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Assessing competence for helminthiases: A lesson learnt from national contest of parasitic diseases in China in 2012-2016

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ABSTRACT

This study aimed to assess the competency of health professionals on helminthiasis control in China. The assessment system comprised of two parts, one being the parasitological knowledge test and the other a technical skills assessment. The knowledge test mainly examined morphology, epidemiology, life history and diagnosis of common and important parasites. The skills assessment consisted of sample slides making and species identification using microscopy. From 2012 to 2016, a total of 616 participants from different levels of parasitic diseases prevention and control departments of CDC took part in the assessment. The results had shown a high level of academic knowledge among participants. Accuracy rates of schistosomiasis, echinococcosis, food-borne helminthiases, and soil-transmitted helminthiasis were all above 60%. This showed an excellent knowledge level of helminthiases by participants. However, among all 616 participants, 94.97% passed the thick-smear passing test (> = 60%), while in microscopy tests the equivalent was only 43.67%. Competencies in different districts varied. It is imperative to set up a North-South skill exchange mechanism of helminthiases diagnostic techniques and to apply new diagnostic tools widely to strengthen helminthiases prevention and control in China.

1. Introduction

The most common helminth parasites of humans in developing countries are from the phyla Nematoda (roundworms) and Platyhelminthes (flatworms). They are caused by intestinal infection with soil-transmitted helminthiases, like *Ascarias lumbricoides, Trichuris trichiura*, and hookworms (*Necator americanus* and *Ancylostoma duodenale*), followed by schistosomiasis (Hotez et al., 2008). If no treatment is administered, most helminth infections develop into chronic inflammatory disorders that cause both present and delayed pathology to the affected human host (King, 2007; Bethony et al., 2006a; Budke et al., 2005).

In addition to the overt and intimidating effects of spleen enlargement and elephantiasis in individuals with schistosomiasis and lymphatic filariasis, it is known that chronic helminth infections are also linked to more persistent health conditions such as anemia, stunted growth, undernutrition, fatigue, and poor cognitive development (Bethony et al., 2006b; King and Dangerfield-Cha, 2008). These easily-neglected morbidities are important where health impairment can be avoided given diagnostic tools and treatment are both in place.

With vast landmass, unbalanced economic development and a large population, helminth infections are one of the most common human infectious diseases in China. Schistosomiasis, echinococcosis, soil-transmitted helminthiasis and food-borne parasitic diseases are major parasitic diseases. Helminth control in China has been in existence since the 1950′s, when schistosomiasis first became a priority. The present strategy for control of parasitic diseases in China is to carry out comprehensive disease management approaches, with an emphasis on controlling sources of infection (Ministry of Health of the People's Republic of China, 2006). At the country level, controlling soil-transmitted helminths and infection with *Clonorchis sinensis* have been prioritized. In addition to this national priority, different regions have identified other diseases as priorities for control: 1) echinococcosis, taeniasis, cysticercosis, trichinosis and leishmaniasis in western China; 2) soil-transmitted helminths in impoverished regions of central and eastern China; and 3) *Clonorchis sinensis* in Guangdong, Guangxi, Heilongjiang, Jilin and Liaoning provinces. Children, women, and ethnic minorities are the key populations to be targeted within all disease-specific interventions (Ministry of Health of the People's Republic of China, 2006; Ministry of Health, 2008a; National Health and Family

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Planning Commission, 2016; Ministry of Health, 2008b). A series of national plans and strategies, such as *Integrated Control of Schistosomiasis in China (2009–2015), National Action Plan for Echinococcosis Control (2010–2015), National Plan for Major Parasitic Diseases (2006–2015)*, were issued to strengthen helminthiases control by central and local government commitments. In Healthy China 2030 issued by the State Council in 2017, the country set clear goals to eliminate schistosomiasis and control echinococcosis by 2030 (Healthy China, 2016).

Prevalence of helminthiases has seen a sharp decrease in recent years in China, many of the diseases are, or are close to being, eradicated. The third national sampling survey for schistosomiasis was conducted in 2004, and studied the prevalence of *S. japonicum* in more than 290,000 people, ranging from 6 to 65 years, from 239 villages in 7 endemic provinces (Zhou et al., 2004). Prevalence rates ranged from 0.3% in Jiangsu province to 4.2% in Hunan province, with a total estimated number of over 726,000 infected individuals throughout the country (Liu et al., 2007). In more than 50% of the villages, infection was less than 1%, and infection exceeded 10% in 7.6 percent of the villages. The study found that infection was more common in men than women (2.6% to 2.2% of participants), and significantly higher in fishermen (Zhou et al., 2004). It is estimated that nearly 10 million people live in at-risk areas for infection, with the majority of infected persons living in lake and marshland regions (Zhou et al., 2004; Liu et al., 2007). However, several conclusions can still be made from the two surveys. There was an estimated decrease from 865,084 to 726,112 total cases (16.1% reduction) from the previous survey in 1995, as well as a 41.3% reduction in prevalence in villages where schistosomiasis was transmitted during the same period. The number of people at risk in disease-endemic villages decreased from 22,209,662 to 13,937,325 as well (a 37.3% decrease). Though these findings indicate progress in schistosomiasis control, the authors found that prevalence rates in areas where transmission control was not achieved increased from 4.9% to 5.1% (Zhou et al., 2004).

However, gaps remain in the present capacity of human resources on control of helminthiases with low morbidity and mortality, and stringent financial resources are dedicated to helminthiases control specifically. The aim of this study is to scrutinize the national contests from five consecutive years (2012–2016) with regards to the capacity of concurrent technical teams for the last mile against helminthiases, and provide evidence for setting priorities in helminthiases prevention and control in the country.

2. Materials and methods

2.1. Subjects

Eligible population was staff from CDC or institutes of parasitic diseases who were younger than 45 years old in China. Each participating provincial health authority selected four eligible candidates from each province including at least two staff from county-level CDC. In addition, participants were only allowed to take part in the competition one time.

2.2. Instruments

The test consisted of two parts: a knowledge test and a technical skill assessment. Both scores were based on the sum of correct answers. Rating system of helminth knowledge and diagnostic techniques were reviewed by the contest committee.

One knowledge test was developed by National Institute of Parasitic Diseases, China CDC each year to evaluate competency in common and important helminths in terms of morphology, life cycle, epidemiology and diagnosis. An examination test, featuring different items each year, composed of single-choice, multiple-choice and true or false questions and was administered to each participant. Single-choice and multiple-choice questions were calculated as the sum of scores on the Likert 4-point scale or Likert 5-point scale. Considering the prevalence, morbidity and mortality of different helminthiases, schistosomiasis and echinococcosis were assigned 20 credit points each, while soil-transmitted helminthiases and food-borne helminthiases were assigned 30–40 credit points together.

The technical skill assessments were developed by National Institute of Parasitic Diseases, China CDC to evaluate participants' diagnostic skills in laboratories. Through 2012–2016, the technical skill assessment comprised of preparing three thick-smears using the Kato-Katz technique in 15 min (10 credit points in total) and detection of parasite eggs with microscopes in a set of 10 stool specimens within 50 min (50 credit points total). Stool specimens were prepared by the test committee in advance and included one negative specimen and nine positive specimens with different combinations of at least one from eight common helminth eggs, i.e. *Schistosoma japonicum, Trichuris trichiura, Paragonimus* spp., *Fasciola* spp., *Ascarias* spp., *Enterobius vermicularis, Clonorchis sinensis,* and *Taenia* spp.. The criteria for thick-smear preparation were also developed by the test committee and applied over all years 2012–2016.

2.3. Procedure

The candidates were tested in one day. The first half on the paper test and the other on technical skills. Staff from National Institute of Parasitic Diseases (NIPD), China CDC selected raters. Before the test the raters received a 2-h training of scoring and procedures. Scores of knowledge tests were machine rated, and scores of technical skill assessment tests were rated by NIPD staff. All disputes regarding tests were referred to an arbitration committee lead by non-CDC member.

2.4. Statistical analysis

A database was set up using Microsoft Excel 2003 and data analysis was conducted by SPSS21.0 software. Descriptive statistics of all tests were expressed with means, frequencies and standard deviations (SDs). Differences of assessment results between groups were compared using one-way ANOVA method. Logistic Regression model was used to explore correlations with the Hosmer and Lemeshow goodness of fit test. Level of statistical significance was defined as $P < 0.05$.

Reliability – internal consistency of knowledge test each year is evaluated by Cronbach's α. which is considered to be the most important reliability index and is based on the number of the variables/items of the tests, as well as on the correlations between the variables. A Principal components analysis was used for each year's knowledge test in order to confirm or not the scale construct validity. To define if the subscales were suitable for factor analysis, two statistical tests were used. The first is the Bartlet Test of Sphericity, to test the inter-independence of subscales, and the Kaiser-Meyer Olkin Measure is conducted to examine sample sufficiency.

3. Results

3.1. General description

From years 2012 to 2016, a total of 616 participants took part in the tests. 120 candidates joined the test in 2012, while 124 candidates per year joined the tests from 2013 to 2016. Among them 60.1% were female, and 39.7% were male. 18.3% were from provincial-level agencies, 29.3% from prefecture-level agencies and 52.2% were from county-level agencies. Senior staff accounts for 3.4% of all participants, while mid-level staff and junior staff made up 33.1% and 63.4%, respectively. Ages of all participants ranged from 21 to 45, with a mean of 31.88 and standard deviation of 5.32. (Figs. 1–3)

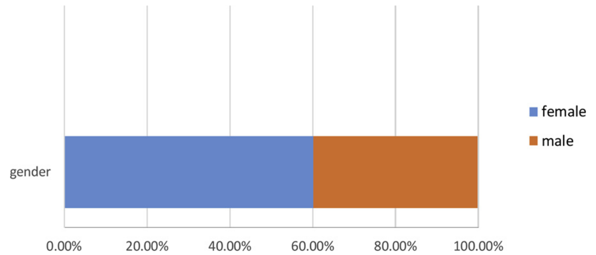

Fig. 1. Gender information of test participants.

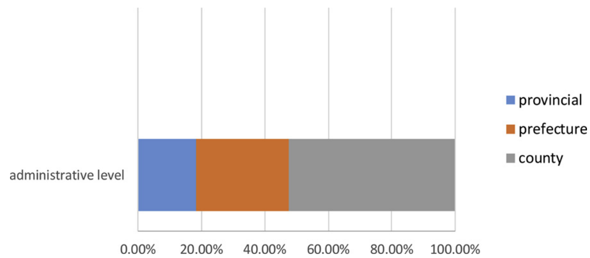

Fig. 2. Percentages of administrative levels of test participants' agencies.

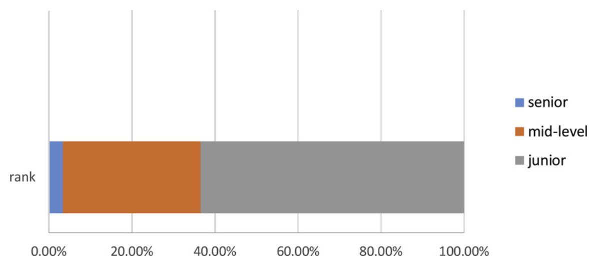

Fig. 3. Percentages of test participants' ranks.

3.2. Reliability and validity

Results are presented of the generalizability analysis based on the personal scores. A reliability of 0.80 is often considered as a minimum requirement if scores are used as a basis for individual decision-making. Reliability Statistics (Table 1) inform us about the value of the coefficient α of Cronbach are 0.839, 0.808, 0.827, 0.811, 0.922 from 2012 to 2016. All results get over the percent of 80%, which show good value for the internal consequence of the conceptual construction of the assessed scale

The following Table 2 gives information about two hypotheses of factor analysis. From the following table, we find out that sample sufficiency index KMO by Kaiser-Meyer-Olkin, which compares the sizes of the observed correlation coefficients to the sizes of the partial correlation coefficients for the sum of analysis variables are 76.3%, 80.7%, 79.9%, 69.2% and 72.3% from 2012 to 2016, and knowledge tests are reliable because they overcomes 70% by far except year 2015. In addition, supposition test of sphericity by the Bartlett tests are rejected for all five years on a level of statistical significance p.

Table 1
Results of reliability test in 2012–2016.

Year	Cronbach's α
2012	0.839
2013	0.808
2014	0.827
2015	0.811
2016	0.922

Table 2
Results of validity tests in 2012–2016.

Year	Kaiser-Meyet-Olkin measure of sampling adequacy	Sphericity (sig.)
2012	0.763	0.000
2013	0.807	0.000
2014	0.799	0.000
2015	0.692	0.000
2016	0.723	0.000

3.3. Results of knowledge tests

Among all 616 participants, 53.9%, 52.1%, 52.6%, 49% had an accuracy rate of no less than 60% in terms of schistosomiasis, echinococcosis, soil-transmitted helminthiases, food-borne helminthiases in knowledge tests. The average accuracy rates of knowledge test in terms of food-borne helminthiases, echinococcosis, schistosomiasis, soil-transmitted helminthiases ranged from 60.4% to 66.2% in 2012–2016. All helminthiases tested saw average accuracy rates exceeding 60%. The accuracy rates over the years showed a lowest 37% of food-borne helminthiases and echinococcosis in 2015, and a highest 84.73% of soil transmitted helminthiasis. Mean differences of all assessments among years 2012–2016 were statistically significant. (Table 3)

3.4. Results of technical skill assessment

Among all 616 participants, 94.97% scored 60% or higher in preparing thick-smears. During 2012–2016, thick-smear preparation scored highest in year 2015 (mean ± SD, 8.27 ± 1.0), while lowest was in 2012 (mean ± SD, 6.89 ± 1.33). Of all 616 participants, 43.67% scored no less than 60% in reading slides. During 2012–2016, microscopy scored highest in year 2015 (mean ± SD, 27.85 ± 11.26), while lowest was in 2012 (mean ± SD, 22.99 ± 11.68). For the technical skill assessment total score, 304 participants out of 616 (49.4%) from year 2012–2016 have reached over 60% of total scores, with the highest in 2015 (mean ± SD, 36.95 ± 11.80) and the lowest in 2012 (mean ± SD, 30.57 ± 12.05). Mean differences of all assessments among years 2012–2016 were statistically significant (Table 4).

The average score of stool specimen detection was 26.15 (total 50 scores) in 2012–2016. Over these years, disease with the lowest mean accuracy rate of all helminthes was *Enterobius vermicularis* (0.45), while the mean accuracy rate was *Clonorchis sinensis* (0.73). In 2012–2013, accuracy rate of *Trichuris trichiura* stool samples detection was the highest, while in 2014–2016, accuracy rate of *Clonorchis sinensis* stool samples detection was the highest. Mean differences of thick-smear preparation, slide reading and technical skill assessments in total among years 2012–2016 were statistically significant (Table 5). However, there are no clear trends or patterns observed in the results for all three tests over the years. Moreover, accuracy rates of *Clonorchis sinensis* and *Taenia* spp. stool samples detection both followed an upward trend over the five years and show a significant difference (Fig. 4).

3.5. Correlations

3.5.1. Factors and results of TSA

Logistic regression model was applied between predictor variables like endemicity of schistosomiasis and echinococcosis, districts of workplace of participants, demographics and the dependent variable of passing or not passing stool samples detection. Results of Omnibus Tests of Model Coefficients showed the model is significant ($p = 0.00$). Hosmer-Lemeshow goodness of fit test showed a nonsignificant chi-square ($p = 0.236$) indicating the data fit the model well. Participants from the Southern part ($p = 0.00$) or schistosomiasis non-endemic ($p = 0.00$) or echinococcosis non-endemic ($p = 0.02$) districts all showed statistically significant predictors of one's TSA results.

Table 3
Accuracy rates of written tests in 2012–2016.

	2012 (n = 120)	2013 (n = 124)	2014 (n = 124)	2015 (n = 124)	2016 (n = 124)	F	*P*
Schistosomiasis	0.74 ± 0.18	0.83 ± 0.16	0.44 ± 0.71	0.49 ± 0.12	0.72 ± 0.17	167.08	.00
Echinococcosis	0.68 ± 0.23	0.92 ± 0.15	0.47 ± 0.74	0.37 ± 0.10	0.87 ± 0.15	326.62	0.00
Soil-borne helminthiases	0.82 ± 0.18	0.87 ± 0.20	0.41 ± 0.91	0 ± 0*	0.92 ± 0.27	608.68	0.00
Food-borne helminthiases	0.86 ± 0.17	0.73 ± 0.15	0.5 ± 0.06	0.37 ± 0.12	0.79 ± 0.28	176.22	0.00

* No item tested on soil-borne helminthiases in year 2015.

Table 4
Results of technical skill assessment.from 2012 to 2016.

	2012	2013	2014	2015	2016	F	P
Thick-smear	6.89 ± 1.33	7.57 ± 1.34	7.86 ± 1.14	8.27 ± 1.01	7.85 ± 0.84	23.993	0.000
Slide reading	22.99 ± 11.68	27.30 ± 13.36	25.31 ± 11.85	27.85 ± 11.26	27.18 ± 11.75	3.366	0.010
TSA in total	30.57 ± 12.05	35.63 ± 14.00	33.95 ± 12.40	36.95 ± 11.80	35.81 ± 11.93	4.82	0.001

TSA: technical skill assessment.

Table 5
Accuracy rates of microscopy.from 2012 to 2016.

	2012 (n = 120)	2013 (n = 124)	2014 (n = 124)	2015 (n = 124)	2016 (n = 124)	F	*P*
Schistosoma japonicum	0.49 ± 0.46	0.54 ± 0.39	0.34 ± 0.30	0.51 ± 0.38	0.51 ± 0.44	4.97	.00
Trichuris *trichiura*	0.70 ± 0.36	0.74 ± 0.40	0.44 ± 0.33	0.36 ± 0.48	0.60 ± 0.48	19.02	0.00
Paragonimus spp.	0.61 ± 0.39	0.63 ± 0.35	0.47 ± 0.42	0.58 ± 0.41	0.70 ± 0.37	5.86	0.00
Fasciola spp.	0.43 ± 0.42	0.53 ± 0.44	0.63 ± 0.49	0.64 ± 0.40	0.48 ± 0.48	5.44	0.00
Ascarias spp.	0.52 ± 0.37	0.45 ± 0.45	0.37 ± 0.44	0.84 ± 0.23	0.78 ± 0.34	38.03	0.00
Enterobius vermicularis	0.50 ± 0.39	0.44 ± 0.45	0.68 ± 0.36	0.17 ± 0.38	0.48 ± 0.48	25.03	0.00
Clonorchis sinensis	0.43 ± 0.43	0.61 ± 0.46	0.87 ± 0.33	0.85 ± 0.28	0.88 ± 0.25	39.00	0.00
Taenia spp.	0.48 ± 0.40	0.57 ± 0.46	0.67 ± 0.34	0.79 ± 0.33	0.84 ± 0.33	19.41	0.00

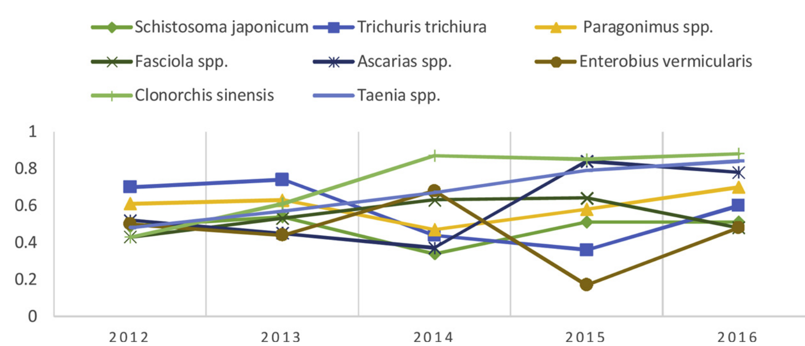

Fig. 4. Trends of accuracy rates of stool sample detection.from 2012 to 2016.

Schistosomiasis non-endemic area was an independent predictor of a lower TSA score (β = -2·06, Odds ratio:0.13(0.07 to 0.24); P = 0·00), whereas echinococcosis non-endemic area was an independent predictor of a higher TSA score (β = 0·68, Odds ratio:1.97(1.13 to 3.44); P = 0·02). As illustrated in Table 6, the odds of a participant from the Southern part (β = 0.62, Odds ratio:1.86(1.08 to 3.20); P = 0·03) of China is 1.86 times higher than his counterpart from the Northern part of China to pass TSA. Gender, rank, age and institute level were not statistically significant.

3.5.2. Factors and results of microscopy

Likewise, correlations between predictor variables of demographic and disease-endemic districts and the dependent variable of whether or not the participant passed the microscopy test (no less than 60% accuracy rate) were analyzed using logistic regression model.

Again, results from Omnibus Tests of Model Coefficients showed the model is significant (p = 0.00). Hosmer-Lemeshow goodness of fit test showed a nonsignificant chi-square (p = 0.236) indicating the data fit the model well. Table 7 showed that age, gender and rank are insignificant indicators in predicting microscopy results. Only disease-endemic districts and CDC-level exert influence on the microscopy results.

Schistosomiasis non-endemic area was an independent predictor of a lower microscopy score (β = -1·39, Odds ratio:0.25(0.14 to 0.45; P = 0·00), whereas echinococcosis non-endemic area was an independent predictor of a higher microscopy score (β = 1·01, Odds ratio:2.74(1.49 to 5.04; P = 0·00). Participants from the Southern part (p = 0.008) or schistosomiasis-endemic (p = 0.000) or echinococcosis-endemic (p = 0.000) districts all showed statistically significant predictors of participants' stool samples detection results. As illustrated in Table 7, the odds of a participant from the Southern part (β = 0.85, Odds ratio:2.35 (1.33 to 4.13); P = 0·00) of China is 1.86 times higher than his counterpart from the Northern part of China to pass the stool samples detection test.

4. Discussion

Early diagnosis and prompt effective treatment are the basis for the

Table 6
Results of logistic regression model for TSA.

	β	Odds ratio	p
Constant	0.55		0.32
sex			
F	−0.06	0.94(0.61,1.45)	0.78
m	Reference	1.00	
rank			
Senior title	−19.45	3.566E	0.00
vice senior title	−0.21	0.81(0.24,2.76)	0.73
mid-level title	−0.22	0.80(0.47,1.37)	0.43
junior title	Reference	1.00	
age			
< 30	0.03	1.04(0.45,2.41)	0.94
30-40	0.19	1.21(0.59,2.51)	0.60
> = 40	Reference	1.00	
institute level			
provincial level	0.47	1.59(0.91,2.79)	0.10
prefecture/city level	0.21	1.23(0.74,2.04)	0.42
county level	Reference	1.00	
endemicity of schistosomiasis			
non-endemic	−2.06	0.13(0.07,0.24)	0.00
endemic	Reference	1.00	
endemicity of echinococcosis			
non-endemic	0.68	1.97(1.13,3.44)	0.02
endemic	Reference	1.00	
district			
south	0.62	1.86(1.08,3.20)	0.03
north	Reference	1.00	

*Districts of participants' agencies were divided into south and north areas according to National Bureau of Statistics.

Table 7
Results of logistic regression model for stool sample detection.

	β	Odds ratio	p
Constant	−0.73		0.21
sex			
F	−0.15	0.87(0.56,1.34)	0.51
m	Reference	1.00	
rank			
Senior title	−18.47	9.499E	0.00
vice senior title	−0.28	0.76(0.22,2.66)	0.66
mid-level title	0.17	1.19(0.69,1.05)	0.53
junior title	Reference	1.00	
age			
< 30	0.34	1.41(0.59,3.34)	0.44
30-40	0.43	1.53(0.73,3.22)	0.26
> = 40	Reference	1.00	
institute level			
provincial level	0.46	1.59(0.89,2.83)	0.12
prefecture/city level	0.18	1.20(0.72,2.00)	0.49
county level	Reference	1.00	
endemicity of schistosomiasis			
non-endemic	−1.39	0.25(0.14,0.45)	0.00
endemic	Reference	1.00	
endemicity of echinococcosis			
non-endemic	1.01	2.74(1.49,5.04)	0.00
endemic	Reference	1.00	
district			
south	0.85	2.35(1.33,4.13)	0.00
north	Reference	1.00	

*Districts of participants' agencies were divided into south and north areas according to National Bureau of Statistics.

management of helminthiases and for reducing helminthiases mortality and morbidity. Demonstration of the presence of helminths before treatment with drugs is fundamental to this goal, as the accuracy of helminthiasis knowledge and clinical diagnosis is poor, leading to misdiagnosis of helminthiasis, poor management of helminthiases and delay in recovery of patients. This study showed the situation of human resource capacity against helminthiases in the last mile. Both strengths and weaknesses of helminth knowledge and diagnostic capacity through all three administrative levels within CDC in 2012–2016 can provide evidence for capacity building to sustain and enhance teams at all levels in helminthiases control programs.

From knowledge test results, accuracy rates of schistosomiasis, echinococcosis, food-borne helminthiases, and soil-transmitted helminthiasis were all above 60%. This showed an excellent knowledge level of helminthiases by participants. However, not all results of technical skill assessments appear as optimistic. Among all 616 participants, 94.97% has scored no less than 60% in preparing thick-smears, while 43.67% has scored no less than 60% in microscopy tests. Of all tests, thick-smear preparation was the highest score, followed by knowledge test and microscopy came the lowest. The lowest of all species of microscopy test was *Enterobius vermicularis* (accuracy rate = 0.45). Low prevalence rate of helminthiases and present surveillance measures on helminthes may explain the outcomes. While microscopy remains the mainstay of parasite-based diagnosis in most large health clinics and hospitals, the quality of microscopy-based diagnosis is frequently inadequate to ensure good health outcomes and optimal use of resources. An acceptable microscopy service is one that is cost–effective and provides results that are consistently accurate and timely enough to have a direct impact on treatment. Hence, while sustaining the concurrent surveillance system, more attention is required to enhance routine practice of helminthiases diagnosis. Moreover, upward trends of accuracy rates of *Clonorchis sinensis* and *Taenia* spp. stool samples detection over the five years may be accredited to the tests which motivate technical staff all over the country to compete for a higher rank.

Correlation analysis clearly demonstrated diagnostic capacity of technical staff varies geographically. Technical staff from Southern China CDC at all levels exhibited better diagnostic skills than that of Northern China technical staff. Schistosomiasis-endemic districts can equip local technical staff with enhanced diagnostic skills of local CDC technical staff, while diagnostic skills of local CDC technical staff in echinococcosis-endemic districts is not as strong as those in echinococcosis non-endemic disctricts. Most schistosomiasis-endemic districts remain in the South and most of echinococcosis-endemic districts remain in the North, except for Sichuan and Yunnan provinces. (Healthy China, 2016; Zhou et al., 2004; Liu et al., 2007; Vuitton et al., 2003; Xu and Yu SH, 1995; Coordinating Office of the National Survey on the Important Human Parasitic Diseases, 2005). These two results are consistent with each other, since distribution of helminthiases and local prevalence are closely related with conditions of poverty. In China's case, the economy of the Southern part shows a better manifestation compared to that of the Northern part (Nakagawa et al., 2015), and most echinococcosis-endemic districts have poor economies. The explanation behind this may be attributed to staff from rich areas being exposed to more opportunities to build their capacity and being provided with sufficient lab equipment in comparison to those from poorer areas.

Workforce capacity and competency is a crucial part of the public health (WHO health workforce World Health Organization, 2019; Sousa et al., 2017). Capacity building practically involves ensuring a combination of tools, skills, staff and support systems required for chosen functions are available and operational. There are no guidelines on how to build capacities in policy and strategy development, however, attention to improving any required support systems may be needed (Arimatsu et al., 2015). Moreover, attention to creating demand for staff with these capabilities may be needed. With rather low prevalence and limited financing in helminthiases prevention and control, sustainability of capacity needs novel approaches to create chances for technical staff in the Northern part to fill the gap. It is suggested to reallocate health resources and re-prioritize its utilization to promote exchanges between helminthiases endemic and non-endemic districts. The effectiveness and efficiency of helminth work also requires workforce development to be a core component for health and community workers (Sousa et al., 2017).

Nowadays, novel cutting-edge diagnostic tools are available, such as molecular biological methods, rapid diagnostic tools, etc (Lin et al., 2008b,a), which show great potential to be widely applied in the field in the near future. Microscopy of eggs in stool using Kato-Katz thick smears have been a major method for 30 years. It is simple, cheap and provides a quantitative result. However, the major concern about Kato-Katz technique is its low sensitivity in low intensity infections. Two studies found that underestimation was highest in those with lowest infection intensity (Yu et al., 1998; WHO, 2012). It is suggested that more sensitive tools other than those used in the assessments be applied especially for enhanced quality control.

There are several limitations in this study. First, sampling methods varied from province to province. Subjects selected were either top scorers out of simulation trainings and assessments in the province, or on a convenience and voluntary basis where manpower is not sufficient enough. Therefore, selection bias leads to unmeasurable results which may not be translatable to the professionals nationwide. Second, though scores of same helminths in terms of morphology, life cycle, epidemiology and diagnosis were fixed, test contents were different each year.

5. Conclusion

Routine diagnosis in most places remains with insensitive and non-specific parasitological tests for humans and with no diagnosis for animal reservoirs. With the new WHO goal to eliminate and eventually eradicate these diseases (Bergquist et al., 2009; Lier et al., 2009), accuracy of test results at the species level becomes crucial, the level of accuracy and precision needed should be guiding the algorithm. Besides, as a consequence of huge achievements in control of zoonotic trematodes, fewer cases with lower infection intensities are expected, which would influence the choice of tests[27]. Using a combination of tests is a well-known way of improving sensitivity and specificity despite having a limited budget. In order to improve test sensitivity and specificity further, the Kato-Katz could be assessed along with molecular methods or dip-stick ELISA[28]. It is recommended that be used to improve the assessment.

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