fund support, personnel supplies, health
 148 education and promotion, awareness of NCDs, satisfaction with health education and
 149 promotion, and civil health literacy.

151 **Table 1** Results from the two round Delphi processes.

Section items	Round 1				Round 2			
	code	agreement (%)	Median (SD)	CV	code	agreement (%)	Median (SD)	CV
Organization management	1	100	9 (1.02)	0.11	1	100	9(1.39)	0.15
	2	78.9	8 (1.08)	0.14	2	73.7	8(1.59)	0.2
	3	100	8 (1.43)	0.18	3	100	8(1.18)	0.15
	4*	89.5	6 (1.66)	0.28	-	-	-	-
Fund support	5	100	9 (0.67)	0.07	5	100	9(0.45)	0.05
	6	78.9	8 (1.55)	0.19	6	89.5	8(1.42)	0.18
	7	89.5	8 (1.18)	0.15	7	89.5	8(0.85)	0.11
	8	89.5	7 (1.03)	0.15	8	94.7	7.5(0.97)	0.13
Personnel supplies	9*	68.4	6 (1.8)	0.3	-	-	-	-
	10	100	8 (0.93)	0.12	10	100	8(0.71)	0.09
Health education and promotion	11	100	8 (0.97)	0.12	11	100	8(0.71)	0.09
	12	100	7 (1.29)	0.18	12	100	7(1.28)	0.18
	13	94.7	7 (1.33)	0.19	13	100	7(1.28)	0.18
	14	84.2	7 (1.18)	0.17	14	84.2	7(1.13)	0.16
	15	84.2	7 (1.18)	0.17	15	84.2	7(1.13)	0.16
	16	84.2	7 (1.12)	0.16	16	78.9	7(1.10)	0.16
	17 ^a	78.9	6 (1.1)	0.18	-	-	-	-
	18	78.9	7 (1.16)	0.17	18 ^a	89.5	6(1.01)	0.17
19 ^a	94.7	6 (1.04)	0.17	-	-	-	-	
20 ^a	68.4	6 (1.41)	0.23	-	-	-	-	
21	94.7	7 (1.4)	0.20	21	94.7	7(1.14)	0.16	

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2									
3		22	89.5	7 (1.3)	0.19	22	89.5	7(1.42)	0.2
4		23	100	8 (1.07)	0.13	23	100	8(0.74)	0.09
5		24	100	7 (1.58)	0.23	24	94.7	7(1.26)	0.18
6		25	94.7	7 (1.56)	0.22	25	89.5	7(1.15)	0.16
7		26	94.7	7.5 (1.1)	0.15	26	100	8(1.11)	0.14
8		27	94.7	7.5 (1.15)	0.15	27	94.7	8(1)	0.12
9		28 ^a	47.4	6 (1.45)	0.24	-	-	-	-
10		29 ^a	52.6	6 (1.33)	0.22	-	-	-	-
11		30	100	8 (1.51)	0.19	30	100	8(0.65)	0.08
12	Awareness and	31 ^a	68.4	8 (1.66)	0.21	-	-	-	-
13	healthy behavior								
14	of NCDs								
15	Control and	32 ^a	52.6	6.5 (1.73)	0.27	-	-	-	-
16	management of	33 ^a	68.4	8 (1.49)	0.19	-	-	-	-
17	NCDs	34 ^a	42.1	7 (1.85)	0.26	-	-	-	-
18		35 ^a	52.6	7 (1.29)	0.18	-	-	-	-
19	Others	36 ^a	68.4	8 (1.38)	0.17	-	-	-	-
20		37	94.7	7.5 (1.77)	0.24	37	100	7(1.08)	0.15
21		38 ^a	73.7	6 (1.59)	0.26	-	-	-	-
22		39	100	7 (1.61)	0.23	39	94.7	8(1.09)	0.14
23									
24									
25	Total		88	7 (1.43)	0.20		93.7	8(1.23)	0.15
26									

152 ^a: Items removed from in each round

153 The Cronbach's α value in the first Delphi round was 0.90, with a 95% confidence interval
 154 (CI) of 0.82-0.95, while the Cronbach's α in the second round was 0.85 (95% CI: 0.74-0.93),
 155 both reaching a good internal consistency.

156 Based on indicators weights by the modified Delphi method, the RSR method was
 157 conducted to normalize the weights (Table 2).

158 Prior to the TOPSIS technique, five NCDs demonstration district were randomly sampled
 159 as the followings: one national level NCDs demonstration district (Furong district), four
 160 provincial level districts (Ziyang district, Shaodong county, Shuangfeng county, Luxi county).
 161 The TOPSIS technique was then used to normalize the real values of assessment indicators in
 162 the sampling districts, and calculate combined indicators values (Table 2).

163 Finally, the five sample districts was ranked in order (from best to worst) as Furong district >
 164 Luxi county > Ziyang district > Shaodong county > Shuangfeng county, where Furong district
 165 surpassed greatly the rest areas (Table 3).

166

167

Table 2. Normalization both weights of assessment indicators and real values in sampling districts of Hunan province, China

Code	Weight	RSR	Real value ($X_{ij} = X'_{ij}$)					Normalization value (Y_{ij})				
			Furong	Ziyang	Shaodong	Shuangfeng	Luxi	Furong	Ziyang	Shaodong	Shuangfeng	Luxi
a1 ^a	20.13	0.0671	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a2 ^a	9.53	0.0318	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a3 ^a	18.13	0.0604	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a4	20.08	0.0669	2436.5	943.1	149.8	730.1	319.5	0.8907	0.3447	0.0547	0.2669	0.1168
a5	11.76	0.0392	96.00	19.60	34.07	41.94	17.74	0.8474	0.1730	0.3007	0.3702	0.1566
a6	12.21	0.0407	23.60	12.47	16.03	15.09	10.91	0.6506	0.3438	0.4418	0.4159	0.3006
a7	10.32	0.0344	0.071	0.056	0.052	0.052	0.070	0.5186	0.4126	0.3848	0.3828	0.5160
a8 ^a	15.42	0.0514	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a9 ^a	17.79	0.0593	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a10	12.08	0.0403	19	2	39	11	44	0.3026	0.0319	0.6211	0.1752	0.7007
a11	12.08	0.0403	5	8	3	2	30	0.1580	0.2527	0.0948	0.0632	0.9477
a12	6.82	0.0227	24	12	18	9	10	0.6857	0.3429	0.5143	0.2571	0.2857
a13	6.82	0.0227	14	10	11	9	6	0.6058	0.4327	0.4760	0.3895	0.2596
a14	5.79	0.0193	88	26	27	15	28	0.8731	0.2580	0.2679	0.1488	0.2778
a15	9.39	0.0313	100	100	100	89.98	100	0.4560	0.4560	0.4560	0.4103	0.4560
a16	7.50	0.025	0.5	0.5	0.5	0.5	0.5	0.4472	0.4472	0.4472	0.4472	0.4472
a17	15.03	0.0501	100	93	100	89.98	100	0.4625	0.4301	0.4625	0.4162	0.4625
a18	9.68	0.0323	4.4	4.3	0.3	4.0	1.9	0.5783	0.5680	0.0365	0.5297	0.2472
a19	10.13	0.0338	4	8	4	4	4	0.3536	0.7071	0.3536	0.3536	0.3536
a20	13.55	0.0452	100	100	100	100	100	0.4472	0.4472	0.4472	0.4472	0.4472
a21	14.71	0.049	100	100	100	100	100	0.4472	0.4472	0.4472	0.4472	0.4472
a22	17.61	0.0587	57.25	55.5	44.26	38.51	31.17	0.5516	0.5348	0.4265	0.3711	0.3003
a23	11.76	0.0392	86.26	73.86	81.96	80.85	71.83	0.4875	0.4174	0.4632	0.4569	0.4059
a24	11.68	0.0389	10.86	10.42	9.79	9.29	8.45	0.4957	0.4756	0.4468	0.4240	0.3857

^a: Representing for qualitative items: the positive items was valued as 1, and the negative was 0

1 **Table 2** Continued

code	Comprehensive normalization values (Z_{ij})				
	Furong	Ziyang	Shaodong	Shuangfeng	Luxi
a1	0.0300	0.0300	0.0300	0.0300	0.0300
a2	0.0142	0.0142	0.0142	0.0142	0.0142
a3	0.0270	0.0270	0.0270	0.0270	0.0270
a4	0.0596	0.0231	0.0037	0.0179	0.0078
a5	0.0332	0.0068	0.0118	0.0145	0.0061
a6	0.0265	0.0140	0.0180	0.0169	0.0122
a7	0.0178	0.0142	0.0132	0.0132	0.0177
a8	0.0230	0.0230	0.0230	0.0230	0.0230
a9	0.0265	0.0265	0.0265	0.0265	0.0265
a10	0.0122	0.0013	0.0250	0.0071	0.0282
a11	0.0064	0.0102	0.0038	0.0025	0.0382
a12	0.0156	0.0078	0.0117	0.0058	0.0065
a13	0.0138	0.0098	0.0108	0.0088	0.0059
a14	0.0169	0.0050	0.0052	0.0029	0.0054
a15	0.0143	0.0143	0.0143	0.0128	0.0143
a16	0.0112	0.0112	0.0112	0.0112	0.0112
a17	0.0232	0.0216	0.0232	0.0208	0.0232
a18	0.0187	0.0183	0.0012	0.0171	0.0080
a19	0.0120	0.0239	0.0120	0.0120	0.0120
a20	0.0202	0.0202	0.0202	0.0202	0.0202
a21	0.0219	0.0219	0.0219	0.0219	0.0219
a22	0.0324	0.0314	0.0250	0.0218	0.0176
a23	0.0191	0.0164	0.0182	0.0179	0.0159
a24	0.0193	0.0185	0.0174	0.0165	0.0150

2

3 **Table 3** Ranking of sample districts in Hunan province by TOPSIS

Subject	D+	D-	Ci	Rank
Furong district	0.0376	0.0716	0.6558	1
Luxi county	0.0663	0.0458	0.4085	2
Ziyang district	0.0628	0.0332	0.3462	3
Shaodong county	0.0744	0.0277	0.2712	4
Shuangfeng county	0.0672	0.0248	0.2693	5

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DISCUSSION

Multi-assessments should be comprehensively employed in health evaluations due to such features as objects, purposes, and data types, compensating for the limitation of single assessment. Featuring with anonymity, iteration, controlled feedback, and statistical summarization, the Delphi technique was chosen as a suitable method for obtaining collective opinion of experts, and has been widely used in health related research.^{15, 24, 25} The TOPSIS developed by Hwang & Yoon²⁶ has been chosen as a family member in Multiple Criteria Decision Making (MCDM).²⁷⁻²⁹ It provides us the optimal solution or alternatives' ranking³⁰ without operational issues or limitation on data types,³¹⁻³³ but often fails to avoid the impact of abnormal values.³⁴ The RSR method based on non-parameter analysis has no restriction of data types too. Moreover, it can eliminate the bias of abnormal values in reflecting the priority of objects evaluated.³⁵

The above methods were used in this study to construct assessment indicators and assess the situation of health education and promotion in NCDs demonstration districts, showing that most NCDs demonstration district have launched an effective construction in health education and promotion with a better performance value, in which Furong district topped obviously than other districts especially in fund support, media promotion, technical support for promotion materials, community promotion and supportive environment supplies, matching to its national level nomination. As a central district in the capital city of Hunan province, the main economic indicators of Furong had been one of the best among counties or districts in the province.^{36, 37} Local government had supported much in NCDs control and prevention related funds. Both the fees of NCDs health education and promotion and the proportion of NCDs control expenditures in total business expenses in local CDC were also in advantage, providing a strong basis for conducting relevant work. Besides, it's solid historically on health education and promotion, of which the "Ten health projects" such as total health mobilization and massive health auditorium, had generated into its own features. It was also leading in building rich-themed NCDs health education database among grass-level medical institutions and information sharing model as well, benefiting greatly residents whose awareness rate, satisfaction and health literacy level in NCDs were all better than other districts.

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3 37 Following Furong district, Luxi county ranked the second with its own features. It's
4
5 38 regarded as one of both Wuling Mountain Areas Regional Development Key Counties and
6
7 39 national poverty-stricken counties,³⁸ with insufficient funds supported by local government in
8
9 40 NCDs control and prevention, and the rest two fund guarantees were also dwarfed apparently
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11 41 by other districts. However, it's not only comprehensive in carrying out ways but extensive in
12
13 42 themes of NCDs control and prevention despite of a simple external form, highlighting a
14
15 43 diverse and frequent media promotion particularly in television station, with an annual
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17 44 forty-four period shows averaging 30 minutes per time. Meanwhile, the NCDs education and
18
19 45 promotion here had permeated into every village (or community), featuring a one hundred
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21 46 percent coverage of fitness centers or rooms, and numerous sorts of NCDs promotion
22
23 47 materials, devoting much to its priority to other objects (except Furong district).

24 48 Middle-ranking Ziyang district performed straight and narrow with most assessment
25
26 49 indicator at middle level. As to the last two ranking objects as Shaodong and Shuangfeng
27
28 50 counties, the comprehensive performances of both were left behind, which may were
29
30 51 contributed to their late-beginning and hasty construction of NCDs demonstration district
31
32 52 during the study conducting period, and historically unsolid work basis as well.

33 34 **Strengths and limitations**

35
36 54 We are the first group in China to build both qualitative and quantitative assessment indicators
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38 55 for health education and promotion in NCD demonstration districts. With a hybrid of
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40 56 multi-assessment methods (all as popular assessment tools in health care research), the results
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42 57 of this study are more reliable. Our study could provide a framework or methodological
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44 58 reference for future similar studies.

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46 59 However, we admitted the study had some limitations. The indicator data collecting from
47
48 60 the sampling districts was based on the past one to two years since their demonstration district
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50 61 construction. A reality is how they work now and from now on, or would they sustain the
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52 62 previous construction remains uncertain in our study. Another limit was that the study was
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54 63 restricted to NCDs demonstration districts, while as no study in non NCDs demonstration
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56 64 districts, which should also brought into as a control target to better show a valid assessment.

57 58 **Conclusions**

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66 We built qualitative and quantitative assessment indicators of health education and promotion
67 in NCDs demonstration districts with a hybrid of multi-assessment methods, providing a valid
68 reference for future similar studies. The sampling NCDs demonstration districts in Hunan
69 province launched an effective construction of health education and promotion, and were
70 representative for that of all NCDs demonstration districts in the province. However, the
71 effectiveness varied from districts with the national level demonstration districts performing
72 better obviously than provincial ones. The variances was not only associated with local fund
73 support but with themselves working basis. And the former factor didn't even matter because
74 the limit could be broken and even shifted into an advantage with a solid working quality.

75

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81 analysis and paper writing; Yuelong Huang was the principal guarantor of the study and
82 contributed to the study design. Biyun Chen managed the study day-to-day and commented
83 on paper writing. All authors have discussed the paper and approved the final version.

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86 **Conflicts of interest:** None declared

87 **Data sharing statement:** No additional data available.

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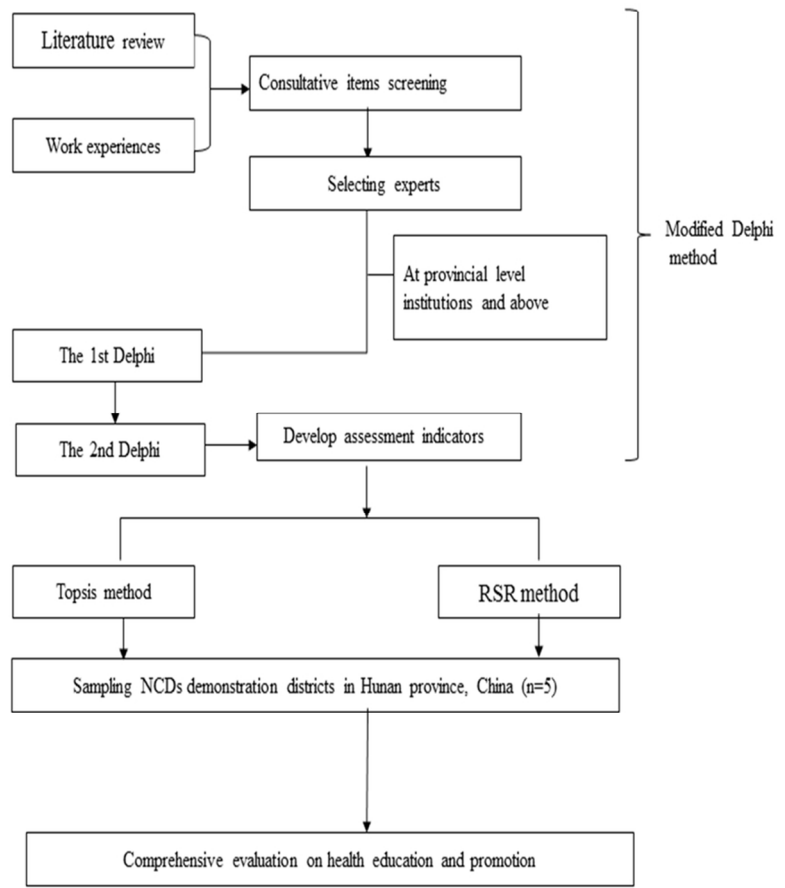
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201 **Figure legends**

- 44
45 202 Figure 1 Flow diagram of the study conducted
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48 203 Figure 2 Characteristics of experts participating in the Delphi process
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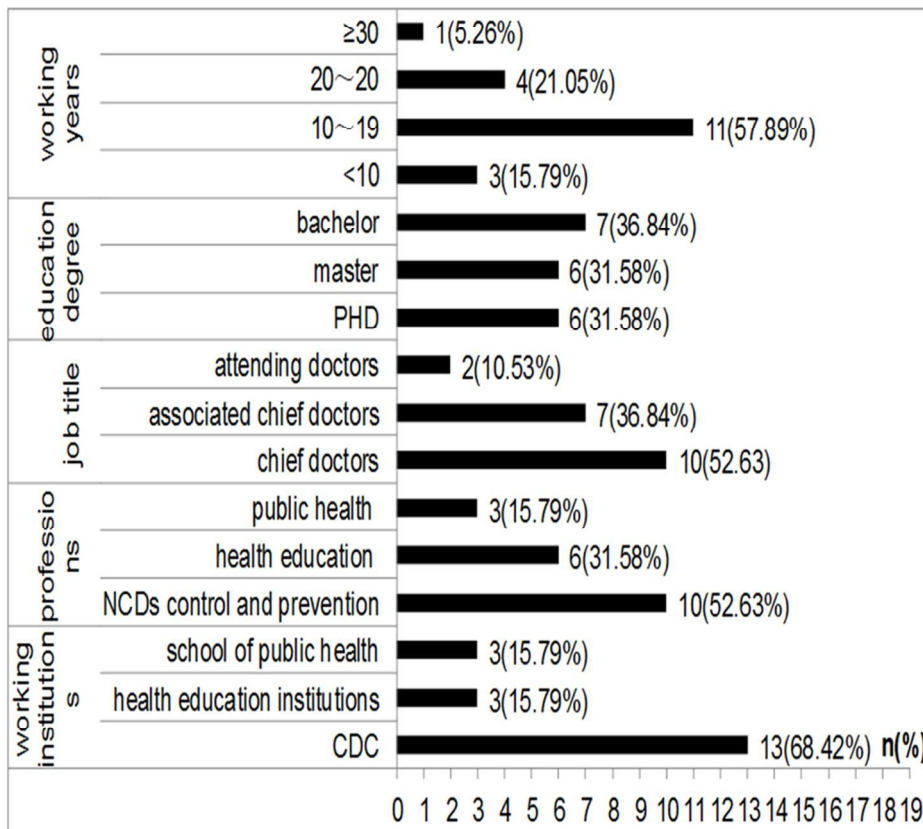
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The flow diagram of this study

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Characteristics of experts participating in the Delphi procedure

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Appendix Table A1 The consultative items screened for the first Delphi round

section items	Sub-section items	Code
Organization guarantees	whether local government based leadership team on NCDs control was established and held meetings once at least per year	1
	whether local administrative health authority based leadership team on NCDs control was established and held meetings once at least per year	2
	whether making a yearly work plan on NCDs health education and promotion	3
	whether a health education or health promotion institution or department was supplied with	4
Fund support	the number of NCDs special fund by local government per thousand population per year (yuan)	5
	the number of NCDs control expenses in local CDC (ten thousand yuan)	6
	the proportion of NCDs control expenses in total business expenses in local CDC (%)	7
Personnel supplies	the number of persons working in NCDs health education and promotion within medical institutions beyond village level per thousand population	8
	the times of parent trainings for those who work in NCDs health education per year.	9
	Health education and health promotion	
	whether a yearly NCDs related health broadcasting planning was developed	10
	whether billboards on NCDs control were presented and advertised regularly in local medias (except TV)	11
	the frequencies of promotion on NCDs control and prevention in local TV station per year	12
	the average minutes of show on NCDs control and prevention in local TV station per time	13
	the mean sorts of NCDs control and prevention materials printed	14
	the mean sorts of NCDs control and prevention billboard presented by town level hospitals	15
	the mean sorts of NCDs control and prevention promotion materials by town level hospitals	16
	the mean sorts of NCDs control and prevention video presented by town level hospitals	17
	the times of public consultation of NCDs related core information on different themes per year	18
	the average times promotion video on NCDs control played by town-level hospitals per week	19
	the average minutes of video on NCDs control played by town-level hospitals every time	20
	the community based coverage of NCDs control and prevention billboard (%)	21
	the average monthly frequencies of NCDs control and prevention billboard updating in community	22

Appendix Table A1 Continued

section items	Sub-section items	Code
Health education and health promotion	the average coverage of fitness center or room in community (%)	23
	the times of NCDs health lecture in community (a scale of >50 persons)	24
	the times of massive promotion activities of NCDs per year (a scale of >100 persons)	25
	the institution based coverage of NCDs control lectures in both elementary and middle school (%)	26
	the student based coverage of NCDs control lectures in both elementary and middle school (%)	27
	the institution based coverage of health lectures in the kindergarten (%)	28
	the preschool children based coverage of health lectures in the kindergarten (%)	29
Awareness of NCDs & healthy behavior	people's awareness rate of NCDs control and prevention (%)	30
	the rate of people's healthy behavior formation(%)	31
Management and control of NCDs patients	the rate of standardized management on hypertension / diabetes patients(%)	32
	the rate of control over hypertension / diabetes patients(%)	33
	the number of NCDs patients oriented self-management groups finishing jobs in the past year	34
	the community-based rate of coverage of NCDs patients(%)	35
Others	whether the assessments of NCDs risk factors had been conducted during the past 3 years	36
	people's satisfaction with supplies of health education and promotion	37
	whether health education associated files had been completed in regular management	38
	people's health literacy level in NCDs control and prevention	39

Appendix Table A2 Assessment indicators by modified Delphi method

Indicator	Code	Weight
whether local government based leadership team on NCDs control was established and held meetings once at least per year	a1	20.13
whether local administrative health authority based leadership team on NCDs control was established and held meetings once at least per year	a2	9.53
whether making a yearly work plan on NCDs health education and promotion	a3	18.13
the number of NCDs special fund by local government per thousand population per year (yuan)	a4	20.08
the number of NCDs control expenditures in local CDC (per ten thousand yuan)	a5	11.76
the proportion of NCDs control expenses in total business expenses in CDC (%)	a6	12.21
the number of persons working in NCDs health education and promotion within medical institutions beyond village level per thousand population	a7	10.32
whether a yearly NCDs health broadcasting planning was developed	a8	15.42
Whether billboards on NCDs control were presented and advertised regularly in local medias (except TV)	a9	17.79
the frequencies of NCDs control and prevention in local TV station per year	a10	12.08
the average minutes of show on NCDs control and prevention in local TV station per time	a11	12.08
the mean sorts of NCDs control and prevention materials printed	a12	6.82
the mean sorts of NCDs control billboard presented by town level hospitals	a13	6.82
the mean sorts of NCDs control and prevention promotion materials presented by town level hospitals	a14	5.79
the community based coverage of NCDs control and prevention billboard (%)	a15	9.39
the average monthly frequencies of NCDs control billboard updating in community	a16	7.5
the average coverage of fitness center or room in community (%)	a17	15.03
the times of NCDs health lecture in community (a scale of >50 persons)	a18	9.68
the times of NCDs promotion activities per year (a scale of >100persons)	a19	10.13
the institution based coverage of NCDs control and prevention lectures in both elementary and secondary school (%)	a20	13.55
the student based coverage of NCDs control and prevention lectures in both elementary and secondary school (%)	a21	14.71
people's awareness rate of NCDs control and prevention (%)	a22	17.61
people's satisfaction with supplies of health education and promotion (%)	a23	11.76
people's health literacy level in NCDs control and prevention (%)	a24	11.68

TRIPOD Checklist: Prediction Model Development and Validation

Section/Topic	Item	Checklist Item	Page	
Title and abstract				
Title	1	D;V	Identify the study as developing and/or validating a multivariable prediction model, the target population, and the outcome to be predicted.	P1
Abstract	2	D;V	Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions.	P2
Introduction				
Background and objectives	3a	D;V	Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models.	P3
	3b	D;V	Specify the objectives, including whether the study describes the development or validation of the model or both.	P4
Methods				
Source of data	4a	D;V	Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable.	P4-P5
	4b	D;V	Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up.	P4-P5
Participants	5a	D;V	Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres.	P4-P5
	5b	D;V	Describe eligibility criteria for participants.	P4-P5
	5c	D;V	Give details of treatments received, if relevant.	P4-P5
Outcome	6a	D;V	Clearly define the outcome that is predicted by the prediction model, including how and when assessed.	P4-P5
	6b	D;V	Report any actions to blind assessment of the outcome to be predicted.	P4-P5
Predictors	7a	D;V	Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured.	P4-P5
	7b	D;V	Report any actions to blind assessment of predictors for the outcome and other predictors.	P5
Sample size	8	D;V	Explain how the study size was arrived at.	P5
Missing data	9	D;V	Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method.	NA
Statistical analysis methods	10a	D	Describe how predictors were handled in the analyses.	P5
	10b	D	Specify type of model, all model-building procedures (including any predictor selection), and method for internal validation.	P5
	10c	V	For validation, describe how the predictions were calculated.	P5
	10d	D;V	Specify all measures used to assess model performance and, if relevant, to compare multiple models.	NA
	10e	V	Describe any model updating (e.g., recalibration) arising from the validation, if done.	NA
Risk groups	11	D;V	Provide details on how risk groups were created, if done.	NA
Development vs. validation	12	V	For validation, identify any differences from the development data in setting, eligibility criteria, outcome, and predictors.	NA
Results				
Participants	13a	D;V	Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful.	P6
	13b	D;V	Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome.	P6
	13c	V	For validation, show a comparison with the development data of the distribution of important variables (demographics, predictors and outcome).	P6-P7
Model development	14a	D	Specify the number of participants and outcome events in each analysis.	P6-P9
	14b	D	If done, report the unadjusted association between each candidate predictor and outcome.	P6-P9
Model specification	15a	D	Present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point).	P6-P9
	15b	D	Explain how to use the prediction model.	P7
Model performance	16	D;V	Report performance measures (with CIs) for the prediction model.	P7-P9
Model-updating	17	V	If done, report the results from any model updating (i.e., model specification, model performance).	P6-P9
Discussion				
Limitations	18	D;V	Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data).	P11
Interpretation	19a	V	For validation, discuss the results with reference to performance in the development data, and any other validation data.	P10-P11
	19b	D;V	Give an overall interpretation of the results, considering objectives, limitations, results from similar studies, and other relevant evidence.	P11-P12
Implications	20	D;V	Discuss the potential clinical use of the model and implications for future research.	P12
Other information				
Supplementary information	21	D;V	Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets.	P4,P6 ,P16
Funding	22	D;V	Give the source of funding and the role of the funders for the present study.	P12

*Items relevant only to the development of a prediction model are denoted by D, items relating solely to a validation of a prediction model are denoted by V, and items relating to both are denoted D;V. We recommend using the TRIPOD Checklist in conjunction with the TRIPOD Explanation and Elaboration document.

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BMJ Open

A comprehensive assessment of health education and health promotion in 5 non-communicable diseases demonstration districts in China: a cross-sectional study

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Primary Subject Heading:	Public health
Secondary Subject Heading:	Research methods, Public health
Keywords:	STATISTICS & RESEARCH METHODS, PUBLIC HEALTH, PREVENTIVE MEDICINE

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13 5 Qiaohua Xu,¹ Yuelong Huang,¹ Biyun Chen.¹
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25 ABSTRACT

26 Objectives

27 This study aims to develop assessment indicators of health education and promotion for
28 non-communicable diseases (NCDs) demonstration districts in China, and find out the
29 significant factors associated with NCDs health education and promotion work.

30 Methods

31 Between late 2013 and 2015 in Hunan province, China, three complementary techniques
32 were used to conduct this study. The Delphi technique was used to develop assessment
33 indicators with weights, followed by Rank Sum Ratio (RSR) to normalize weights through
34 rank conversion. Lastly, a Technique for Order Preference by Similarity to Ideal Solution
35 (TOPSIS) was conducted to assess five randomly selected NCDs demonstration districts
36 representing five different orientations of the province.

37 Results

38 A total of 24 assessment indicators were constructed, covering the following sections:
39 organizational management, fund support, personnel supplies, health education and
40 promotion, people awareness of NCDs, management and control of NCDs patients,
41 satisfaction with health education and promotion, and health literacy of residents. Five
42 districts were selected as evaluated samples, namely Furong district, Ziyang district,
43 Shaodong county, Shuangfeng county, Luxi county. Performance varied among them with
44 Furong district greatly surpassing others, especially in the following factors as fund support,
45 media promotion, technical support for publicity materials, community promotion and
46 supportive environment supplies. The latter four factors were also advantaged by the second
47 ranked Luxi county over others (except Furong district).

48 Conclusions

49 There were gaps in health education and promotion work of NCDs demonstration districts in
50 Hunan province. Those who perform better had obvious advantages in fund support, media
51 promotion, technical support, community promotion and supportive environment supplies.
52 Our study could provide both a methodological reference and an assessment indicator
53 framework for similar, future studies.

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4 54 **Keywords:** assessment; health education; health promotion; non-communicable diseases.
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8 56 **Strengths and limitations of this study**

- 9
10 57 ● To the author's knowledge, this is the first study to build assessment indicators for health
11 education and promotion in NCD demonstration districts in China.
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13 58 ● This study involved three popular assessment tools both qualitatively and quantitatively
14 with Delphi, RSR, and TOPSIS, and hence it can provide a methodological reference for
15 similar, future studies.
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17 59 ● One limitation of this study is fewer NCDs demonstration districts were selected as
18 evaluated samples, failing to fully reflect the whole situation in China.
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20 60 ● Another limitation is its cross-sectional design and lack of control data either from the
21 history of those districts or from non-NCD demonstration districts.
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29 67 **INTRODUCTION**

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31 68 China has undergone a swift health transition over the past two decades. The spectrum of
32 people's diseases are now dominated by NCDs or known as chronic diseases, such as
33 cardiovascular diseases, lung cancer, chronic obstructive pulmonary disease, and road
34 injuries,¹ instead of infectious diseases, along with a rapid incidence rise and heavy disease
35 burden. Currently, some 260 million Chinese, accounting for 19% of the nation's population,
36 suffer from NCDs, which contributed to 85% of the mortality rate and 70% of the disease
37 burden.² China is now facing great challenges from NCDs.

38
39 70 The National Health and Family Planning Commission of China (NHFPC, the former
40 Ministry of Health) has launched a nationwide NCDs demonstration districts (or counties)
41 program since late 2010, similar to widely known health cities occurred in many countries
42 from the late 1980s.³ The program was aimed to take an exemplary effect of NCDs
43 demonstration districts for other regions, and further promote NCDs control and prevention
44 across the country. In the principle of voluntary, step-by-step declaration, those who wanted
45 to be national NCD demonstration districts, had to get a recommendation from provincial
46 health administration department at first, followed by passing an assessment organized by
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3 83 NHFPC. Similarly, the declaration of provincial NCD demonstration districts would go
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5 84 through a city-level recommendation first and then a provincial assessment.
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7 85 Health education is defined as a systematic social activity of helping people improve their
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9 86 health related behaviors. For NCDs, health education is often seen in publicizing people a
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11 87 healthy lifestyle with non-smoking, low-salt diet, proper diet, adequate physical activities and
12
13 88 mental health, by publicity materials, billboard, lectures, media promotion, etc. Health
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15 89 promotion is the process of enabling people to increase control over, and to improve, their
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17 90 health.⁴ Ottawa Charter for health promotion action means five policies,⁴ including building
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19 91 healthy public policy (e.g. raise tobacco excise tax), creating supportive environments (e.g.
20
21 92 build fitness trail), strengthening community actions, developing personal skills, reorienting
22
23 93 health services. Integrated health education and promotion are both the first priority policy
24
25 94 and primary means of NCDs control and prevention, also play important roles in NCD
26
27 95 demonstration districts program. However, the work was young in China with rare systematic
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29 96 assessments reported (none assessment indicators available). Thus, based on health education
30
31 97 and promotion in the districts, this study was conducted to develop their assessment
32
33 98 indicators, compare with their performances among districts, and analyze important factors of
34
35 99 health education and promotion, so as to provide a framework or methodological reference
36
37 100 for other health studies.

37 101 **METHODS**

38 102 **Study design**

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40 103 Three evaluation techniques were comprehensively followed in the study. Figure 1 showed
41
42 104 the flow diagram. A modified Delphi method originally developed by RAND/UCLA⁵ was
43
44 105 firstly used in the following steps (conducted between late 2013 and 2014) :

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46 106 1. Based on work manuals of NCD demonstration districts developed by the national
47
48 107 Center for Diseases Control and Prevention (CDC) and our own work experiences, thirty-nine
49
50 108 sub-sectional consultative items in seven sections were selected for the first Delphi round
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52 109 (Appendix Table A1).

53
54 110 2. Experts nationwide were invited if they met the following demands: Working either in
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56 111 NCDs control and prevention, health education and promotion, or other public health
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122 professions; Working for provincial institutions and above. Five years or more of work
 123 experience; Showing an interest to participate in the study.

124 3. A two round Delphi process was conducted. In the first round, experts were asked to
 125 judge whether items should be included, and were free to add items or make comments. They
 126 scored each item with a 9 point Likert scale (1 to 9: extremely unimportant to extremely
 127 important).⁶⁻⁸ Data were summarized, revised, and sent to experts for a second round
 128 following the same format as the first round. After that, assessment indicators were
 129 determined.

120 Secondly, the RSR method introduced by Tian FD⁹ was followed (conducted in 2015).
 121 The basic theory behind the method is that a dimensionless statistical indicator (RSR) is
 122 calculated from an $n \times m$ matrix using rank conversion. The subjects' status (worst/best) could
 123 be evaluated using the RSR order. All items were firstly ranked as R_{ij} ($i \leq n, j \leq m$), with the
 124 higher quality items ranked in ascending and the lower quality items descending. A weighted

125 RSR was then calculated by equation $RSR_i = \frac{\sum_{j=1}^m R_{ij}}{m \times n}$.

126 Lastly, a TOPSIS technique¹⁰⁻¹² was employed to assess the sampling NCDs
 127 demonstration districts (conducted in 2015). Prior to the technique, Some NCDs districts
 128 needed to be set as evaluated samples. To take a balance of geographical distribution, we
 129 randomly selected 5 districts representing different orientations (south, north, east, west, and
 130 middle located each) out of the total 28 districts in the province, and generated the following
 131 districts as samples: Furong district, Ziyang district, Shaodong county, Shuangfeng county,
 132 Luxi county, with a random function in Excel. The data of assessment indicator were
 133 collected between 2014 and 2015 in the above districts. The TOPSIS was then conducted by
 134 the following six steps:

135 1. The original values of items (X_{ij}) were converted as the high quality (X'_{ij}) ones. There
 136 was no need to convert here because of their natural high quality features.

137 2. Normalizing the mono-trended matrix as Y_{ij} and calculating by equation

138
$$Y_{ij} = X'_{ij} \div \sqrt{\sum_{i=1}^m (X'_{ij})^2}.$$

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4 139 3. Based on weights by RSR, combined values of normalized matrix were calculated as Z_{ij}
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6 140 by equation: $Z_{ij} = RSR_i * Y_{ij}$.
7
8 141 4. Determining the ideal solution ($A+$) and negative ideal solution ($A-$).
9
10 142 5. Calculating the distance of each alternative to ideal ($Di+$) and negative ideal ($Di-$)
11
12 143 solution, and relative similarities of an alternative to the ideal solution (Ci).
13
14 144 6. Ranking alternatives based on Ci . The larger Ci , the greater alternative was.

145 **Statistical analyses**

146 During the Delphi process, assessment items were excluded unless they simultaneously
147 reached experts agreement ($\% \geq 70\%$,¹³⁻¹⁵ median scores ≥ 7 ,¹⁶⁻¹⁸ and coefficient of
148 variation(CV) < 0.25 .¹⁹⁻²⁰ Internal consistency of items was taken with a Cronbach's α
149 coefficient test. Cronbach's α of 0.7 or greater are regarded as reasonable reliability, of 0.8 or
150 greater are regarded as good reliability.²¹⁻²³

151 Data was analyzed from 2014 to 2015, when the variables of "Mean", Standard Deviance
152 (SD) and CV, along with Cronbach's α test, were analyzed with SPSS17.0 (SPSS Inc.,
153 Chicago). Other related data in the above methods were addressed by Microsoft Excel 2010.

154 **RESULTS**

155 In total, nineteen experts (Figure 2) coming from national or provincial public health
156 institutions completed the Delphi process. Most of them (68.42%) came from CDC. They had
157 been working for a mean of 15.53 ± 7.40 years, approximately 90% of whom awarded as
158 senior doctors. All experts had bachelor degrees (in public health), and 63% had master's
159 degrees.

160 The two round Delphi process showed that (Table 1) fifteen items were removed, including
161 fourteen in the first round and one in the second round. Twenty-four items were stayed as
162 assessment indicators with scores defined as weights (appendix table A2), covering the
163 following sections as organizational management, fund support, personnel supplies, health
164 education and promotion, awareness of NCDs, satisfaction with health education and
165 promotion, and health literacy of residents.

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167 **Table 1** Results from the two round Delphi processes.

Section items	Round 1				Round 2			
	code	agreement (%)	Median (SD)	CV	code	agreement (%)	Median (SD)	CV
Organization	1	100	9 (1.02)	0.11	1	100	9(1.39)	0.15
management	2	78.9	8 (1.08)	0.14	2	73.7	8(1.59)	0.20
	3	100	8 (1.43)	0.18	3	100	8(1.18)	0.15
	4*	89.5	6 (1.66)	0.28	-	-	-	-
Fund support	5	100	9 (0.67)	0.07	5	100	9(0.45)	0.05
	6	78.9	8 (1.55)	0.19	6	89.5	8(1.42)	0.18
	7	89.5	8 (1.18)	0.15	7	89.5	8(0.85)	0.11
Personnel	8	89.5	7 (1.03)	0.15	8	94.7	7.5(0.97)	0.13
supplies	9*	68.4	6 (1.8)	0.30	-	-	-	-
Health education	10	100	8 (0.93)	0.12	10	100	8(0.71)	0.09
and promotion	11	100	8 (0.97)	0.12	11	100	8(0.71)	0.09
	12	100	7 (1.29)	0.18	12	100	7(1.28)	0.18
	13	94.7	7 (1.33)	0.19	13	100	7(1.28)	0.18
	14	84.2	7 (1.18)	0.17	14	84.2	7(1.13)	0.16
	15	84.2	7 (1.18)	0.17	15	84.2	7(1.13)	0.16
	16	84.2	7 (1.12)	0.16	16	78.9	7(1.10)	0.16
	17 ^a	78.9	6 (1.1)	0.18	-	-	-	-
	18	78.9	7 (1.16)	0.17	18 ^a	89.5	6(1.01)	0.17
	19 ^a	94.7	6 (1.04)	0.17	-	-	-	-
	20 ^a	68.4	6 (1.41)	0.23	-	-	-	-
	21	94.7	7 (1.4)	0.20	21	94.7	7(1.14)	0.16
	22	89.5	7 (1.3)	0.19	22	89.5	7(1.42)	0.2
	23	100	8 (1.07)	0.13	23	100	8(0.74)	0.09
	24	100	7 (1.58)	0.23	24	94.7	7(1.26)	0.18
	25	94.7	7 (1.56)	0.22	25	89.5	7(1.15)	0.16
	26	94.7	7.5 (1.1)	0.15	26	100	8(1.11)	0.14
	27	94.7	7.5 (1.15)	0.15	27	94.7	8(1)	0.12
	28 ^a	47.4	6 (1.45)	0.24	-	-	-	-
	29 ^a	52.6	6 (1.33)	0.22	-	-	-	-
Awareness and	30	100	8 (1.51)	0.19	30	100	8(0.65)	0.08
healthy behavior	31 ^a	68.4	8 (1.66)	0.21	-	-	-	-
of NCDs	32 ^a	52.6	6.5 (1.73)	0.27	-	-	-	-
Control and	33 ^a	68.4	8 (1.49)	0.19	-	-	-	-
management of	34 ^a	42.1	7 (1.85)	0.26	-	-	-	-
NCDs	35 ^a	52.6	7 (1.29)	0.18	-	-	-	-
Others	36 ^a	68.4	8 (1.38)	0.17	-	-	-	-
	37	94.7	7.5 (1.77)	0.24	37	100	7(1.08)	0.15
	38 ^a	73.7	6 (1.59)	0.26	-	-	-	-
	39	100	7 (1.61)	0.23	39	94.7	8(1.09)	0.14
Total		88	7 (1.43)	0.20		93.7	8(1.23)	0.15

168 ^a: Items removed from in each round

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3 169 The Cronbach's α value in the first Delphi round was 0.90, with a 95% confidence interval
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5 170 (CI) of 0.82-0.95, while the Cronbach's α in the second round was 0.85 (95% CI: 0.74-0.93),
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7 171 both reaching a good internal consistency.

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9 172 Based on indicators weights by the modified Delphi method, the RSR method was
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11 173 conducted to normalize the weights (Table 2).

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13 174 Prior to the TOPSIS technique, five NCDs demonstration district were randomly sampled
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15 175 as the followings: one national level NCDs demonstration district (Furong district), four
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17 176 provincial level districts (Ziyang district, Shaodong county, Shuangfeng county, Luxi county).
18
19 177 The TOPSIS technique was then used to normalize the real values of assessment indicators in
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21 178 the sample districts, and calculate combined indicators values (Table 2).

22 179 Finally, the five sample districts was ranked in order (from best to worst) as Furong
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24 180 district > Luxi county> Ziyang district > Shaodong county > Shuangfeng county, where
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26 181 Furong district surpassed greatly the rest areas with the highest Ci (Table 3).
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182 **Table 2.** Normalization both weights of assessment indicators and real values in sampling districts of Hunan province, China

Code	Weight	RSR	Real value ($X_{ij} = X'_{ij}$)					Normalization value ($Y_{i,j}$)				
			Furong	Ziyang	Shaodong	Shuangfeng	Luxi	Furong	Ziyang	Shaodong	Shuangfeng	Luxi
a1 ^a	20.13	0.0671	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a2 ^a	9.53	0.0318	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a3 ^a	18.13	0.0604	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a4	20.08	0.0669	2436.5	943.1	149.8	730.1	319.5	0.8907	0.3447	0.0547	0.2669	0.1168
a5	11.76	0.0392	96.00	19.60	34.07	41.94	17.74	0.8474	0.1730	0.3007	0.3702	0.1566
a6	12.21	0.0407	23.60	12.47	16.03	15.09	10.91	0.6506	0.3438	0.4418	0.4159	0.3006
a7	10.32	0.0344	0.071	0.056	0.052	0.052	0.070	0.5186	0.4126	0.3848	0.3828	0.5160
a8 ^a	15.42	0.0514	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a9 ^a	17.79	0.0593	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a10	12.08	0.0403	19	2	39	11	44	0.3026	0.0319	0.6211	0.1752	0.7007
a11	12.08	0.0403	5	8	3	2	30	0.1580	0.2527	0.0948	0.0632	0.9477
a12	6.82	0.0227	24	12	18	9	10	0.6857	0.3429	0.5143	0.2571	0.2857
a13	6.82	0.0227	14	10	11	9	6	0.6058	0.4327	0.4760	0.3895	0.2596
a14	5.79	0.0193	88	26	27	15	28	0.8731	0.2580	0.2679	0.1488	0.2778
a15	9.39	0.0313	100	100	100	89.98	100	0.4560	0.4560	0.4560	0.4103	0.4560
a16	7.50	0.025	0.5	0.5	0.5	0.5	0.5	0.4472	0.4472	0.4472	0.4472	0.4472
a17	15.03	0.0501	100	93	100	89.98	100	0.4625	0.4301	0.4625	0.4162	0.4625
a18	9.68	0.0323	4.4	4.3	0.3	4.0	1.9	0.5783	0.5680	0.0365	0.5297	0.2472
a19	10.13	0.0338	4	8	4	4	4	0.3536	0.7071	0.3536	0.3536	0.3536
a20	13.55	0.0452	100	100	100	100	100	0.4472	0.4472	0.4472	0.4472	0.4472
a21	14.71	0.049	100	100	100	100	100	0.4472	0.4472	0.4472	0.4472	0.4472
a22	17.61	0.0587	57.25	55.5	44.26	38.51	31.17	0.5516	0.5348	0.4265	0.3711	0.3003
a23	11.76	0.0392	86.26	73.86	81.96	80.85	71.83	0.4875	0.4174	0.4632	0.4569	0.4059
a24	11.68	0.0389	10.86	10.42	9.79	9.29	8.45	0.4957	0.4756	0.4468	0.4240	0.3857

183 ^a: Representing for qualitative items: the positive items was valued as 1, and the negative was 0

185 **Table 2** Continued

code	Comprehensive normalization values (Z_{ij})				
	Furong	Ziyang	Shaodong	Shuangfeng	Luxi
a1	0.0300	0.0300	0.0300	0.0300	0.0300
a2	0.0142	0.0142	0.0142	0.0142	0.0142
a3	0.0270	0.0270	0.0270	0.0270	0.0270
a4	0.0596	0.0231	0.0037	0.0179	0.0078
a5	0.0332	0.0068	0.0118	0.0145	0.0061
a6	0.0265	0.0140	0.0180	0.0169	0.0122
a7	0.0178	0.0142	0.0132	0.0132	0.0177
a8	0.0230	0.0230	0.0230	0.0230	0.0230
a9	0.0265	0.0265	0.0265	0.0265	0.0265
a10	0.0122	0.0013	0.0250	0.0071	0.0282
a11	0.0064	0.0102	0.0038	0.0025	0.0382
a12	0.0156	0.0078	0.0117	0.0058	0.0065
a13	0.0138	0.0098	0.0108	0.0088	0.0059
a14	0.0169	0.0050	0.0052	0.0029	0.0054
a15	0.0143	0.0143	0.0143	0.0128	0.0143
a16	0.0112	0.0112	0.0112	0.0112	0.0112
a17	0.0232	0.0216	0.0232	0.0208	0.0232
a18	0.0187	0.0183	0.0012	0.0171	0.0080
a19	0.0120	0.0239	0.0120	0.0120	0.0120
a20	0.0202	0.0202	0.0202	0.0202	0.0202
a21	0.0219	0.0219	0.0219	0.0219	0.0219
a22	0.0324	0.0314	0.0250	0.0218	0.0176
a23	0.0191	0.0164	0.0182	0.0179	0.0159
a24	0.0193	0.0185	0.0174	0.0165	0.0150

186

187 **Table 3** Ranking of sample districts in Hunan province by TOPSIS

Subject	D+	D-	Ci	Rank
Furong district	0.0376	0.0716	0.6558	1
Luxi county	0.0663	0.0458	0.4085	2
Ziyang district	0.0628	0.0332	0.3462	3
Shaodong county	0.0744	0.0277	0.2712	4
Shuangfeng county	0.0672	0.0248	0.2693	5

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192 DISCUSSION

193 Multi-assessments should be comprehensively employed in health evaluations due to such
194 features as objects, purposes, and data types, compensating for the limitation of single
195 assessment. Featuring with anonymity, iteration, controlled feedback, and statistical
196 summarization, the Delphi technique was chosen as a suitable method for obtaining collective
197 opinion of experts, and has been widely used in health related research.^{15, 24, 25} The TOPSIS
198 developed by Hwang & Yoon²⁶ has been chosen as a family member in Multiple Criteria
199 Decision Making (MCDM).²⁷⁻²⁹ It provides an optimal solution or alternatives' ranking³⁰
200 without operational issues or limitation on data types,³¹⁻³³ but often fails to avoid the impact
201 of abnormal values.³⁴ The RSR method based on non-parameter analysis has no restriction of
202 data types too. Moreover, it can eliminate the bias of abnormal values in reflecting the
203 priority of objects evaluated.³⁵

204 The above methods were used in this study to construct assessment indicators and assess
205 the situation of health education and promotion in NCDs demonstration districts, showing
206 that Furong district topped and surpassed obviously than other districts, especially in fund
207 support, media promotion, technical support for promotion materials, community promotion
208 and supportive environment supplies, matching to its national level nomination. As a central
209 district in the capital city of Hunan province, the main economic indicators of Furong had
210 been one of the best among counties /districts in the province.^{36, 37} Local government had
211 supported much in NCDs control and prevention related funds. Both the fees of NCDs health
212 education and promotion and the proportion of NCDs control expenditures in total business
213 expenses in local CDC were also in advantage, providing a strong basis for conducting
214 relevant work. Besides, it's solid historically on health education and promotion, of which the
215 "Ten health projects" such as total health mobilization and massive health auditorium, had
216 generated into its own features. It was also leading in building rich-themed NCDs health
217 education database among grass-level medical institutions and information sharing model as
218 well, benefiting greatly residents whose awareness rate, satisfaction and health literacy level
219 in NCDs were all better than other districts.

220 Following Furong district, Luxi county ranked the second with its own features. It's

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3 221 regarded as one of both Wuling Mountain Areas Regional Development Key Counties and
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5 222 national poverty-stricken counties,³⁸ with insufficient funds supported by local government in
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7 223 NCDs control and prevention, and the rest two fund guarantees were also dwarfed apparently
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9 224 by other districts. However, it's not only comprehensive in carrying out ways but extensive in
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11 225 themes of NCDs control and prevention despite of a simple external form, highlighting a
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13 226 diverse and frequent media promotion particularly in television station, with an annual
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15 227 forty-four period shows averaging 30 minutes per time. Meanwhile, the NCDs education and
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17 228 promotion here had permeated into every village (or community), featuring one hundred
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19 229 percent coverage of fitness centers or rooms, and numerous sorts of NCDs promotion
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21 230 materials, devoting much to its priority to other objects (except Furong district).

22 231 Middle-ranking Ziyang district performed straight and narrow with most assessment
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24 232 indicators at middle level. As to the last two ranked objects as Shaodong and Shuangfeng
25
26 233 counties, the comprehensive performances of both were left behind, which may were
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28 234 contributed to their late-beginning and hasty NCDs demonstration district process during the
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30 235 study period, and historically unsolid work basis as well.

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33 34 237 **Conclusions**

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36 238 We built qualitative and quantitative assessment indicators of health education and promotion
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38 239 in NCDs demonstration districts with a hybrid of multi-assessment methods, providing a
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40 240 valid reference for future similar studies. There were gaps in health education and promotion
41
42 241 work of NCDs demonstration districts in Hunan province. Those who perform better had
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44 242 obvious advantages in fund support, media promotion, technical support, community
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46 243 promotion and supportive environment supplies. The variances were not only associated with
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48 244 local fund support but with themselves working basis. Fund support didn't always matter at
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50 245 the variances, because the limitation of inadequate fund support could be broken and even
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52 246 shifted into an advantage with a solid working quality.

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57
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251 data collection and survey conduction.

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253 analysis and paper writing; Yuelong Huang was the principal guarantor of the study and
254 contributed to the study design. Biyun Chen managed the study day-to-day and commented
255 on paper writing. All authors have discussed the paper and approved the final version.

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258 **Conflicts of interest:** None declared

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261 **Data sharing statement:** No additional data available.

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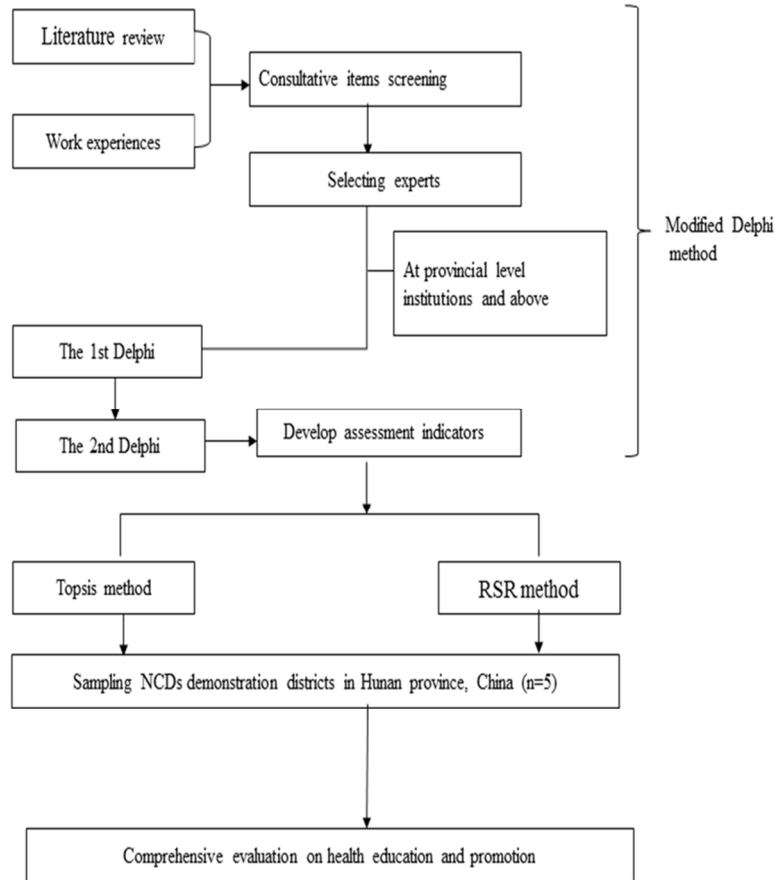
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378 **Figure legends**

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27 379 Figure 1: Flow diagram of the study conducted
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29 380 Figure 2: Characteristics of experts participating in the Delphi process
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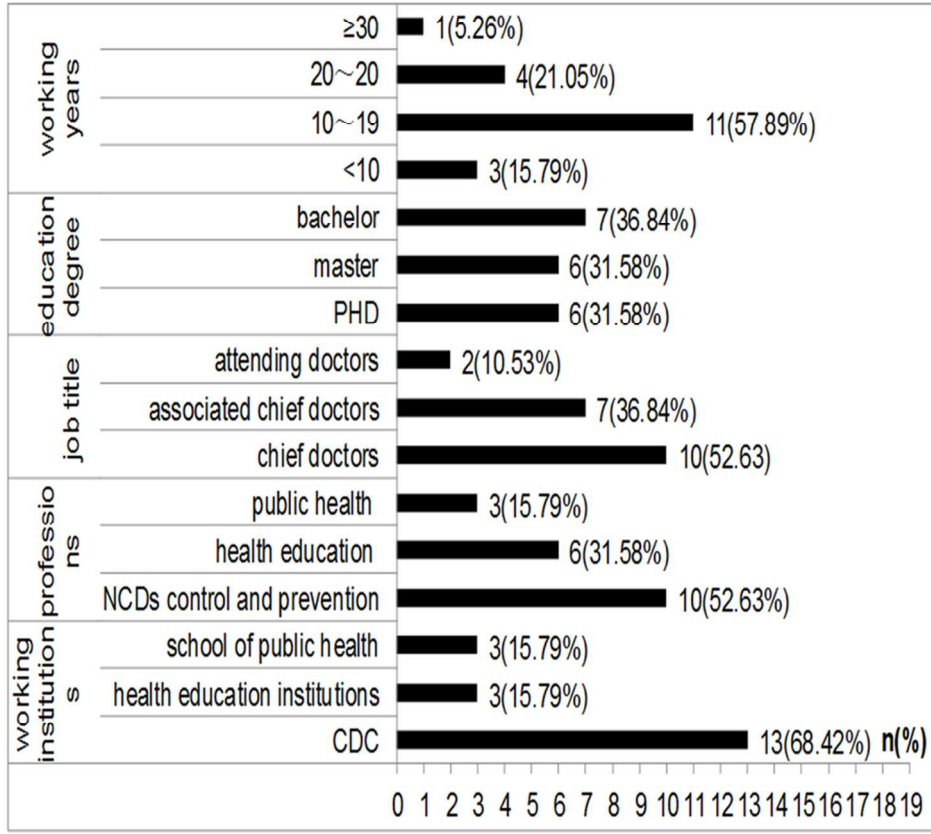


The flow diagram of this study

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Characteristics of experts participating in the Delphi procedure

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Appendix Table A1 The consultative items screened for the first Delphi round

section items	Sub-section items	Code
Organization guarantees	whether local government based leadership team on NCDs control was established and held meetings once at least per year	1
	whether local administrative health authority based leadership team on NCDs control was established and held meetings once at least per year	2
	whether making a yearly work plan on NCDs health education and promotion	3
	whether a health education or health promotion institution or department was supplied with	4
Fund support	the number of NCDs special fund by local government per thousand population per year (yuan)	5
	the number of NCDs control expenses in local CDC (ten thousand yuan)	6
	the proportion of NCDs control expenses in total business expenses in local CDC (%)	7
Personnel supplies	the number of persons working in NCDs health education and promotion within medical institutions beyond village level per thousand population	8
	the times of parent trainings for those who work in NCDs health education per year.	9
	Health education and health promotion	
	whether a yearly NCDs related health broadcasting planning was developed	10
	whether billboards on NCDs control were presented and advertised regularly in local medias (except TV)	11
	the frequencies of promotion on NCDs control and prevention in local TV station per year	12
	the average minutes of show on NCDs control and prevention in local TV station per time	13
	the mean sorts of NCDs control and prevention materials printed	14
	the mean sorts of NCDs control and prevention billboard presented by town level hospitals	15
	the mean sorts of NCDs control and prevention promotion materials by town level hospitals	16
	the mean sorts of NCDs control and prevention video presented by town level hospitals	17
	the times of public consultation of NCDs related core information on different themes per year	18
	the average times promotion video on NCDs control played by town-level hospitals per week	19
	the average minutes of video on NCDs control played by town-level hospitals every time	20
	the community based coverage of NCDs control and prevention billboard (%)	21
	the average monthly frequencies of NCDs control and prevention billboard updating in community	22

Appendix Table A1 Continued

section items	Sub-section items	Code
Health education and health promotion	the average coverage of fitness center or room in community (%)	23
	the times of NCDs health lecture in community (a scale of >50 persons)	24
	the times of massive promotion activities of NCDs per year (a scale of >100 persons)	25
	the institution based coverage of NCDs control lectures in both elementary and middle school (%)	26
	the student based coverage of NCDs control lectures in both elementary and middle school (%)	27
	the institution based coverage of health lectures in the kindergarten (%)	28
	the preschool children based coverage of health lectures in the kindergarten (%)	29
Awareness of NCDs & healthy behavior	people's awareness rate of NCDs control and prevention (%)	30
	the rate of people's healthy behavior formation(%)	31
Management and control of NCDs patients	the rate of standardized management on hypertension / diabetes patients(%)	32
	the rate of control over hypertension / diabetes patients(%)	33
	the number of NCDs patients oriented self-management groups finishing jobs in the past year	34
	the community-based rate of coverage of NCDs patients(%)	35
Others	whether the assessments of NCDs risk factors had been conducted during the past 3 years	36
	people's satisfaction with supplies of health education and promotion	37
	whether health education associated files had been completed in regular management	38
	people's health literacy level in NCDs control and prevention	39

Appendix Table A2 Assessment indicators by modified Delphi method

Indicator	Code	Weight
whether local government based leadership team on NCDs control was established and held meetings once at least per year	a1	20.13
whether local administrative health authority based leadership team on NCDs control was established and held meetings once at least per year	a2	9.53
whether making a yearly work plan on NCDs health education and promotion	a3	18.13
the number of NCDs special fund by local government per thousand population per year (yuan)	a4	20.08
the number of NCDs control expenditures in local CDC (per ten thousand yuan)	a5	11.76
the proportion of NCDs control expenses in total business expenses in CDC (%)	a6	12.21
the number of persons working in NCDs health education and promotion within medical institutions beyond village level per thousand population	a7	10.32
whether a yearly NCDs health broadcasting planning was developed	a8	15.42
Whether billboards on NCDs control were presented and advertised regularly in local medias (except TV)	a9	17.79
the frequencies of NCDs control and prevention in local TV station per year	a10	12.08
the average minutes of show on NCDs control and prevention in local TV station per time	a11	12.08
the mean sorts of NCDs control and prevention materials printed	a12	6.82
the mean sorts of NCDs control billboard presented by town level hospitals	a13	6.82
the mean sorts of NCDs control and prevention promotion materials presented by town level hospitals	a14	5.79
the community based coverage of NCDs control and prevention billboard (%)	a15	9.39
the average monthly frequencies of NCDs control billboard updating in community	a16	7.5
the average coverage of fitness center or room in community (%)	a17	15.03
the times of NCDs health lecture in community (a scale of >50 persons)	a18	9.68
the times of NCDs promotion activities per year (a scale of >100persons)	a19	10.13
the institution based coverage of NCDs control and prevention lectures in both elementary and secondary school (%)	a20	13.55
the student based coverage of NCDs control and prevention lectures in both elementary and secondary school (%)	a21	14.71
people's awareness rate of NCDs control and prevention (%)	a22	17.61
people's satisfaction with supplies of health education and promotion (%)	a23	11.76
people's health literacy level in NCDs control and prevention (%)	a24	11.68

TRIPOD Checklist: Prediction Model Development and Validation

Section/Topic	Item	Checklist Item	Page	
Title and abstract				
Title	1	D;V	Identify the study as developing and/or validating a multivariable prediction model, the target population, and the outcome to be predicted.	P1
Abstract	2	D;V	Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions.	P2
Introduction				
Background and objectives	3a	D;V	Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models.	P3-P4
	3b	D;V	Specify the objectives, including whether the study describes the development or validation of the model or both.	P4
Methods				
Source of data	4a	D;V	Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable.	P4-P5
	4b	D;V	Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up.	P4-P5
Participants	5a	D;V	Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres.	P5
	5b	D;V	Describe eligibility criteria for participants.	P5
	5c	D;V	Give details of treatments received, if relevant.	P5
Outcome	6a	D;V	Clearly define the outcome that is predicted by the prediction model, including how and when assessed.	P4-P6
	6b	D;V	Report any actions to blind assessment of the outcome to be predicted.	P5-P6
Predictors	7a	D;V	Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured.	P4
	7b	D;V	Report any actions to blind assessment of predictors for the outcome and other predictors.	P4-P6
Sample size	8	D;V	Explain how the study size was arrived at.	P5
Missing data	9	D;V	Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method.	NA
Statistical analysis methods	10a	D	Describe how predictors were handled in the analyses.	P6
	10b	D	Specify type of model, all model-building procedures (including any predictor selection), and method for internal validation.	P6
	10c	V	For validation, describe how the predictions were calculated.	P5
	10d	D;V	Specify all measures used to assess model performance and, if relevant, to compare multiple models.	NA
	10e	V	Describe any model updating (e.g., recalibration) arising from the validation, if done.	NA
Risk groups	11	D;V	Provide details on how risk groups were created, if done.	NA
Development vs. validation	12	V	For validation, identify any differences from the development data in setting, eligibility criteria, outcome, and predictors.	NA
Results				
Participants	13a	D;V	Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful.	P6
	13b	D;V	Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome.	P6
	13c	V	For validation, show a comparison with the development data of the distribution of important variables (demographics, predictors and outcome).	P6
Model development	14a	D	Specify the number of participants and outcome events in each analysis.	P6-P10
	14b	D	If done, report the unadjusted association between each candidate predictor and outcome.	P6-P10
Model specification	15a	D	Present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point).	P6-P10
	15b	D	Explain how to use the prediction model.	P8
Model performance	16	D;V	Report performance measures (with CIs) for the prediction model.	P8-P10
Model-updating	17	V	If done, report the results from any model updating (i.e., model specification, model performance).	P6-P10
Discussion				
Limitations	18	D;V	Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data).	P3
Interpretation	19a	V	For validation, discuss the results with reference to performance in the development data, and any other validation data.	P11-P12
	19b	D;V	Give an overall interpretation of the results, considering objectives, limitations, results from similar studies, and other relevant evidence.	P12
Implications	20	D;V	Discuss the potential clinical use of the model and implications for future research.	NA
Other information				
Supplementary information	21	D;V	Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets.	P4,P6,P17
Funding	22	D;V	Give the source of funding and the role of the funders for the present study.	P13

*Items relevant only to the development of a prediction model are denoted by D, items relating solely to a validation of a prediction model are denoted by V, and items relating to both are denoted D;V. We recommend using the TRIPOD Checklist in conjunction with the TRIPOD Explanation and Elaboration document

BMJ Open

A comprehensive assessment of health education and health promotion in 5 non-communicable disease demonstration districts in China: a cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-015943.R2
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Complete List of Authors:	Xu, Qiaohua; Hunan provincial center for diseases control and prevention, China, chronic diseases control Huang , Yuelong; Hunan provincial center for diseases control and prevention, chronic diseases control Chen, Biyun; Hunan provincial center for diseases control and prevention, chronic diseases control
Primary Subject Heading:	Public health
Secondary Subject Heading:	Research methods, Public health
Keywords:	STATISTICS & RESEARCH METHODS, PUBLIC HEALTH, PREVENTIVE MEDICINE

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25 ABSTRACT

26 Objectives

27 This study aims to develop assessment indicators of health education and promotion for
28 non-communicable disease (NCD) demonstration districts in China and to identify significant
29 factors associated with NCD health education and promotion work.

30 Methods

31 Three complementary techniques were used to conduct this study in Hunan Province, China,
32 between late 2013 and 2015. The Delphi technique was used to develop weighted assessment
33 indicators, followed by the rank sum ratio (RSR) to normalize the weights through rank
34 conversion. Lastly, the technique for order preference by similarity to ideal solution (TOPSIS)
35 was conducted to assess five randomly selected NCD demonstration districts representing
36 five different orientations in the province.

37 Results

38 A total of 24 assessment indicators were constructed covering the following sections:
39 organizational management, fund support, personnel supplies, health education and
40 promotion, people's awareness of NCDs, management and control of NCD patients,
41 satisfaction with health education and promotion, and health literacy of residents. Five
42 districts were selected as samples for evaluation (Furong District, Ziyang District, Shaodong
43 County, Shuangfeng County, and Luxi County). Performance varied among the sites, with
44 Furong District greatly surpassing the other sites, especially in fund support, media
45 promotion, technical support for publicity materials, community promotion and supportive
46 environment supplies. The latter four factors were also much greater in the second-ranked
47 Luxi County site than those in the other sites (except Furong District).

48 Conclusions

49 There were gaps in health education and promotion work in NCD demonstration districts in
50 Hunan Province. The districts that performed better had obvious advantages in fund support,
51 media promotion, technical support, community promotion and supportive environment
52 supplies. Our study provided both a methodological reference and an assessment indicator
53 framework for similar future studies.

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Keywords: assessment; health education; health promotion; non-communicable diseases

Strengths and limitations of this study

- To the best of the authors' knowledge, this study is the first to build assessment indicators for health education and promotion in NCD demonstration districts in China.
- This study utilized three popular assessment tools (Delphi, RSR, and TOPSIS) that are both qualitative and quantitative and hence provide a methodological reference for similar future studies.
- One limitation of this study was that fewer NCD demonstration districts were selected as evaluation samples and thus failed to fully reflect the whole situation in China.
- Another limitation was the cross-sectional design and lack of control data from either the history of those districts or non-NCD demonstration districts.

INTRODUCTION

China has undergone a swift health transition over the past two decades. Currently, the spectrum of people's diseases is dominated by non-communicable diseases (NCDs) (also known as chronic diseases), such as cardiovascular diseases, lung cancer, chronic obstructive pulmonary disease, and road injuries,¹ instead of infectious diseases. This transition has resulted in a rapid increase in the incidence of these diseases and a heavy disease burden. Currently, approximately 260 million Chinese accounting for 19% of the nation's population suffer from NCDs, which contribute to 85% of the mortality rate and 70% of the disease burden.² Thus, China is facing great challenges from NCDs.

The National Health and Family Planning Commission of China (NHFPC, the former Ministry of Health) launched a nationwide NCD demonstration district (or county) programme in late 2010 that was similar to the widely known health cities that were designated in many countries in the late 1980s.³ The programme aimed to create an exemplary effect of NCD demonstration districts for other regions and to promote NCD control and prevention across the country. In the principle of voluntary, step-by-step declaration, areas that wanted to become national NCD demonstration districts had to obtain

1
2
3 83 a recommendation from the provincial health administration department and then pass an
4
5 84 assessment organized by the NHFPC. Similarly, the declaration of provincial NCD
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7 85 demonstration districts went through a city-level recommendation first and then a provincial
8
9 86 assessment.

10
11 87 Health education is defined as a systematic social activity that helps people improve their
12
13 88 health-related behaviours. For NCDs, health education often involves publicizing a healthy
14
15 89 lifestyle, such as non-smoking, a low-salt diet, a proper diet, adequate physical activities and
16
17 90 mental health, using publicity materials, billboard, lectures, and media promotion. Health
18
19 91 promotion is the process of enabling people to increase control over and improve their
20
21 92 health.⁴ The Ottawa Charter for health promotion action includes the following five policies:⁴
22
23 93 building a healthy public policy (e.g., raising the tobacco excise tax), creating supportive
24
25 94 environments (e.g., building a fitness trail), strengthening community actions, developing
26
27 95 personal skills, and reorienting health services. Integrated health education and promotion are
28
29 96 the first priorities of the policy and the primary means of NCD control and prevention; thus,
30
31 97 these policies play important roles in NCD demonstration district programmes. However, the
32
33 98 work is relatively new in China, and only rare systematic assessments have been reported (i.e.,
34
35 99 no assessment indicators are available). Thus, based on health education and promotion in the
36
37 100 districts, this study was conducted to develop assessment indicators, compare the
38
39 101 performances among districts, and analyse important factors for health education and
40
41 102 promotion to provide a framework or methodological reference for other health studies.

41 **METHODS**

42 **Study design**

43
44
45 104 Three evaluation techniques were comprehensively followed in the study. Figure 1 shows the
46
47 105 flow diagram. A modified Delphi method originally developed by RAND/UCLA⁵ was used in
48
49 106 the following steps (conducted between late 2013 and 2014):
50

51 107
52 108 1. Thirty-nine sub-sectional consultative items in seven sections were selected for the first
53
54 109 Delphi round based on the work manuals of the NCD demonstration districts developed by
55
56 110 the national Centre for Disease Control and Prevention (CDC) and our own work experiences
57
58 111 (Appendix Table A1).

1
2
3 112 2. Experts nationwide were invited if they met the following demands: worked in NCD
4
5 113 control and prevention, health education and promotion, or other public health professions,
6
7 114 worked for provincial or national institutions with five years or more of work experience, and
8
9 115 showed an interest in participating in the study.

10
11 116 3. A two-round Delphi process was conducted. In the first round, experts were asked to
12
13 117 judge whether items should be included and were free to add items or make comments. The
14
15 118 experts scored each item using a 9-point Likert scale (1 to 9: extremely unimportant to
16
17 119 extremely important).⁶⁻⁸ The data were summarized, revised, and sent to experts for a second
18
19 120 round following the same format as the first round. Then, the assessment indicators were
20
21 121 determined.

22
23 122 Second, the rank sum ratio (RSR) method introduced by Tian FD⁹ was followed
24
25 123 (conducted in 2015). The basic theory behind the method is that a dimensionless statistical
26
27 124 indicator (RSR) is calculated from an $n \times m$ matrix using rank conversion. The subjects'
28
29 125 statuses (worst/best) were evaluated using the RSR order. All items were first ranked as R_{ij}
30
31 126 ($i \leq n, j \leq m$), with the higher quality items ranked in ascending order and the lower quality
32
33 127 items ranked in descending order. Then, a weighted RSR was calculated with the equation

34
35 128
$$RSR_i = \frac{\sum_{j=1}^m R_{ij}}{m \times n}.$$

36
37 129 Finally, the technique for order preference by similarity to ideal solution (TOPSIS)¹⁰⁻¹²
38
39 130 was employed to assess the sampled NCD demonstration districts (conducted in 2015). Prior
40
41 131 to the technique, some NCD districts were chosen as evaluation samples. To ensure a
42
43 132 balanced geographic distribution of the districts, we randomly selected 5 districts
44
45 133 representing different orientations (south, north, east, west, and middle) out of the total 28
46
47 134 districts in the province and generated the following districts as samples with a randomizing
48
49 135 function in Microsoft Excel 2010: Furong District, Ziyang District, Shaodong County,
50
51 136 Shuangfeng County, and Luxi County. The assessment indicator data were collected between
52
53 137 2014 and 2015 from the above districts. TOPSIS was conducted using the following six steps:

54
55 138 1. The original values of items (X_{ij}) were converted to the high-quality (X'_{ij}) values.
56
57 139 However, there was no need to convert the values here due to their natural high-quality
58
59
60

140 features.

141 2. The mono-trended matrix was normalized as Y_{ij} and calculated using the equation

$$142 \quad Y_{ij} = X'_{ij} \div \sqrt{\sum_{i=1}^m (X'_{ij})^2}.$$

143 3. Based on the weights introduced by RSR, the combined values of the normalized matrix
144 were calculated as Z_{ij} using the equation $Z_{ij} = RSR_i * Y_{ij}$.

145 4. The ideal solution (A^+) and negative ideal solution (A^-) were determined.

146 5. The distance of each alternative to the ideal (Di^+) and negative ideal (Di^-) solutions and
147 the relative similarities of an alternative to the ideal solution (Ci) were calculated.

148 6. The alternatives were ranked based on Ci . A larger Ci indicated a greater alternative.

149 **Statistical analyses**

150 During the Delphi process, the assessment items were excluded unless they simultaneously
151 reached expert agreement (%) $\geq 70\%$,¹³⁻¹⁵ a median score ≥ 7 ,¹⁶⁻¹⁸ and a coefficient of variation
152 (CV) < 0.25 .¹⁹⁻²⁰ The internal consistency of the items was evaluated with Cronbach's α
153 coefficient test. A Cronbach's α of 0.7 or greater was regarded as reasonable reliability, and a
154 value of 0.8 or greater was regarded as good reliability.²¹⁻²³

155 The data were analysed from 2014 to 2015. The variable mean, standard deviation (SD),
156 CV, and Cronbach's α were analysed with SPSS 17.0 (SPSS Inc., Chicago, IL, USA). Other
157 related data obtained from the above methods were addressed using Microsoft Excel 2010.

158 **RESULTS**

159 In total, nineteen experts (Figure 2) from national or provincial public health institutions
160 completed the Delphi process. Most of the experts (68.42%) came from the CDC. The experts
161 had been working for a mean of 15.53 ± 7.40 years, and approximately 90% of the experts had
162 been awarded honours as senior doctors. All the experts had bachelor degrees in public health,
163 and 63% of the experts had master's degrees.

164 The two-round Delphi process (Table 1) removed fifteen items, including fourteen in the
165 first round and one in the second round. Twenty-four items remained as assessment indicators
166 with scores defined as weights (appendix Table A2), which covered the following sections:
167 organizational management, fund support, personnel supplies, health education and

168 promotion, awareness of NCDs, satisfaction with health education and promotion, and health
 169 literacy of residents.

170

171 **Table 1.** Results from the two-round Delphi process

Section items	Round 1				Round 2			
	Code	Agreement (%)	Median (SD)	CV	Code	Agreement (%)	Median (SD)	CV
Organization management	1	100	9 (1.02)	0.11	1	100	9 (1.39)	0.15
	2	78.9	8 (1.08)	0.14	2	73.7	8 (1.59)	0.20
	3	100	8 (1.43)	0.18	3	100	8 (1.18)	0.15
	4*	89.5	6 (1.66)	0.28	-	-	-	-
Fund support	5	100	9 (0.67)	0.07	5	100	9 (0.45)	0.05
	6	78.9	8 (1.55)	0.19	6	89.5	8 (1.42)	0.18
	7	89.5	8 (1.18)	0.15	7	89.5	8 (0.85)	0.11
Personnel supplies	8	89.5	7 (1.03)	0.15	8	94.7	7.5 (0.97)	0.13
	9*	68.4	6 (1.8)	0.30	-	-	-	-
Health education and promotion	10	100	8 (0.93)	0.12	10	100	8 (0.71)	0.09
	11	100	8 (0.97)	0.12	11	100	8 (0.71)	0.09
	12	100	7 (1.29)	0.18	12	100	7 (1.28)	0.18
	13	94.7	7 (1.33)	0.19	13	100	7 (1.28)	0.18
	14	84.2	7 (1.18)	0.17	14	84.2	7 (1.13)	0.16
	15	84.2	7 (1.18)	0.17	15	84.2	7 (1.13)	0.16
	16	84.2	7 (1.12)	0.16	16	78.9	7 (1.10)	0.16
	17 ^a	78.9	6 (1.1)	0.18	-	-	-	-
	18	78.9	7 (1.16)	0.17	18 ^a	89.5	6 (1.01)	0.17
	19 ^a	94.7	6 (1.04)	0.17	-	-	-	-
	20 ^a	68.4	6 (1.41)	0.23	-	-	-	-
21	94.7	7 (1.4)	0.20	21	94.7	7 (1.14)	0.16	
22	89.5	7 (1.3)	0.19	22	89.5	7 (1.42)	0.2	
23	100	8 (1.07)	0.13	23	100	8 (0.74)	0.09	
24	100	7 (1.58)	0.23	24	94.7	7 (1.26)	0.18	
25	94.7	7 (1.56)	0.22	25	89.5	7 (1.15)	0.16	
26	94.7	7.5 (1.1)	0.15	26	100	8 (1.11)	0.14	
27	94.7	7.5 (1.15)	0.15	27	94.7	8 (1)	0.12	
28 ^a	47.4	6 (1.45)	0.24	-	-	-	-	
29 ^a	52.6	6 (1.33)	0.22	-	-	-	-	
Awareness and healthy behaviour of	30	100	8 (1.51)	0.19	30	100	8 (0.65)	0.08
	31 ^a	68.4	8 (1.66)	0.21	-	-	-	-
Control and management of NCDs	32 ^a	52.6	6.5 (1.73)	0.27	-	-	-	-
	33 ^a	68.4	8 (1.49)	0.19	-	-	-	-
	34 ^a	42.1	7 (1.85)	0.26	-	-	-	-
	35 ^a	52.6	7 (1.29)	0.18	-	-	-	-
	36 ^a	68.4	8 (1.38)	0.17	-	-	-	-
Others	37	94.7	7.5 (1.77)	0.24	37	100	7 (1.08)	0.15

	38 ^a	73.7	6 (1.59)	0.26	-	-	-	-
	39	100	7 (1.61)	0.23	39	94.7	8 (1.09)	0.14
Total		88	7 (1.43)	0.20		93.7	8 (1.23)	0.15

172 ^a: Items removed in each round

173 The Cronbach's α value in the first Delphi round was 0.90 with a 95% confidence interval
 174 (CI) of 0.82-0.95, whereas the Cronbach's α in the second round was 0.85 (95% CI:
 175 0.74-0.93). Thus, both rounds exhibited good internal consistency.

176 The RSR method was used to normalize the indicator weights provided by the modified
 177 Delphi method (Table 2).

178 Prior to the TOPSIS technique, five NCD demonstration districts were randomly sampled
 179 as follows: one national level NCD demonstration district (Furong District) and four
 180 provincial level districts (Ziyang District, Shaodong County, Shuangfeng County, and Luxi
 181 County). Then, the TOPSIS technique was used to normalize the real values of the
 182 assessment indicators in the sample districts and to calculate combined indicator values
 183 (Table 2).

184 Finally, the five sample districts were ranked in order (from best to worst) as Furong
 185 District > Luxi County > Ziyang District > Shaodong County > Shuangfeng County, with
 186 Furong District greatly surpassing the other areas with the highest C_i (Table 3).

187 **Table 2.** Normalization weights of the assessment indicators and real values in the sampling districts of Hunan Province, China

Code	Weight	RSR	Real value ($X_{ij} = X'_{ij}$)					Normalization value (Y_{ij})				
			Furong	Ziyang	Shaodong	Shuangfeng	Luxi	Furong	Ziyang	Shaodong	Shuangfeng	Luxi
a1 ^a	20.13	0.0671	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a2 ^a	9.53	0.0318	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a3 ^a	18.13	0.0604	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a4	20.08	0.0669	2436.5	943.1	149.8	730.1	319.5	0.8907	0.3447	0.0547	0.2669	0.1168
a5	11.76	0.0392	96.00	19.60	34.07	41.94	17.74	0.8474	0.1730	0.3007	0.3702	0.1566
a6	12.21	0.0407	23.60	12.47	16.03	15.09	10.91	0.6506	0.3438	0.4418	0.4159	0.3006
a7	10.32	0.0344	0.071	0.056	0.052	0.052	0.070	0.5186	0.4126	0.3848	0.3828	0.5160
a8 ^a	15.42	0.0514	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a9 ^a	17.79	0.0593	1	1	1	1	1	0.4472	0.4472	0.4472	0.4472	0.4472
a10	12.08	0.0403	19	2	39	11	44	0.3026	0.0319	0.6211	0.1752	0.7007
a11	12.08	0.0403	5	8	3	2	30	0.1580	0.2527	0.0948	0.0632	0.9477
a12	6.82	0.0227	24	12	18	9	10	0.6857	0.3429	0.5143	0.2571	0.2857
a13	6.82	0.0227	14	10	11	9	6	0.6058	0.4327	0.4760	0.3895	0.2596
a14	5.79	0.0193	88	26	27	15	28	0.8731	0.2580	0.2679	0.1488	0.2778
a15	9.39	0.0313	100	100	100	89.98	100	0.4560	0.4560	0.4560	0.4103	0.4560
a16	7.50	0.025	0.5	0.5	0.5	0.5	0.5	0.4472	0.4472	0.4472	0.4472	0.4472
a17	15.03	0.0501	100	93	100	89.98	100	0.4625	0.4301	0.4625	0.4162	0.4625
a18	9.68	0.0323	4.4	4.3	0.3	4.0	1.9	0.5783	0.5680	0.0365	0.5297	0.2472
a19	10.13	0.0338	4	8	4	4	4	0.3536	0.7071	0.3536	0.3536	0.3536
a20	13.55	0.0452	100	100	100	100	100	0.4472	0.4472	0.4472	0.4472	0.4472
a21	14.71	0.049	100	100	100	100	100	0.4472	0.4472	0.4472	0.4472	0.4472
a22	17.61	0.0587	57.25	55.5	44.26	38.51	31.17	0.5516	0.5348	0.4265	0.3711	0.3003
a23	11.76	0.0392	86.26	73.86	81.96	80.85	71.83	0.4875	0.4174	0.4632	0.4569	0.4059
a24	11.68	0.0389	10.86	10.42	9.79	9.29	8.45	0.4957	0.4756	0.4468	0.4240	0.3857

188 ^a: Represents qualitative items: positive items were valued as 1, and the negative items were valued as 0

190 **Table 2.** Continued

Code	Comprehensive normalization values (Z_{ij})				
	Furong	Ziyang	Shaodong	Shuangfeng	Luxi
a1	0.0300	0.0300	0.0300	0.0300	0.0300
a2	0.0142	0.0142	0.0142	0.0142	0.0142
a3	0.0270	0.0270	0.0270	0.0270	0.0270
a4	0.0596	0.0231	0.0037	0.0179	0.0078
a5	0.0332	0.0068	0.0118	0.0145	0.0061
a6	0.0265	0.0140	0.0180	0.0169	0.0122
a7	0.0178	0.0142	0.0132	0.0132	0.0177
a8	0.0230	0.0230	0.0230	0.0230	0.0230
a9	0.0265	0.0265	0.0265	0.0265	0.0265
a10	0.0122	0.0013	0.0250	0.0071	0.0282
a11	0.0064	0.0102	0.0038	0.0025	0.0382
a12	0.0156	0.0078	0.0117	0.0058	0.0065
a13	0.0138	0.0098	0.0108	0.0088	0.0059
a14	0.0169	0.0050	0.0052	0.0029	0.0054
a15	0.0143	0.0143	0.0143	0.0128	0.0143
a16	0.0112	0.0112	0.0112	0.0112	0.0112
a17	0.0232	0.0216	0.0232	0.0208	0.0232
a18	0.0187	0.0183	0.0012	0.0171	0.0080
a19	0.0120	0.0239	0.0120	0.0120	0.0120
a20	0.0202	0.0202	0.0202	0.0202	0.0202
a21	0.0219	0.0219	0.0219	0.0219	0.0219
a22	0.0324	0.0314	0.0250	0.0218	0.0176
a23	0.0191	0.0164	0.0182	0.0179	0.0159
a24	0.0193	0.0185	0.0174	0.0165	0.0150

191

192 **Table 3.** Ranking of the sample districts in Hunan province by TOPSIS

Subject	D+	D-	Ci	Rank
Furong District	0.0376	0.0716	0.6558	1
Luxi County	0.0663	0.0458	0.4085	2
Ziyang District	0.0628	0.0332	0.3462	3
Shaodong County	0.0744	0.0277	0.2712	4
Shuangfeng County	0.0672	0.0248	0.2693	5

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197 DISCUSSION

198 Multi-assessments should be comprehensively employed in health evaluations due to features
199 such as objects, purposes, and data types to compensate for the limitations of a single
200 assessment. With features including anonymity, iteration, controlled feedback, and statistical
201 summarization, the Delphi technique was chosen as a suitable method for obtaining collective
202 expert opinions because this method was widely used in health-related research.^{15, 24, 25}
203 TOPSIS, which was developed by Hwang and Yoon²⁶, was chosen as a family member of
204 multiple-criteria decision-making (MCDM).²⁷⁻²⁹ This method provides an optimal solution or
205 alternative ranking³⁰ without operational issues or limitations on data types³¹⁻³³ but often fails
206 to avoid the impact of abnormal values.³⁴ The RSR method is based on a non-parameter
207 analysis and has no data type restrictions. Moreover, RSR can eliminate the bias of abnormal
208 values by reflecting the priority of the evaluated objects.³⁵

209 The above methods were used in this study to construct assessment indicators and to
210 evaluate the health education and promotion situations in the NCD demonstration districts.
211 The results showed that the Furong District obviously surpassed the other districts, especially
212 in fund support, media promotion, technical support for promotion materials, community
213 promotion and supportive environment supplies, and matched the national level nomination.
214 As a central district in the capital city of Hunan Province, the main economic indicators of
215 Furong were among the best of the counties/districts in the province.^{36, 37} Local government
216 supported much of the NCD control and prevention-related funds. Both the fees for NCD
217 health education and promotion and proportion of NCD control expenditures in total business
218 expenses in the local CDC were also advantages and provided a strong basis for conducting
219 relevant work. Additionally, this district has been historically solid in health education and
220 promotion, with the “Ten health projects”, such as total health mobilization and a massive
221 health auditorium. Furong was also leading in building a rich-themed NCD health education
222 database among grass-level medical institutions and information sharing models, which
223 greatly benefitted the residents, whose awareness rates, satisfaction and health literacy levels
224 for NCDs were all superior compared to the levels of the residents of the other districts.

225 Following Furong District, Luxi County ranked second with its own features. This county

1
2
3 226 is regarded as one of the Wuling Mountain Areas Regional Development Key Counties and is
4
5 227 a national poverty-stricken county,³⁸ with insufficient funds for NCD control and prevention
6
7 228 supported by the local government. The other two fund guarantees were also dwarfed by the
8
9 229 other districts. However, Luxi County was not only comprehensive in conducting methods
10
11 230 but was also extensive in its NCD control and prevention themes despite having a simple
12
13 231 external form, which highlighted its diverse and frequent media promotion strategies
14
15 232 (particularly with television stations, with an annual forty-four period showing for an average
16
17 233 of 30 minutes per time). NCD education and promotion permeated into every village or
18
19 234 community, featuring one hundred percent coverage of fitness centres or rooms and numerous
20
21 235 types of NCD promotion materials, gaining an advantage over other objects (except for
22
23 236 Furong District).

24 237 The middle-ranking Ziyang District had the most assessment indicators at the middle level.
25
26 238 In the last two ranked objects, the comprehensive performances of both Shaodong and
27
28 239 Shuangfeng counties were lacking, which might have been a result of their late beginning and
29
30 240 hasty NCD demonstration district processes during the study period as well as a historically
31
32 241 unsolid work basis.

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34 242

35 243 **Conclusions**

36
37 244 We built qualitative and quantitative assessment indicators of health education and promotion
38
39 245 in NCD demonstration districts using a hybrid of multi-assessment methods to provide a
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41 246 valid reference for future similar studies. There were gaps in health education and promotion
42
43 247 work in the NCD demonstration districts in Hunan province. The districts that performed
44
45 248 better had obvious advantages in fund support, media promotion, technical support,
46
47 249 community promotion and supportive environment supplies. The variances were not only
48
49 250 associated with local fund support but also with the working basis within the district. Fund
50
51 251 support did not always influence the variances because the limitation of inadequate fund
52
53 252 support could be broken and even shifted into an advantage with a solid working quality.

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56
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58
59

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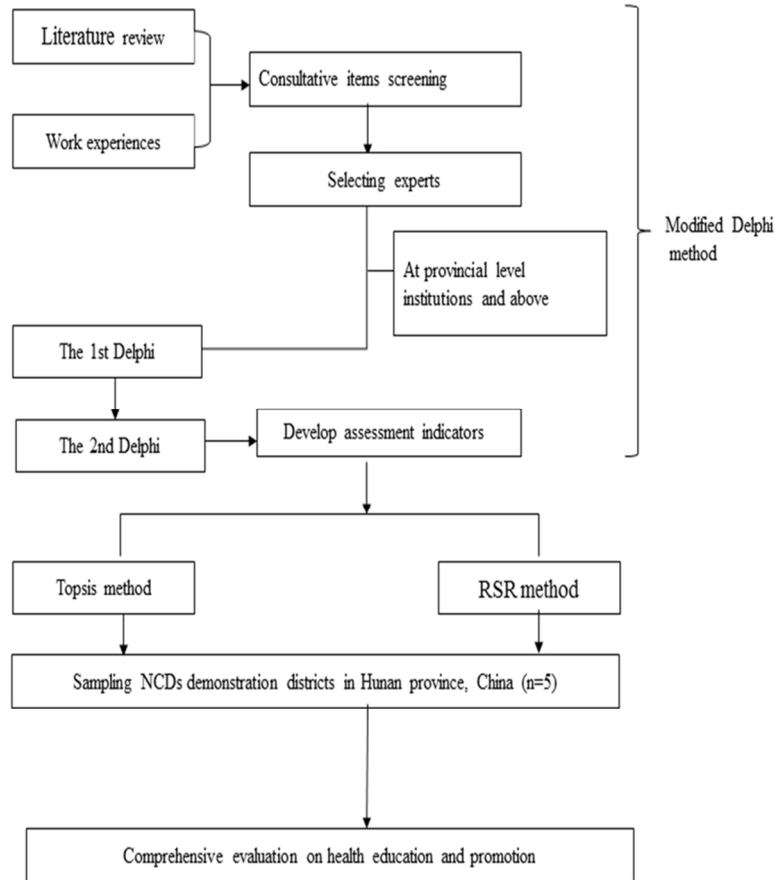
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385 **Figure legends**

386 Figure 1: Study flow diagram

387 Figure 2: Characteristics of the experts who participated in the Delphi process

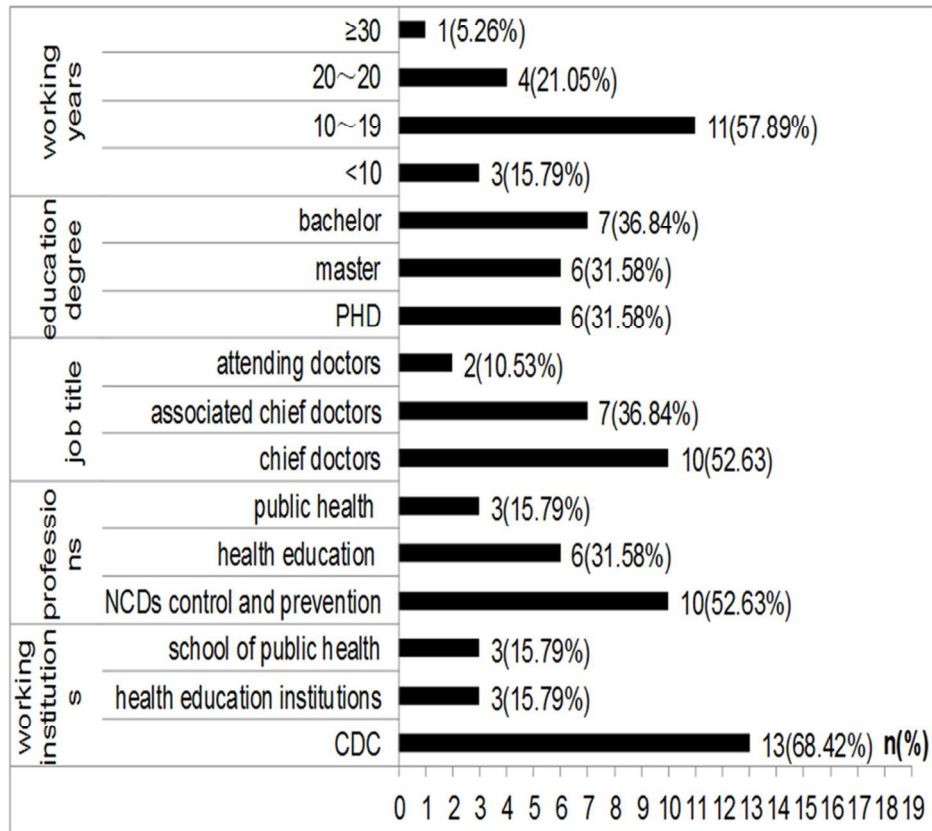
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The flow diagram of this study

89x89mm (300 x 300 DPI)





Characteristics of experts participating in the Delphi procedure

89x89mm (300 x 300 DPI)



Appendix Table A1 The consultative items screened for the first Delphi round

section items	Sub-section items	Code
Organization guarantees	whether local government based leadership team on NCDs control was established and held meetings once at least per year	1
	whether local administrative health authority based leadership team on NCDs control was established and held meetings once at least per year	2
	whether making a yearly work plan on NCDs health education and promotion	3
	whether a health education or health promotion institution or department was supplied with	4
Fund support	the number of NCDs special fund by local government per thousand population per year (yuan)	5
	the number of NCDs control expenses in local CDC (ten thousand yuan)	6
	the proportion of NCDs control expenses in total business expenses in local CDC (%)	7
Personnel supplies	the number of persons working in NCDs health education and promotion within medical institutions beyond village level per thousand population	8
	the times of parent trainings for those who work in NCDs health education per year.	9
	Health education and health promotion	
	whether a yearly NCDs related health broadcasting planning was developed	10
	whether billboards on NCDs control were presented and advertised regularly in local medias (except TV)	11
	the frequencies of promotion on NCDs control and prevention in local TV station per year	12
	the average minutes of show on NCDs control and prevention in local TV station per time	13
	the mean sorts of NCDs control and prevention materials printed	14
	the mean sorts of NCDs control and prevention billboard presented by town level hospitals	15
	the mean sorts of NCDs control and prevention promotion materials by town level hospitals	16
	the mean sorts of NCDs control and prevention video presented by town level hospitals	17
	the times of public consultation of NCDs related core information on different themes per year	18
	the average times promotion video on NCDs control played by town-level hospitals per week	19
	the average minutes of video on NCDs control played by town-level hospitals every time	20
	the community based coverage of NCDs control and prevention billboard (%)	21
	the average monthly frequencies of NCDs control and prevention billboard updating in community	22

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Appendix Table A1 Continued

section items	Sub-section items	Code
Health education and health promotion	the average coverage of fitness center or room in community (%)	23
	the times of NCDs health lecture in community (a scale of >50 persons)	24
	the times of massive promotion activities of NCDs per year (a scale of >100 persons)	25
	the institution based coverage of NCDs control lectures in both elementary and middle school (%)	26
	the student based coverage of NCDs control lectures in both elementary and middle school (%)	27
	the institution based coverage of health lectures in the kindergarten (%)	28
	the preschool children based coverage of health lectures in the kindergarten (%)	29
Awareness of NCDs & healthy behavior	people’s awareness rate of NCDs control and prevention (%)	30
	the rate of people’s healthy behavior formation(%)	31
Management and control of NCDs patients	the rate of standardized management on hypertension / diabetes patients(%)	32
	the rate of control over hypertension / diabetes patients(%)	33
	the number of NCDs patients oriented self-management groups finishing jobs in the past year	34
	the community-based rate of coverage of NCDs patients(%)	35
Others	whether the assessments of NCDs risk factors had been conducted during the past 3 years	36
	people’s satisfaction with supplies of health education and promotion	37
	whether health education associated files had been completed in regular management	38
	people’s health literacy level in NCDs control and prevention	39

Appendix Table A2 Assessment indicators by modified Delphi method

Indicator	Code	Weight
whether local government based leadership team on NCDs control was established and held meetings once at least per year	a1	20.13
whether local administrative health authority based leadership team on NCDs control was established and held meetings once at least per year	a2	9.53
whether making a yearly work plan on NCDs health education and promotion	a3	18.13
the number of NCDs special fund by local government per thousand population per year (yuan)	a4	20.08
the number of NCDs control expenditures in local CDC (per ten thousand yuan)	a5	11.76
the proportion of NCDs control expenses in total business expenses in CDC (%)	a6	12.21
the number of persons working in NCDs health education and promotion within medical institutions beyond village level per thousand population	a7	10.32
whether a yearly NCDs health broadcasting planning was developed	a8	15.42
Whether billboards on NCDs control were presented and advertised regularly in local medias (except TV)	a9	17.79
the frequencies of NCDs control and prevention in local TV station per year	a10	12.08
the average minutes of show on NCDs control and prevention in local TV station per time	a11	12.08
the mean sorts of NCDs control and prevention materials printed	a12	6.82
the mean sorts of NCDs control billboard presented by town level hospitals	a13	6.82
the mean sorts of NCDs control and prevention promotion materials presented by town level hospitals	a14	5.79
the community based coverage of NCDs control and prevention billboard (%)	a15	9.39
the average monthly frequencies of NCDs control billboard updating in community	a16	7.5
the average coverage of fitness center or room in community (%)	a17	15.03
the times of NCDs health lecture in community (a scale of >50 persons)	a18	9.68
the times of NCDs promotion activities per year (a scale of >100persons)	a19	10.13
the institution based coverage of NCDs control and prevention lectures in both elementary and secondary school (%)	a20	13.55
the student based coverage of NCDs control and prevention lectures in both elementary and secondary school (%)	a21	14.71
people's awareness rate of NCDs control and prevention (%)	a22	17.61
people's satisfaction with supplies of health education and promotion (%)	a23	11.76
people's health literacy level in NCDs control and prevention (%)	a24	11.68

TRIPOD Checklist: Prediction Model Development and Validation

Section/Topic	Item	Checklist Item	Page	
Title and abstract				
Title	1	D;V	Identify the study as developing and/or validating a multivariable prediction model, the target population, and the outcome to be predicted.	P1
Abstract	2	D;V	Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions.	P2
Introduction				
Background and objectives	3a	D;V	Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models.	P3-P4
	3b	D;V	Specify the objectives, including whether the study describes the development or validation of the model or both.	P4
Methods				
Source of data	4a	D;V	Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable.	P4-P5
	4b	D;V	Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up.	P4-P5
Participants	5a	D;V	Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres.	P5
	5b	D;V	Describe eligibility criteria for participants.	P5
	5c	D;V	Give details of treatments received, if relevant.	P5
Outcome	6a	D;V	Clearly define the outcome that is predicted by the prediction model, including how and when assessed.	P4-P6
	6b	D;V	Report any actions to blind assessment of the outcome to be predicted.	P5-P6
Predictors	7a	D;V	Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured.	P4
	7b	D;V	Report any actions to blind assessment of predictors for the outcome and other predictors.	P4-P6
Sample size	8	D;V	Explain how the study size was arrived at.	P5
Missing data	9	D;V	Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method.	NA
Statistical analysis methods	10a	D	Describe how predictors were handled in the analyses.	P6
	10b	D	Specify type of model, all model-building procedures (including any predictor selection), and method for internal validation.	P6
	10c	V	For validation, describe how the predictions were calculated.	P5
	10d	D;V	Specify all measures used to assess model performance and, if relevant, to compare multiple models.	NA
	10e	V	Describe any model updating (e.g., recalibration) arising from the validation, if done.	NA
Risk groups	11	D;V	Provide details on how risk groups were created, if done.	NA
Development vs. validation	12	V	For validation, identify any differences from the development data in setting, eligibility criteria, outcome, and predictors.	NA
Results				
Participants	13a	D;V	Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful.	P6
	13b	D;V	Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome.	P6
	13c	V	For validation, show a comparison with the development data of the distribution of important variables (demographics, predictors and outcome).	P6
Model development	14a	D	Specify the number of participants and outcome events in each analysis.	P6-P10
	14b	D	If done, report the unadjusted association between each candidate predictor and outcome.	P6-P10
Model specification	15a	D	Present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point).	P6-P10
	15b	D	Explain how to use the prediction model.	P8
Model performance	16	D;V	Report performance measures (with CIs) for the prediction model.	P8-P10
Model-updating	17	V	If done, report the results from any model updating (i.e., model specification, model performance).	P6-P10
Discussion				
Limitations	18	D;V	Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data).	P3
Interpretation	19a	V	For validation, discuss the results with reference to performance in the development data, and any other validation data.	P11-P12
	19b	D;V	Give an overall interpretation of the results, considering objectives, limitations, results from similar studies, and other relevant evidence.	P12
Implications	20	D;V	Discuss the potential clinical use of the model and implications for future research.	NA
Other information				
Supplementary information	21	D;V	Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets.	P4,P6,P17
Funding	22	D;V	Give the source of funding and the role of the funders for the present study.	P13

*Items relevant only to the development of a prediction model are denoted by D, items relating solely to a validation of a prediction model are denoted by V, and items relating to both are denoted D;V. We recommend using the TRIPOD Checklist in conjunction with the TRIPOD Explanation and Elaboration document