BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-015943
Article Type:	Research
Date Submitted by the Author:	25-Jan-2017
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Research methods
Keywords:	PREVENTIVE MEDICINE, PUBLIC HEALTH, STATISTICS & RESEARCH METHODS

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

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Word count: 2118

ABSTRACT

Objectives

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

Methods

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

Results

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

Conclusions

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

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

Strengths and limitations of this study

First study to build assessment indicators for health education and promotion in NCD demonstration districts in China.

Three popular assessment tools were comprehensively used to set assessment indicators both qualitatively and quantitatively.

This study provide a framework or methodological reference for future similar studies.

It's uncertain whether the sampling NCDs demonstration districts will sustain their effectiveness on health education and promotion from now on.

It's restricted to NCDs demonstration districts with no consideration for non NCDs demonstration districts.

INTRODUCTION

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

The National Health and Family Planning Commission of China (former the Ministry of Health) has launched a nationwide community-based NCD demonstration districts (or counties) campaign since late 2010, similar to widely known healthy cities occurred in many countries from the late 1980s,[3] to curb the surging NCDs across the country. Since then, a series of NCD demonstration districts, aimed to play their demonstrational effects and promote NCDs' control and prevention, has been set up either at national or provincial level.

Health education is defined as a systematic social activity of helping people improve their health related behaviors, while health promotion is the process of enabling people to increase control over, and to improve, their health.[4] Integrated health education and promotion are both the first priority policy and primary means of NCDs control and prevention, also play important roles in the construction of NCD demonstration districts, especially at community

level. However, the work was young in China with rare systematic assessments have been reported (none assessment indicators available). Thus, based on health education and promotion in the districts, this study was conducted to develop their assessment indicators, followed by evaluation on the sampled demonstration districts, to provide a framework or methodological reference for other community health studies.

METHODS

Study design

Three evaluation techniques were comprehensively followed in the study. Figure 1 showed the flow diagram. A modified Delphi method originally developed by RAND/UCLA[5] was firstly used in the following steps（conducted between late 2013 and 2014）:

1. Based on work manuals of NCD demonstration districts developed by the national Center for Diseases Control and Prevention (CDC) and our own work experiences, thirty-nine sub-sectional consultative items in seven sections were selected for the first Delphi round (appendix table A1).

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

3. Following a two round Delphi process. In the first round, experts were asked to judge whether items should be included, and were free to add items or make comments. Additionally, they scored importance of each item with a 9 point Likert scale (1 to 9: extremely unimportant to extremely important).[6-8] Data were summarized, revised, and fed back to experts for a second round conducting the same as the first round. After that, assessment indicators were determined.

Secondly, the RSR method introduced by Tian FD [9] was followed (conducted in 2015). The basic theory behind the method is that a dimensionless statistical indicator (RSR) is calculated from an n×m matrix using rank conversion. The subjects' status (worst/best) could be evaluated using the RSR order. All items were firstly ranked as *Rij* ($i \leq n$, $j \leq m$), with the higher quality items ranked in ascending and the lower quality items descending. A weighted RSR

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

Lastly, a TOPSIS technique [10-12] was employed to assess the sampling NCDs demonstration districts (conducted in 2015). Prior to the technique, five out of twenty-eight NCDs demonstration districts in the province, namely Furong district, Ziyang district, Shaodong county, Shuangfeng county, Luxi county, were randomly sampled as evaluated target. They were collected data in the term of the assessment indicator between 2014 and 2015. The TOPSIS was then conducted by the following six steps:

1. The original values of items (*Xij*) were converted as the high quality (*X'ij*) ones. There was no need to convert here because of their naturally high quality features.

2. Normalizing the mono-trended matrix as *Yij* and calculating by the equation $Y_{ij} = X'_{ij} \div \sqrt{\sum_{i=1}^{m} (X'_{ij})^2}$.

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

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

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

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

Statistical analyses

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

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

RESULTS

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

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

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
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）	0.3	-	-	-	-
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 behavior of NCDs	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	-	-	-	-
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

[a]：Items removed from in each round

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

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

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

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

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

Code	Weight	RSR	Real value ($Xij = X'ij$)					Normalization value （ Yij ）				
			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

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

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

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 & Yoon[26] has been chosen as a family member in Multiple Criteria Decision Making (MCDM).[27-29] It provides us the optimal solution or alternatives' ranking[30] 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.

Following Furong district, Luxi county ranked the second with its own features. It's regarded as one of both Wuling Mountain Areas Regional Development Key Counties and national poverty-stricken counties,[38] with insufficient funds supported by local government in NCDs control and prevention, and the rest two fund guarantees were also dwarfed apparently by other districts. However, it's not only comprehensive in carrying out ways but extensive in themes of NCDs control and prevention despite of a simple external form, highlighting a diverse and frequent media promotion particularly in television station, with an annual forty-four period shows averaging 30 minutes per time. Meanwhile, the NCDs education and promotion here had permeated into every village (or community), featuring a one hundred percent coverage of fitness centers or rooms, and numerous sorts of NCDs promotion materials, devoting much to its priority to other objects (except Furong district).

Middle-ranking Ziyang district performed straight and narrow with most assessment indicator at middle level. As to the last two ranking objects as Shaodong and Shuangfeng counties, the comprehensive performances of both were left behind, which may were contributed to their late-beginning and hasty construction of NCDs demonstration district during the study conducting period, and historically unsolid work basis as well.

Strengths and limitations

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

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

Conclusions

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

Acknowledgements: We are grateful all experts participating in the Delphi process. We also would like to thank Furong district CDC, Ziyang district CDC, Shaodong county CDC, Shuangfeng county CDC, and Luxi county CDC for their great work in assisting data collection and survey conduction.

Contributors: Qiaohua Xu contributed to the study design, study conducting, data analysis and paper writing; Yuelong Huang was the principal guarantor of the study and contributed to the study design. Biyun Chen managed the study day-to–day and commented on paper writing. All authors have discussed the paper and approved the final version.

Funding: This work was supported by China Hunan Provincial Science & Technology Department (No: 2013zk2054).

Conflicts of interest: None declared

Data sharing statement: No additional data available.

REFERENCES

1 Yang G, Wang Y, Zeng Y, et al. Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet 2013; 381:1987-2015. doi: 10.1016/S0140-6736(13)61097-1.

2 Information Office of the State Council. Medical and Health Services in China. Beijing, China: Foreign Language Press 2012.

3 Lee A, Cheng FF, Fung Y, et al. Can Health Promoting Schools contribute to the better health and wellbeing of young people? The Hong Kong experience. J Epidemiol Community Health 2006; 60:530-36. doi: 10.1136/jech.2005.040121.

4 Word Health Organization. Ottawa charter for health promotion. Geneva: WHO 1986. http://www.who.int/healthpromotion/conferences/previous/ottawa/en/ (accessed 21 July 2016).

5 Fitch K, Bernstein SJ, Aguilar MD, et al. The RAND/UCL appropriateness method user's Manual. Santa Monica, CA: RAND 2001. doi :10.1016/j.seizure.2011.09.007.

6 Suzuki Y, Fukasawa M, Nakajima S, et al. Development of disaster mental health guidelines through the Delphi process in Japan. Int J Ment Health Syst 2012; 6:7. doi: 10.1186/1752-4458-6-7.

7 Mrowietz U, de Jong EM, Kragballe K, et al. A consensus report on appropriate treatment optimization and transitioning in the management of moderate-to-severe plaque psoriasis. J Eur Acad Dermatol Venereol 2014; 28: 438-53. doi: 10.1111/jdv.12118.

8 Konstantinou K, Hider SL, Vogel S, et al. Development of an assessment schedule for patients with low back-associated leg pain in primary care: a Delphi consensus study. Eur Spine J. 2012; 21:1241-49. doi: 10.1007/s00586-011-2057-2.

9 Sun ZQ, Tian FD. Medical Systematic Evaluation. Beijing, China: China Sci and Technol Press 1994 (In Chinese).

10 Fang JQ. Health Statistics (6th ed). Beijing, China: People's Medical Publishing house 2008: 428-31(in Chinese).

11 Opricovic S, Tzeng GH. Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. Eur J Oper Res 2004;156: 445-55.

12 Jahanshahloo GR, Lotfi FH, Izadikhah M. An algorithmic method to extend TOPSIS for decision-making problems with interval data. Appl Math Comput 2006;175: 1375-84. doi: 10.1016/j.amc.2005.08.048.

13 Booth A, Clarke M, Ghersi D, et al. Establishing a Minimum Dataset for Prospective Registration of Systematic Reviews: An International Consultation. PLoS One 2011; 6: e27319. doi: 10.1371/journal.pone.0027319.

14 Chipchase LS, Buttrum PJ, Dunwoodie R. Characteristics of student preparedness for clinical learning: clinical educator perspectives using the Delphi approach. BMC Med Educ 2012; 12:112. doi: 10.1186/1472-6920-12-112.

15 Robinson KR, Leighton P, Logan P, et al. Developing the principles of chair based exercise for older people: a modified Delphi study. BMC Geriatr 2014;14:65. doi:10.1186/1471-2318-14-65.

16 Benhamou M, Baron G, Dalichampt M, et al. Development and Validation of a Questionnaire Assessing Fears and Beliefs of Patients with Knee Osteoarthritis: The Knee Osteoarthritis Fears and Beliefs Questionnaire (KOFBeQ). PLoS One 2013; 8: e53886. doi: 10.1371/journal.pone.0053886.

17 Slade SC, Dionne CE, Underwood M, et al. Standardized method for reporting exercise programmes: protocol for a modified Delphi study. BMJ Open 2014; 4: e006682. doi: 10.1136/bmjopen-2014-006682.

18 Taylor RM, Feltbower RG, Aslam N,et al. Modified international e-Delphi survey to define healthcare professional competencies for working with teenagers and young adults with cancer. BMJ Open 2016; 6: e011361. doi: 10.1136/bmjopen-2016-011361.

19 Muñoz Fernández S, Lázaro y De Mercado P, Alegre López J, et al. Quality of care standards for nursing clinics in rheumatology. Reumatol Clin 2013; 9: 206-15. doi: 10.1016/j.reuma.2012.10.016.

20 Bao H, Yang F, Wang X, et al. Developing a set of quality items for breast cancer care in China. Int J Qual Health Care 2015; 27: 291-96. doi: 10.1093/intqhc/mzv042.

21 Bland JM, Altman DG. Statistics notes: Cronbach's alpha. BMJ 1997; 314:572.

22 Slootweg IA, Lombarts KM, Boerebach BC, et al. Development and Validation of an Instrument for Measuring the Quality of Teamwork in Teaching Teams in Postgraduate Medical Training (TeamQ). PLoS One 2014; 9: e112805. doi:10.1371/journal.pone. 0112805.

23 Zlateva I, Anderson D, Coman E, et al. Development and validation of the Medical Home Care Coordination Survey for assessing care coordination in the primary care setting from the patient and provider perspectives. BMC Health Serv Res 2015; 15:226. doi: 10.1186/s12913-015-0893-1.

24 Schopper D, Torres AM, Pereira J, et al. Setting health priorities in a Swiss canton: what do different methods tell us? J Epidemiol Community Health 2000; 54:388-93.

25 Veerman JL, Barendregt JJ, Mackenbach JP. Quantitative health impact assessment: current practice and future directions. J Epidemiol Community Health 2005;59:361-70. doi: 10.1136/jech.2004.026039

26 C. L. Hwang, K. Yoon. Multiple Attribute Decision Making: Methods and Applications. Berlin, Germany: Springer;1981.

27 Sun ZQ. Medical Statistics (2nd ed). Beijing, China: People's Medical Publishing House 2005; 514-18 (in Chinese).

28 Zaboli R, Tourani S, Seyedin SH, et al. Prioritizing the Determinants of Social-health Inequality in Iran: A Multiple Attribute Decision Making Application. Iran Red Crescent Med J 2014; 16: e12607. doi: 10.5812/ircmj.12607.

29 Bai ZY. An Interval-Valued Intuitionistic Fuzzy TOPSIS Method Based on an Improved Score Function. Scientific World Journal 2013; 2013: 879089. doi: 10.1155/2013/879089.

30 Shabaninejad H, Mehralian G, Rashidian A, et al. Identifying and prioritizing industry-level competitiveness factors: evidence from pharmaceutical market. Daru 2014; 22:35. doi: 10.1186/2008-2231-22-35.

31 Kuo RJ, Wu YH, Hsu TS. Integration of fuzzy set theory and TOPSIS into HFMEA to improve outpatient service for elderly patients in Taiwan. J Chin Med Assoc 2012; 75:341-48. doi: 10.1016/j.jcma.2012.05.001.

32 Shen M, Zeng N, Hu J, et al. Weighted TOPSIS method and weighted RSR method in the construction of drug supervision and supply networks in rural areas of Hunan. J Cent South Univ (Med Sci) 2013; 38: 301-06. doi:10.3969/j.issn.1672-734. 2013.03.014 (in Chinese).

33 Wang M, Fang H, Bishwajit G, et al. Evaluation of Rural Primary Health Care in Western China: A Cross-Sectional Study. Int J Environ Res Public Health 2015; 12:13843-60. doi: 10.3390/ijerph121113843.

34 Wang H, Song P, An L. Comprehensive Evaluation of the Situation of Maternal Health Care with TOPSIS and RSR. China J Health Statis 2015; 32: 240-42 (in Chinese).

35 Wang Z, Dang S, Xing Y, et al. Applying Rank Sum Ratio (RSR) to the Evaluation of Feeding Practices Behaviors, and Its Associations with Infant Health Risk in Rural Lhasa, Tibet. Int J Environ Res Public Health 2015; 12:15173-81. doi: 10.3390/ijerph121214976.

36 Statistical Communique on the National Economic and Social Development (Year2015) of Furong District. Statistical Information of Changsha city (Hunan province, China) website. http://www.cstj.gov.cn/ndqx/index.jhtml (accessed 21 July 2016).

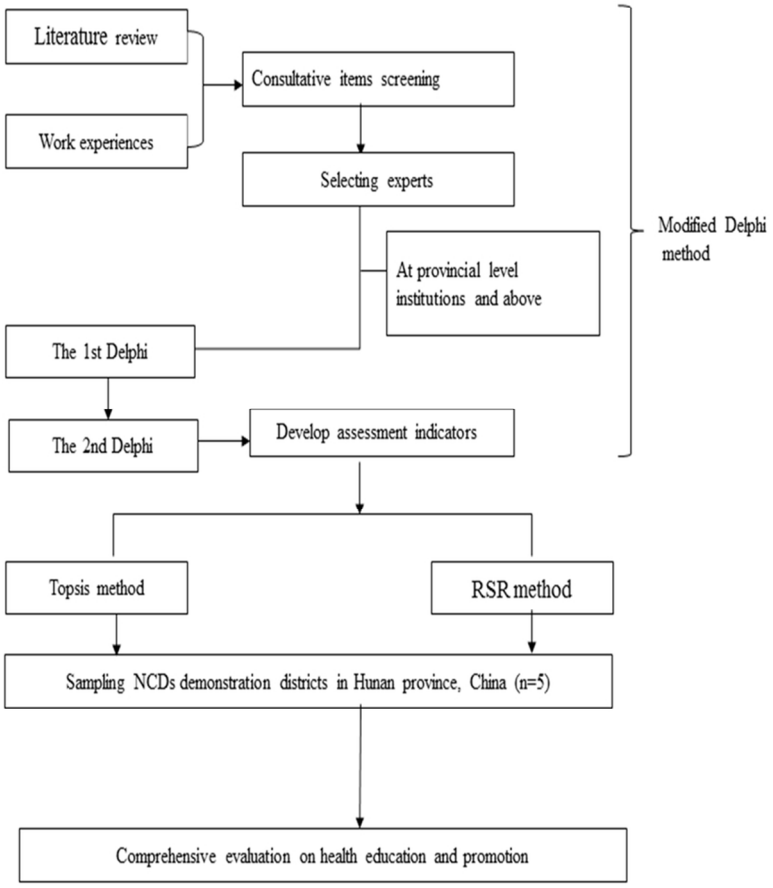
37 Statistical Communique of Hunan province on the National Economic and Social Development (Year 2015). The People's Government of Hunan province, China. http://www.hunan.gov.cn/2015xxgk/szfzcbm_8834/tjbm_6941/tjgbzb/201603/t20160318_2964470.html (accessed 21 July 2016).

38 Reply on Wuling Mountain Area Regional Development and Poverty Alleviation Plan (2011-2020) by the State Council of China. http://www.seac.gov.cn/art/2013/3/18/art_6497_179231_1.html (accessed 21 July 2016).

Figure legends

Figure 1 Flow diagram of the study conducted

Figure 2 Characteristics of experts participating in the Delphi process



The flow diagram of this study

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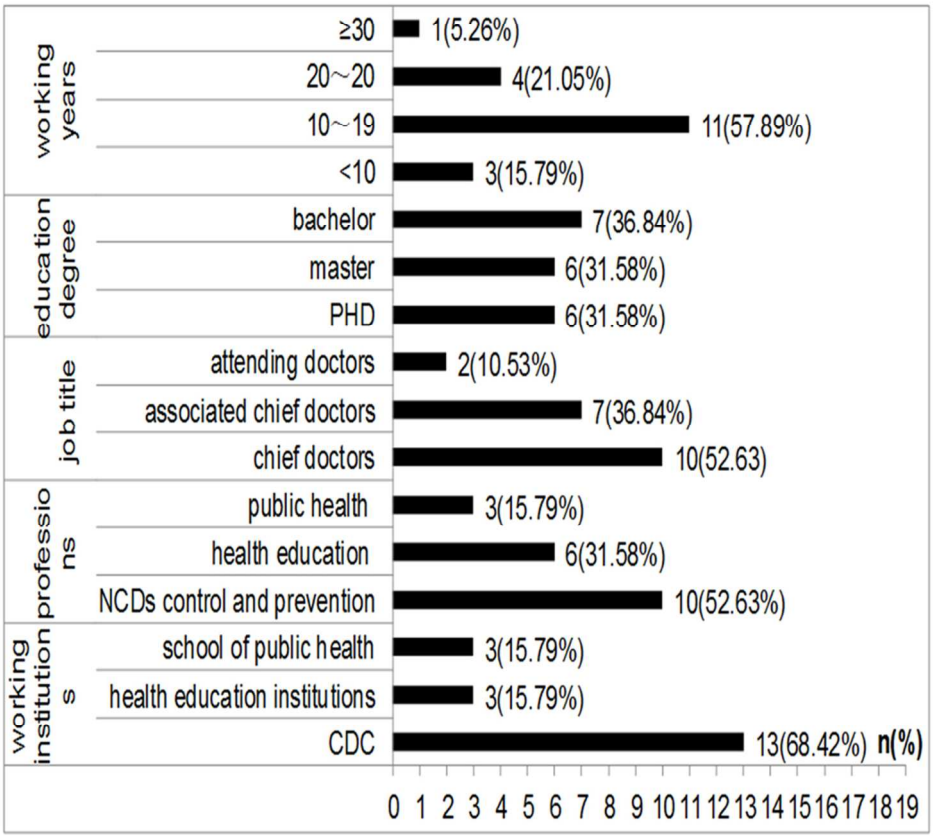

Characteristics of experts participating in the Delphi procedure

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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 the 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.

BMJ Open

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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-015943.R1
Article Type:	Research
Date Submitted by the Author:	21-Jul-2017
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

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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Word count: 2105

ABSTRACT

Objectives

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

Methods

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

Results

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

Conclusions

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

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

Strengths and limitations of this study

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

INTRODUCTION

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

The National Health and Family Planning Commission of China (NHFPC, the former Ministry of Health) has launched a nationwide NCDs demonstration districts (or counties) program since late 2010, similar to widely known health cities occurred in many countries from the late 1980s.[3] The program was aimed to take an exemplary effect of NCDs demonstration districts for other regions**,** and further promote NCDs control and prevention across the country. In the principle of voluntary, step-by-step declaration, those who wanted to be national NCD demonstration districts, had to get a recommendation from provincial health administration department at first, followed by passing an assessment organized by

NHFPC. Similarly, the declaration of provincial NCD demonstration districts would go through a city-level recommendation first and then a provincial assessment.

Health education is defined as a systematic social activity of helping people improve their health related behaviors. For NCDs, health education is often seen in publicizing people a healthy lifestyle with non-smoking, low-salt diet, proper diet, adequate physical activities and mental health, by publicity materials, billboard, lectures, media promotion, etc. Health promotion is the process of enabling people to increase control over, and to improve, their health.[4] Ottawa Charter for health promotion action means five policies,[4] including building healthy public policy (e.g. raise tobacco excise tax), creating supportive environments (e.g. build fitness trail), strengthening community actions, developing personal skills, reorienting health services. Integrated health education and promotion are both the first priority policy and primary means of NCDs control and prevention, also play important roles in NCD demonstration districts program. However, the work was young in China with rare systematic assessments reported (none assessment indicators available). Thus, based on health education and promotion in the districts, this study was conducted to develop their assessment indicators, compare with their performances among districts, and analyze important factors of health education and promotion, so as to provide a framework or methodological reference for other health studies.

METHODS

Study design

Three evaluation techniques were comprehensively followed in the study. Figure 1 showed the flow diagram. A modified Delphi method originally developed by RAND/UCLA[5] was firstly used in the following steps（conducted between late 2013 and 2014）:

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

2. Experts nationwide were invited if they met the following demands: Working either in NCDs control and prevention, health education and promotion, or other public health

professions; Working for provincial institutions and above. Five years or more of work experience; Showing an interest to participate in the study.

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

Secondly, the RSR method introduced by Tian FD [9] was followed (conducted in 2015). The basic theory behind the method is that a dimensionless statistical indicator (RSR) is calculated from an n×m matrix using rank conversion. The subjects' status (worst/best) could be evaluated using the RSR order. All items were firstly ranked as *Rij* (i≤n, j≤m), with the higher quality items ranked in ascending and the lower quality items descending. A weighted RSR was then calculated by equation $RSR_i = \frac{\sum_{j=1}^{m} R_{ij}}{m \times n}$.

Lastly, a TOPSIS technique [10-12] was employed to assess the sampling NCDs demonstration districts (conducted in 2015). Prior to the technique, Some NCDs districts needed to be set as evaluated samples. To take a balance of geographical distribution, we randomly selected 5 districts representing different orientations (south, north, east, west, and middle located each) out of the total 28 districts in the province, and generated the following districts as samples: Furong district, Ziyang district, Shaodong county, Shuangfeng county, Luxi county, with a random function in Excel. The data of assessment indicator were collected between 2014 and 2015 in the above districts. The TOPSIS was then conducted by the following six steps:

1. The original values of items (*Xij*) were converted as the high quality (*X'ij*) ones. There was no need to convert here because of their natural high quality features.

2. Normalizing the mono-trended matrix as *Yij* and calculating by equation $Y_{ij} = X'_{ij} \div \sqrt{\sum_{i=1}^{m} (X'_{ij})^2}$.

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

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

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

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

Statistical analyses

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

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

RESULTS

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

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

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)	0.20
	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 behavior of NCDs	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	-	-	-	-
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

[a]：Items removed from in each round

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

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

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

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

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

Code	Weight	RSR	Real value ($Xij = X'ij$)					Normalization value （ Yij ）				
			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

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

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

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 & Yoon[26] has been chosen as a family member in Multiple Criteria Decision Making (MCDM).[27-29] It provides an optimal solution or alternatives' ranking[30] 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 Furong district topped and surpassed 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 /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.

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

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

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

Conclusions

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

Acknowledgements: We are grateful to all experts participating in the Delphi process. We also would like to thank Furong district CDC, Ziyang district CDC, Shaodong county

CDC, Shuangfeng county CDC, and Luxi county CDC for their great work in assisting the data collection and survey conduction.

Contributors: Qiaohua Xu contributed to the study design, study conducting, data analysis and paper writing; Yuelong Huang was the principal guarantor of the study and contributed to the study design. Biyun Chen managed the study day-to–day and commented on paper writing. All authors have discussed the paper and approved the final version.

Funding: This work was supported by China Hunan Provincial Science & Technology Department (No: 2013zk2054).

Conflicts of interest: None declared

Ethics approval: This study was approved by the Ethics Committee of Hunan Provincial Center for Diseases Control and Prevention, China (HNCDC/JL31-044: 2013011).

Data sharing statement: No additional data available.

REFERENCES

1. Yang G, Wang Y, Zeng Y, et al. Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet 2013; 381:1987-2015. doi: 10.1016/S0140-6736(13)61097-1.
2. Information Office of the State Council. Medical and Health Services in China. Beijing, China: Foreign Language Press 2012.
3. Lee A, Cheng FF, Fung Y, et al. Can Health Promoting Schools contribute to the better health and wellbeing of young people? The Hong Kong experience. J Epidemiol Community Health 2006; 60:530-36. doi: 10.1136/jech.2005.040121.
4. Word Health Organization. Ottawa charter for health promotion. Geneva: WHO 1986. http://www.who.int/healthpromotion/conferences/previous/ottawa/en/ (accessed 21 July 2016).
5. Fitch K, Bernstein SJ, Aguilar MD, et al. The RAND/UCL appropriateness method user's Manual. Santa Monica, CA: RAND 2001. doi :10.1016/j.seizure.2011.09.007.

6. Suzuki Y, Fukasawa M, Nakajima S, et al. Development of disaster mental health guidelines through the Delphi process in Japan. Int J Ment Health Syst 2012; 6:7. doi: 10.1186/1752-4458-6-7.
7. Mrowietz U, de Jong EM, Kragballe K, et al. A consensus report on appropriate treatment optimization and transitioning in the management of moderate-to-severe plaque psoriasis. J Eur Acad Dermatol Venereol 2014; 28: 438-53. doi: 10.1111/jdv.12118.
8. Konstantinou K, Hider SL, Vogel S, et al. Development of an assessment schedule for patients with low back-associated leg pain in primary care: a Delphi consensus study. Eur Spine J. 2012; 21:1241-49. doi: 10.1007/s00586-011-2057-2.
9. Sun ZQ, Tian FD. Medical Systematic Evaluation. Beijing, China: China Sci and Technol Press 1994 (In Chinese).
10. Fang JQ. Health Statistics (6th ed). Beijing, China: People's Medical Publishing house 2008: 428-31(in Chinese).
11. Opricovic S, Tzeng GH. Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. Eur J Oper Res 2004;156: 445-55.
12. Jahanshahloo GR, Lotfi FH, Izadikhah M. An algorithmic method to extend TOPSIS for decision-making problems with interval data. Appl Math Comput 2006;175: 1375-84. doi: 10.1016/j.amc.2005.08.048.
13. Booth A, Clarke M, Ghersi D, et al. Establishing a Minimum Dataset for Prospective Registration of Systematic Reviews: An International Consultation. PLoS One 2011; 6: e27319. doi: 10.1371/journal.pone.0027319.
14. Chipchase LS, Buttrum PJ, Dunwoodie R. Characteristics of student preparedness for clinical learning: clinical educator perspectives using the Delphi approach. BMC Med Educ 2012; 12:112. doi: 10.1186/1472-6920-12-112.
15. Robinson KR, Leighton P, Logan P, et al. Developing the principles of chair based exercise for older people: a modified Delphi study. BMC Geriatr 2014;14:65. doi:10.1186/1471-2318-14-65.
16. Benhamou M, Baron G, Dalichampt M, et al. Development and Validation of a Questionnaire Assessing Fears and Beliefs of Patients with Knee Osteoarthritis: The

Knee Osteoarthritis Fears and Beliefs Questionnaire (KOFBeQ). PLoS One 2013; 8: e53886. doi: 10.1371/journal.pone.0053886.

17. Slade SC, Dionne CE, Underwood M, et al. Standardized method for reporting exercise programmes: protocol for a modified Delphi study. BMJ Open 2014; 4: e006682. doi: 10.1136/bmjopen-2014-006682.
18. Taylor RM, Feltbower RG, Aslam N,et al. Modified international e-Delphi survey to define healthcare professional competencies for working with teenagers and young adults with cancer. BMJ Open 2016; 6: e011361. doi: 10.1136/bmjopen-2016-011361.
19. Muñoz Fernández S, Lázaro y De Mercado P, Alegre López J, et al. Quality of care standards for nursing clinics in rheumatology. Reumatol Clin 2013; 9: 206-15. doi: 10.1016/j.reuma.2012.10.016.
20. Bao H, Yang F, Wang X, et al. Developing a set of quality items for breast cancer care in China. Int J Qual Health Care 2015; 27: 291-96. doi: 10.1093/intqhc/mzv042.
21. Bland JM, Altman DG. Statistics notes: Cronbach's alpha. BMJ 1997; 314:572.
22. Slootweg IA, Lombarts KM, Boerebach BC, et al. Development and Validation of an Instrument for Measuring the Quality of Teamwork in Teaching Teams in Postgraduate Medical Training (TeamQ). PLoS One 2014; 9: e112805. doi:10.1371/journal.pone. 0112805.
23. Zlateva I, Anderson D, Coman E, et al. Development and validation of the Medical Home Care Coordination Survey for assessing care coordination in the primary care setting from the patient and provider perspectives. BMC Health Serv Res 2015; 15:226. doi: 10.1186/s12913-015-0893-1.
24. Schopper D, Torres AM, Pereira J, et al. Setting health priorities in a Swiss canton: what do different methods tell us? J Epidemiol Community Health 2000; 54:388-93.
25. Veerman JL, Barendregt JJ, Mackenbach JP. Quantitative health impact assessment: current practice and future directions. J Epidemiol Community Health 2005;59:361-70. doi: 10.1136/jech.2004.026039
26. C. L. Hwang, K. Yoon. Multiple Attribute Decision Making: Methods and Applications. Berlin, Germany: Springer;1981.

27. Sun ZQ. Medical Statistics (2nd ed). Beijing, China: People's Medical Publishing House 2005; 514-18 (in Chinese).
28. Zaboli R, Tourani S, Seyedin SH, et al. Prioritizing the Determinants of Social-health Inequality in Iran: A Multiple Attribute Decision Making Application. Iran Red Crescent Med J 2014; 16: e12607. doi: 10.5812/ircmj.12607.
29. Bai ZY. An Interval-Valued Intuitionistic Fuzzy TOPSIS Method Based on an Improved Score Function. Scientific World Journal 2013; 2013: 879089. doi: 10.1155/2013/879089.
30. Shabaninejad H, Mehralian G, Rashidian A, et al. Identifying and prioritizing industry-level competitiveness factors: evidence from pharmaceutical market. Daru 2014; 22:35. doi: 10.1186/2008-2231-22-35.
31. Kuo RJ, Wu YH, Hsu TS. Integration of fuzzy set theory and TOPSIS into HFMEA to improve outpatient service for elderly patients in Taiwan. J Chin Med Assoc 2012; 75:341-48. doi: 10.1016/j.jcma.2012.05.001.
32. Shen M, Zeng N, Hu J, et al. Weighted TOPSIS method and weighted RSR method in the construction of drug supervision and supply networks in rural areas of Hunan. J Cent South Univ (Med Sci) 2013; 38: 301-06. doi:10.3969/j.issn.1672-734. 2013.03.014 (in Chinese).
33. Wang M, Fang H, Bishwajit G, et al. Evaluation of Rural Primary Health Care in Western China: A Cross-Sectional Study. Int J Environ Res Public Health 2015; 12:13843-60. doi: 10.3390/ijerph121113843.
34. Wang H, Song P, An L. Comprehensive Evaluation of the Situation of Maternal Health Care with TOPSIS and RSR. China J Health Statis 2015; 32: 240-42 (in Chinese).
35. Wang Z, Dang S, Xing Y, et al. Applying Rank Sum Ratio (RSR) to the Evaluation of Feeding Practices Behaviors, and Its Associations with Infant Health Risk in Rural Lhasa, Tibet. Int J Environ Res Public Health 2015; 12:15173-81. doi: 10.3390/ ijerph121214976.
36. Statistical Communique on the National Economic and Social Development (Year2015) of Furong District. Statistical Information of Changsha city (Hunan

province, China) website. http://www.cstj.gov.cn/ndqx/index.jhtml (accessed 21 July 2016).

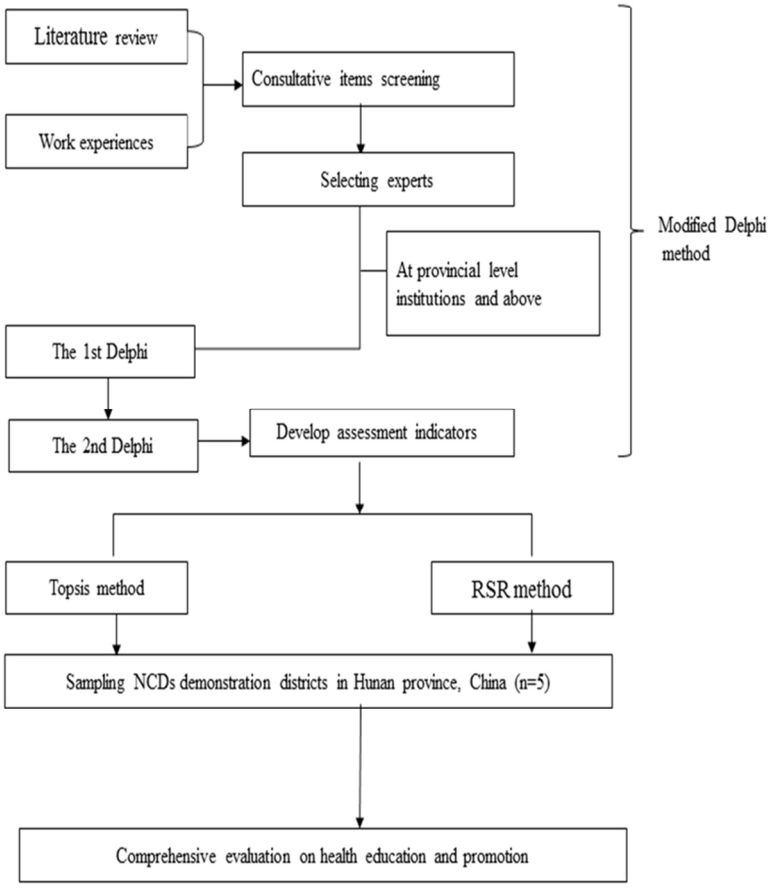
37. Statistical Communique of Hunan province on the National Economic and Social Development (Year 2015). The People's Government of Hunan province, China. http://www.hunan.gov.cn/2015xxgk/szfzcbm_8834/tjbm_6941/tjgbzb/201603/t20160318_2964470.html (accessed 21 July 2016).

38. Reply on Wuling Mountain Area Regional Development and Poverty Alleviation Plan (2011-2020) by the State Council of China. http://www.seac.gov.cn/art/2013/3/18/art_6497_179231_1.html (accessed 21 July 2016).

Figure legends

Figure 1: Flow diagram of the study conducted

Figure 2: Characteristics of experts participating in the Delphi process



The flow diagram of this study

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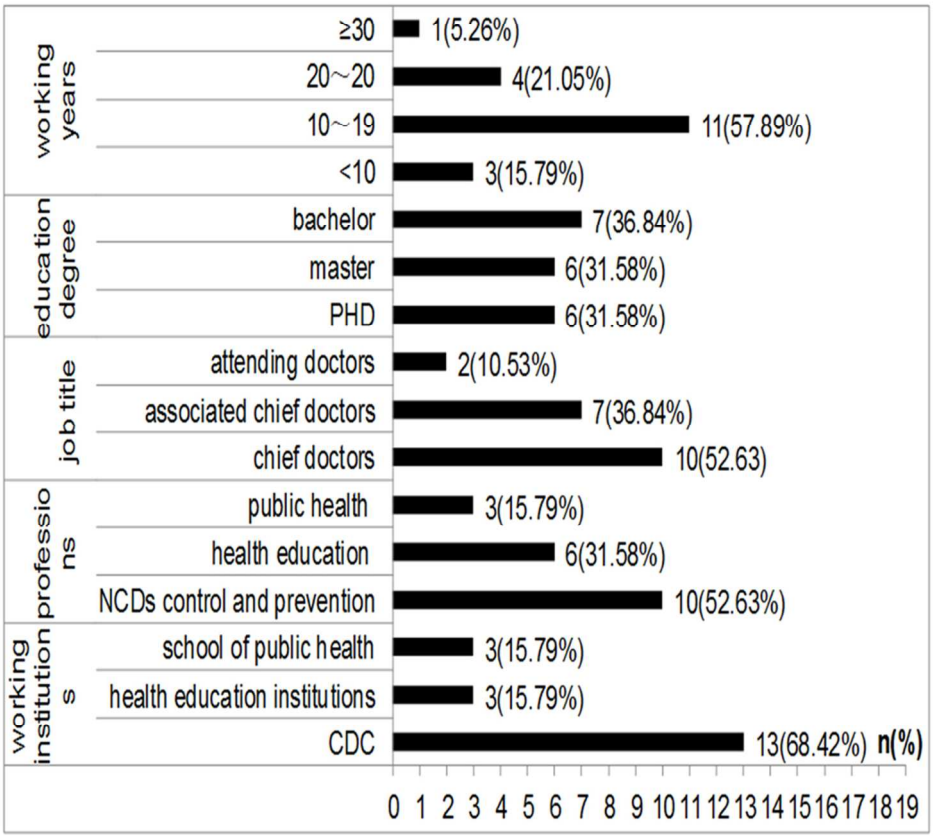

Characteristics of experts participating in the Delphi procedure

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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 the 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:	*BMJ Open*
Manuscript ID	bmjopen-2017-015943.R2
Article Type:	Research
Date Submitted by the Author:	03-Oct-2017
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

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

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Word count: 2198

ABSTRACT

Objectives

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

Methods

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

Results

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

Conclusions

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

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

a recommendation from the provincial health administration department and then pass an assessment organized by the NHFPC. Similarly, the declaration of provincial NCD demonstration districts went through a city-level recommendation first and then a provincial assessment.

Health education is defined as a systematic social activity that helps people improve their health-related behaviours. For NCDs, health education often involves publicizing a healthy lifestyle, such as non-smoking, a low-salt diet, a proper diet, adequate physical activities and mental health, using publicity materials, billboard, lectures, and media promotion. Health promotion is the process of enabling people to increase control over and improve their health.[4] The Ottawa Charter for health promotion action includes the following five policies:[4] building a healthy public policy (e.g., raising the tobacco excise tax), creating supportive environments (e.g., building a fitness trail), strengthening community actions, developing personal skills, and reorienting health services. Integrated health education and promotion are the first priorities of the policy and the primary means of NCD control and prevention; thus, these policies play important roles in NCD demonstration district programmes. However, the work is relatively new in China, and only rare systematic assessments have been reported (i.e., no assessment indicators are available). Thus, based on health education and promotion in the districts, this study was conducted to develop assessment indicators, compare the performances among districts, and analyse important factors for health education and promotion to provide a framework or methodological reference for other health studies.

METHODS

Study design

Three evaluation techniques were comprehensively followed in the study. Figure 1 shows the flow diagram. A modified Delphi method originally developed by RAND/UCLA[5] was used in the following steps (conducted between late 2013 and 2014):

1. Thirty-nine sub-sectional consultative items in seven sections were selected for the first Delphi round based on the work manuals of the NCD demonstration districts developed by the national Centre for Disease Control and Prevention (CDC) and our own work experiences (Appendix Table A1).

2. Experts nationwide were invited if they met the following demands: worked in NCD control and prevention, health education and promotion, or other public health professions, worked for provincial or national institutions with five years or more of work experience, and showed an interest in participating in the study.

3. A two-round Delphi process was conducted. In the first round, experts were asked to judge whether items should be included and were free to add items or make comments. The experts scored each item using a 9-point Likert scale (1 to 9: extremely unimportant to extremely important).[6-8] The data were summarized, revised, and sent to experts for a second round following the same format as the first round. Then, the assessment indicators were determined.

Second, the rank sum ratio (RSR) method introduced by Tian FD[9] was followed (conducted in 2015). The basic theory behind the method is that a dimensionless statistical indicator (RSR) is calculated from an n×m matrix using rank conversion. The subjects' statuses (worst/best) were evaluated using the RSR order. All items were first ranked as *Rij* (i≤n, j≤m), with the higher quality items ranked in ascending order and the lower quality items ranked in descending order. Then, a weighted RSR was calculated with the equation $RSR_i = \frac{\sum_{j=1}^{m} R_{i,j}}{m \times n}$.

Finally, the technique for order preference by similarity to ideal solution (TOPSIS)[10-12] was employed to assess the sampled NCD demonstration districts (conducted in 2015). Prior to the technique, some NCD districts were chosen as evaluation samples. To ensure a balanced geographic distribution of the districts, we randomly selected 5 districts representing different orientations (south, north, east, west, and middle) out of the total 28 districts in the province and generated the following districts as samples with a randomizing function in Microsoft Excel 2010: Furong District, Ziyang District, Shaodong County, Shuangfeng County, and Luxi County. The assessment indicator data were collected between 2014 and 2015 from the above districts. TOPSIS was conducted using the following six steps:

1. The original values of items (Xij) were converted to the high-quality ($X'ij$) values. However, there was no need to convert the values here due to their natural high-quality

features.

2. The mono-trended matrix was normalized as Yij and calculated using the equation $Y_{ij} = X'_{ij} \div \sqrt{\sum_{i=1}^{m} (X'_{ij})^2}$.

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

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

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

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

Statistical analyses

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

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

RESULTS

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

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

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

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	-	-	-	-
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

[a]: Items removed in each round

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

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

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

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

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

Code	Weight	RSR	Real value ($Xij = X'ij$)					Normalization value （ Yij ）				
			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]: Represents qualitative items: positive items were valued as 1, and the negative items were valued as 0

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

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

DISCUSSION

Multi-assessments should be comprehensively employed in health evaluations due to features such as objects, purposes, and data types to compensate for the limitations of a single assessment. With features including anonymity, iteration, controlled feedback, and statistical summarization, the Delphi technique was chosen as a suitable method for obtaining collective expert opinions because this method was widely used in health-related research.[15, 24, 25] TOPSIS, which was developed by Hwang and Yoon[26], was chosen as a family member of multiple-criteria decision-making (MCDM).[27-29] This method provides an optimal solution or alternative ranking[30] without operational issues or limitations on data types[31-33] but often fails to avoid the impact of abnormal values.[34] The RSR method is based on a non-parameter analysis and has no data type restrictions. Moreover, RSR can eliminate the bias of abnormal values by reflecting the priority of the evaluated objects.[35]

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

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

is regarded as one of the Wuling Mountain Areas Regional Development Key Counties and is a national poverty-stricken county,[38] with insufficient funds for NCD control and prevention supported by the local government. The other two fund guarantees were also dwarfed by the other districts. However, Luxi County was not only comprehensive in conducting methods but was also extensive in its NCD control and prevention themes despite having a simple external form, which highlighted its diverse and frequent media promotion strategies (particularly with television stations, with an annual forty-four period showing for an average of 30 minutes per time). NCD education and promotion permeated into every village or community, featuring one hundred percent coverage of fitness centres or rooms and numerous types of NCD promotion materials, gaining an advantage over other objects (except for Furong District).

The middle-ranking Ziyang District had the most assessment indicators at the middle level. In the last two ranked objects, the comprehensive performances of both Shaodong and Shuangfeng counties were lacking, which might have been a result of their late beginning and hasty NCD demonstration district processes during the study period as well as a historically unsolid work basis.

Conclusions

We built qualitative and quantitative assessment indicators of health education and promotion in NCD demonstration districts using a hybrid of multi-assessment methods to provide a valid reference for future similar studies. There were gaps in health education and promotion work in the NCD demonstration districts in Hunan province. The districts that performed better had obvious advantages in fund support, media promotion, technical support, community promotion and supportive environment supplies. The variances were not only associated with local fund support but also with the working basis within the district. Fund support did not always influence the variances because the limitation of inadequate fund support could be broken and even shifted into an advantage with a solid working quality.

Acknowledgements: We are grateful to all experts who participated in the Delphi

process. We also thank the Furong District CDC, Ziyang District CDC, Shaodong County CDC, Shuangfeng County CDC, and Luxi County CDC for their great work in assisting with the data collection and survey conduction.

Contributors: Qiaohua Xu contributed to the study design, conducted the study, analysed the data and wrote the manuscript. Yuelong Huang was the principal guarantor of the study and contributed to the study design. Biyun Chen managed the study day-to–day and commented on manuscript writing. All authors have discussed the paper and approved the final version.

Funding: This work was supported by China Hunan Provincial Science & Technology Department (No. 2013zk2054).

Conflicts of interest: None declared

Ethics approval: This study was approved by the Ethics Committee of Hunan Provincial Centre for Disease Control and Prevention, China (HNCDC/JL31-044: 2013011).

Data sharing statement: No additional data are available.

REFERENCES

1. Yang G, Wang Y, Zeng Y, et al. Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet 2013; 381:1987-2015. doi: 10.1016/S0140-6736(13)61097-1.
2. Information Office of the State Council. Medical and Health Services in China. Beijing, China: Foreign Language Press 2012.
3. Lee A, Cheng FF, Fung Y, et al. Can Health Promoting Schools contribute to the better health and wellbeing of young people? The Hong Kong experience. J Epidemiol Community Health 2006; 60:530-36. doi: 10.1136/jech.2005.040121.
4. Word Health Organization. Ottawa charter for health promotion. Geneva: WHO 1986. http://www.who.int/healthpromotion/conferences/previous/ottawa/en/ (accessed 21 July 2016).

5. Fitch K, Bernstein SJ, Aguilar MD, et al. The RAND/UCL appropriateness method user's Manual. Santa Monica, CA: RAND 2001. doi :10.1016/j.seizure.2011.09.007.
6. Suzuki Y, Fukasawa M, Nakajima S, et al. Development of disaster mental health guidelines through the Delphi process in Japan. Int J Ment Health Syst 2012; 6:7. doi: 10.1186/1752-4458-6-7.
7. Mrowietz U, de Jong EM, Kragballe K, et al. A consensus report on appropriate treatment optimization and transitioning in the management of moderate-to-severe plaque psoriasis. J Eur Acad Dermatol Venereol 2014; 28: 438-53. doi: 10.1111/jdv.12118.
8. Konstantinou K, Hider SL, Vogel S, et al. Development of an assessment schedule for patients with low back-associated leg pain in primary care: a Delphi consensus study. Eur Spine J. 2012; 21:1241-49. doi: 10.1007/s00586-011-2057-2.
9. Sun ZQ, Tian FD. Medical Systematic Evaluation. Beijing, China: China Sci and Technol Press 1994 (In Chinese).
10. Fang JQ. Health Statistics (6th ed). Beijing, China: People's Medical Publishing house 2008: 428-31(in Chinese).
11. Opricovic S, Tzeng GH. Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. Eur J Oper Res 2004;156: 445-55.
12. Jahanshahloo GR, Lotfi FH, Izadikhah M. An algorithmic method to extend TOPSIS for decision-making problems with interval data. Appl Math Comput 2006;175: 1375-84. doi: 10.1016/j.amc.2005.08.048.
13. Booth A, Clarke M, Ghersi D, et al. Establishing a Minimum Dataset for Prospective Registration of Systematic Reviews: An International Consultation. PLoS One 2011; 6: e27319. doi: 10.1371/journal.pone.0027319.
14. Chipchase LS, Buttrum PJ, Dunwoodie R. Characteristics of student preparedness for clinical learning: clinical educator perspectives using the Delphi approach. BMC Med Educ 2012; 12:112. doi: 10.1186/1472-6920-12-112.
15. Robinson KR, Leighton P, Logan P, et al. Developing the principles of chair based exercise for older people: a modified Delphi study. BMC Geriatr 2014;14:65. doi:10.1186/1471-2318-14-65.

16. Benhamou M, Baron G, Dalichampt M, et al. Development and Validation of a Questionnaire Assessing Fears and Beliefs of Patients with Knee Osteoarthritis: The Knee Osteoarthritis Fears and Beliefs Questionnaire (KOFBeQ). PLoS One 2013; 8: e53886. doi: 10.1371/journal.pone.0053886.

17. Slade SC, Dionne CE, Underwood M, et al. Standardized method for reporting exercise programmes: protocol for a modified Delphi study. BMJ Open 2014; 4: e006682. doi: 10.1136/bmjopen-2014-006682.

18. Taylor RM, Feltbower RG, Aslam N,et al. Modified international e-Delphi survey to define healthcare professional competencies for working with teenagers and young adults with cancer. BMJ Open 2016; 6: e011361. doi: 10.1136/bmjopen-2016-011361.

19. Muñoz Fernández S, Lázaro y De Mercado P, Alegre López J, et al. Quality of care standards for nursing clinics in rheumatology. Reumatol Clin 2013; 9: 206-15. doi: 10.1016/j.reuma.2012.10.016.

20. Bao H, Yang F, Wang X, et al. Developing a set of quality items for breast cancer care in China. Int J Qual Health Care 2015; 27: 291-96. doi: 10.1093/intqhc/mzv042.

21. Bland JM, Altman DG. Statistics notes: Cronbach's alpha. BMJ 1997; 314:572.

22. Slootweg IA, Lombarts KM, Boerebach BC, et al. Development and Validation of an Instrument for Measuring the Quality of Teamwork in Teaching Teams in Postgraduate Medical Training (TeamQ). PLoS One 2014; 9: e112805. doi:10.1371/journal.pone. 0112805.

23. Zlateva I, Anderson D, Coman E, et al. Development and validation of the Medical Home Care Coordination Survey for assessing care coordination in the primary care setting from the patient and provider perspectives. BMC Health Serv Res 2015; 15:226. doi: 10.1186/s12913-015-0893-1.

24. Schopper D, Torres AM, Pereira J, et al. Setting health priorities in a Swiss canton: what do different methods tell us? J Epidemiol Community Health 2000; 54:388-93.

25. Veerman JL, Barendregt JJ, Mackenbach JP. Quantitative health impact assessment: current practice and future directions. J Epidemiol Community Health 2005;59:361-70. doi: 10.1136/jech.2004.026039

26. C. L. Hwang, K. Yoon. Multiple Attribute Decision Making: Methods and Applications. Berlin, Germany: Springer;1981.
27. Sun ZQ. Medical Statistics (2nd ed). Beijing, China: People's Medical Publishing House 2005; 514-18 (in Chinese).
28. Zaboli R, Tourani S, Seyedin SH, et al. Prioritizing the Determinants of Social-health Inequality in Iran: A Multiple Attribute Decision Making Application. Iran Red Crescent Med J 2014; 16: e12607. doi: 10.5812/ircmj.12607.
29. Bai ZY. An Interval-Valued Intuitionistic Fuzzy TOPSIS Method Based on an Improved Score Function. Scientific World Journal 2013; 2013: 879089. doi: 10.1155/2013/879089.
30. Shabaninejad H, Mehralian G, Rashidian A, et al. Identifying and prioritizing industry-level competitiveness factors: evidence from pharmaceutical market. Daru 2014; 22:35. doi: 10.1186/2008-2231-22-35.
31. Kuo RJ, Wu YH, Hsu TS. Integration of fuzzy set theory and TOPSIS into HFMEA to improve outpatient service for elderly patients in Taiwan. J Chin Med Assoc 2012; 75:341-48. doi: 10.1016/j.jcma.2012.05.001.
32. Shen M, Zeng N, Hu J, et al. Weighted TOPSIS method and weighted RSR method in the construction of drug supervision and supply networks in rural areas of Hunan. J Cent South Univ (Med Sci) 2013; 38: 301-06. doi:10.3969/j.issn.1672-734. 2013.03.014 (in Chinese).
33. Wang M, Fang H, Bishwajit G, et al. Evaluation of Rural Primary Health Care in Western China: A Cross-Sectional Study. Int J Environ Res Public Health 2015; 12:13843-60. doi: 10.3390/ijerph121113843.
34. Wang H, Song P, An L. Comprehensive Evaluation of the Situation of Maternal Health Care with TOPSIS and RSR. China J Health Statis 2015; 32: 240-42 (in Chinese).
35. Wang Z, Dang S, Xing Y, et al. Applying Rank Sum Ratio (RSR) to the Evaluation of Feeding Practices Behaviors, and Its Associations with Infant Health Risk in Rural Lhasa, Tibet. Int J Environ Res Public Health 2015; 12:15173-81. doi: 10.3390/ ijerph121214976.

36. Statistical Communique on the National Economic and Social Development (Year2015) of Furong District. Statistical Information of Changsha city (Hunan province, China) website. http://www.cstj.gov.cn/ndqx/index.jhtml (accessed 21 July 2016).

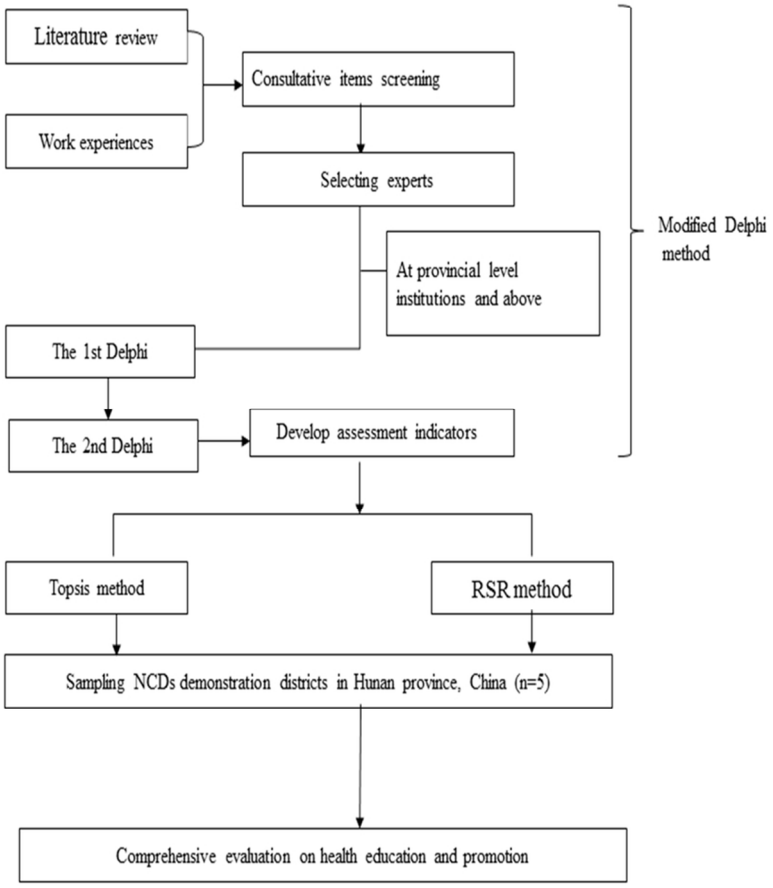
37. Statistical Communique of Hunan province on the National Economic and Social Development (Year 2015). The People's Government of Hunan province, China. http://www.hunan.gov.cn/2015xxgk/szfzcbm_8834/tjbm_6941/tjgbzb/201603/t20160318_2964470.html (accessed 21 July 2016).

38. Reply on Wuling Mountain Area Regional Development and Poverty Alleviation Plan (2011-2020) by the State Council of China. http://www.seac.gov.cn/art/2013/3/18/art_6497_179231_1.html (accessed 21 July 2016).

Figure legends

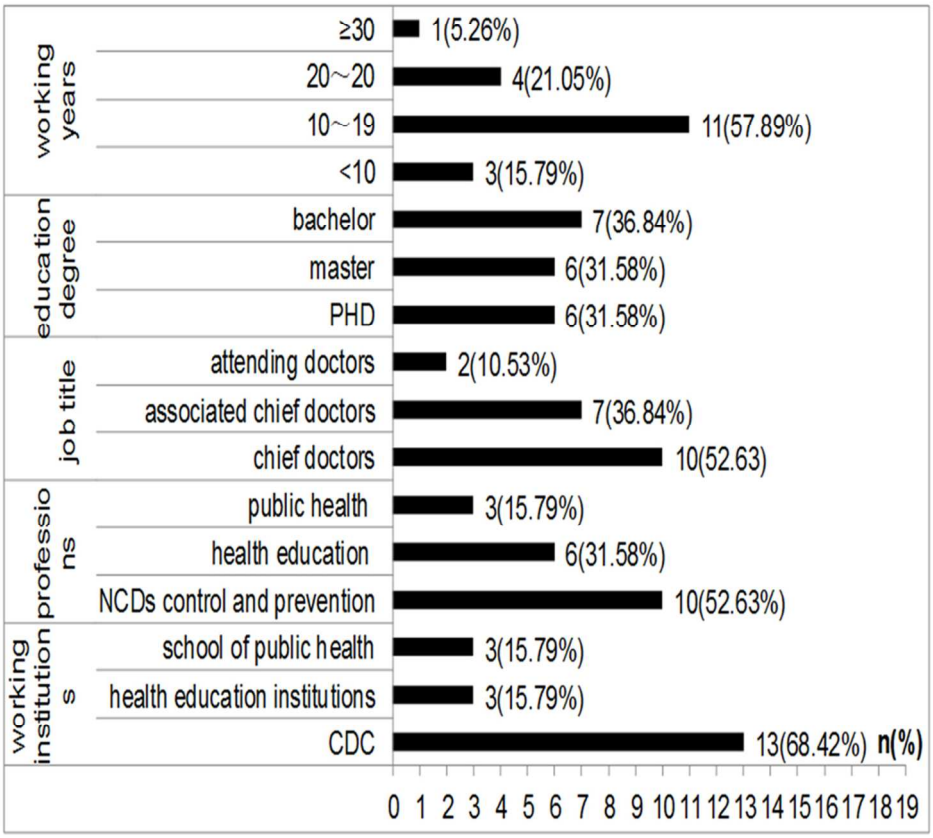
Figure 1: Study flow diagram

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



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

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 the 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.