GEOGRAPHICAL DISTRIBUTION OF HEALTH WORKFORCES IN LAO PDR

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Abstract. The aim of this study was to establish a health management information system (HMIS) using GIS technology that concerns the distribution of health workforces in Lao PDR for management decision support. Data were primarily obtained from the Ministry of Health, and the Ministry of Planning and Investments, Lao PDR. Microsoft Access was used to create the database and manage all attribute data, and GIS applications were utilized to display the geographical distribution and cluster areas of health workforce density in 2011-2012 at district and provincial levels in Lao PDR. The results suggested that there was a geographical imbalance in health workforce within the country. Vientiane capital had the highest number of medical doctors; Attapue and Sekong had highest number of nurses and midwives among all provinces of Lao PDR. However, the numbers of all health workforces were still lower than standard threshold. Furthermore, the cluster analysis showed that there was no significant cluster of health workforces at provincial level, but was significant at the district level. Districts in central region seemed to have high clusters of medical doctors and midwives compared to Northern and Southern regions; whereas, high clusters of nurses were found in the Southern regions. The heath information database developed by this study would be valuable for Lao health management. The Ministry of Health, Lao PDR should establish collaboration among all departments for better data reporting system. GIS technology can illustrate the health resources in Lao PDR, which will be benefit for decision making and planning in the future.

Keywords: health workforces, geographical distribution, GIS, cluster analysis, Lao PDR

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INTRODUCTION

The health workforce is one of the core components of health systems that are required for improving health care access and quality. 'Health workforce' is defined as all people engaged in actions whose primary intent is to enhance health (WHO, 2006), including physicians,

nurses, midwives, dentists, allied health professions, community health workers and volunteers, social health workers and other health-care providers. Several countries globally have been identified as having critical shortages and maldistribution of health workforce (Sousa *et al*, 2012; Hazarika, 2013; Tandi *et al*, 2015; Zhou *et al*, 2015) that hinder progress towards the health Millennium Development Goals (MDG) and contribute to inequalities in health outcomes (Chen *et al*, 2004).

In Southeast Asia, the aggregate data suggest no critical shortage of health care workforce, with a regional average of 2.7 doctors, nurses, and midwives (combined) per 1,000 population. However, at a national level, five countries (Cambodia, Indonesia, Lao PDR, Myanmar, and Vietnam) fall below the critical shortage threshold of 2.28 doctors, nurses, and midwives per 1,000 population; with Lao PDR having only 1.2 doctors, nurses and midwives per 1,000 population (WHO, 2006; Kanchanachitra *et al*, 2011).

Over the past decade, Lao People's Democratic Republic (Lao PDR) has been experiencing minimal improvement in quantity and quality of health workforce to meet the demand of the increasing population, as well as uneven distribution of workforce. As a result, some people do not have adequate access to healthcare in the country and others still seek medical care in other countries. Since 1998, the number of health workers remained stagnant (12,481 to 12,422 in 2009) and has slightly increased to 14,189 in 2012 after implementation of the first National Health Personnel Development Strategy 2009-2020 by the Ministry of Health (MoH).

There are also shortages of middle and high level health workforces at primary and secondary health care facilities and a widening gap of quality of health care services between urban and remote rural areas (Lao PDR MoH, 2010). Highly educated staffs are concentrated in the urban area, whereas health centers and district hospitals that are close to the majority of people (more than 75%) still lack qualified health workers, in which 50% of health workers working in these areas hold vocational training certificates (the lowest level of higher education). The management and awarding of staff working in remote areas are also lacking; there was low motivation, conflict of interests and a lack of training and career development opportunities. Further aggravating the issue, Health Information System (HIS) in Lao PDR has not yet been adequately developed to provide high quality data. All health care data are recorded in paper-based form and scattered in different departments of the MoH, making it difficult to present the trends of health workforce distribution required for policy making (WHO, 2009).

Geographic Information System (GIS) is a data management system that stores, analyzes, and presents geographical information (Koutsopolos, 2005). It has been used by health professionals to support decision making and understand current public health issues, such as health service access difficulties and disparities in different geographical areas (Foley, 2002; Fradelos *et al*, 2014). GIS tools with spatial analysis on the distribution of health facilities and health care workers have been extensively studied in many regions, including Africa (Tanser *et al*, 2006; Abbas, 2012; Tandi *et al*, 2015), America (Beedasy, 2010; Rosero-Bixby, 2004), Asia (Murad, 2011; Shanmugasundaram *et al*, 2012; Pallikadavath *et al*, 2013) and Europe (Higgs and Gould, 2001; Foley, 2002). However,

Fig 1–Provincial map of Lao PDR.

few studies have been conducted and little is known about the geographical distribution of health workforces in Lao PDR.

The present study aimed to establish a health management information system (HMIS) and consolidate health information from various data sources under the MoH of Lao PDR. GIS tools are used to display the geographical distribution of health workforces in Lao PDR, which could be beneficial for generating reports, decision-making and strategic workforce planning.

MATERIALS AND METHODS

Study area

The Lao People's Democratic Republic (Lao PDR) is a land-locked country of 236,800 km^2 and has an estimated population of 6.4 million with the growth-rate of 2.1% in 2010. The country shares border with five counties namely China, Vietnam, Cambodia, Myanmar and Thailand with 17 provinces, 142 districts and 8,654 villages (Fig 1). In 2010, the density of population is 27 persons per km^2, 66.8% of the population lives in rural areas and has 49 officially recognized ethnic groups, each with different cultures, traditions and livelihood systems. Many of the minority ethnic groups live in remote, rural, and highland areas of the country (Lao PDR MoH, 2012). Lao PDR remains a low-income country in Southeast Asia; per capita gross domestic product (GDP) was USD 740 in 2008. However, the economic growth had rapidly increased since 1997. The proportion of people below the national poverty line had reduced from 45% in 1993 to 30.7% in 2005; while inflation averaged 7.1% between 2003 and 2007. However, the economic growth is not equally distributed in urban areas (Lao PDR MoH, 2013).

Data sources

All data were collected from multiple departments under the MoH of Lao PDR.

Data on number of all health workforce (including medical doctors, nurses, midwives, dentists, pharmacists, hygienists and physiotherapists) at district and provincial levels, and population data in 2011-2012 were collected from the Department of Organization and Personnel (DOP) and the Health Statistical Unit, Department of Planning and Finances (DPF). Geographical data of all administrative levels of Lao PDR in the form of shape file used as the base maps were collected from the National Statistic Center, Ministry of Planning and Investment.

Data analysis

Descriptive analysis. Health workforce density and distribution is one of the health system indicators according to the WHO Global Reference List of 100 core health indicators (WHO, 2015). The database was created with Microsoft Access (version 2010), which contained information regarding each province, such as the number of population and the number of all health workforce. Workforce density was determined as the numbers of all health workforces, medical doctors, nurses, and midwives per 10,000 population. All data were then exported as text files and integrated with the base map by Quantum GIS® (version 2.0.1 Dufour) to create the health workforce density map.

Cluster analysis. Local Indicator of Spatial Association (LISA), developed by Anselin (1995) was used to detect local spatial clusters (hot spots) of similar or dissimilar health workforce allocation values around a particular observation (Schabenberger and Gotway, 2005) in which local Moran's I detects spatial autocorrelation at the local scale; a spatial autocorrelation value must be derived for each area unit (Rogerson, 2001). There are four definitions of hot spots and cold spots as: a) High-High cluster (hot spots) refers to high rate in an area surrounded by high values of the neighboring area, b) Low-Low cluster (cold spot) refers to low rate in an area surrounded by low values of the neighboring area, c) Low-High cluster refers to low rate in an area surrounded by high values of the neighboring areas and d) High-Low cluster refers to high rate in an area surrounded by low values of the neighboring areas. The cluster analysis was performed by GeoDa 0.9 software. Fig 2 shows the conceptual framework of this study.

RESULTS

Descriptive analysis of health workforces

According to the Lao Statistics Bureau in 2012, Lao PDR had an estimated population 6,514,432 people with 236,800 km^2, with population density of 28 people per km^2, as shown in Table 1 (Lao Statistics Bureau, 2012). The Vientiane capital, not only had a smallest area, but also was the most crowded, in which the population density was 203 people per km^2, while the other 16 provinces were around 11-to-43 persons per km^2. In terms of the health workforce geographical distribution (Fig 3), Vientiane capital had the highest density of combined health workforce (44.08 per 10,000 population, Fig 3a), followed by Luangnamtha, Sekong, and Attapue (24.36, 33.77, 33.77 per 10,000 population, respectively). The lowest density was observed in Savannakhet Province (14.59 per 10,000 population), albeit having higher population than the Vientiane capital.

Fig 3b, 3c, and 3d present the number of medical doctors, nurses and midwives per 10,000 population in 2012, respectively. As anticipated, medical doctors are centrally located in Vientiane capital, making it the province with the highest

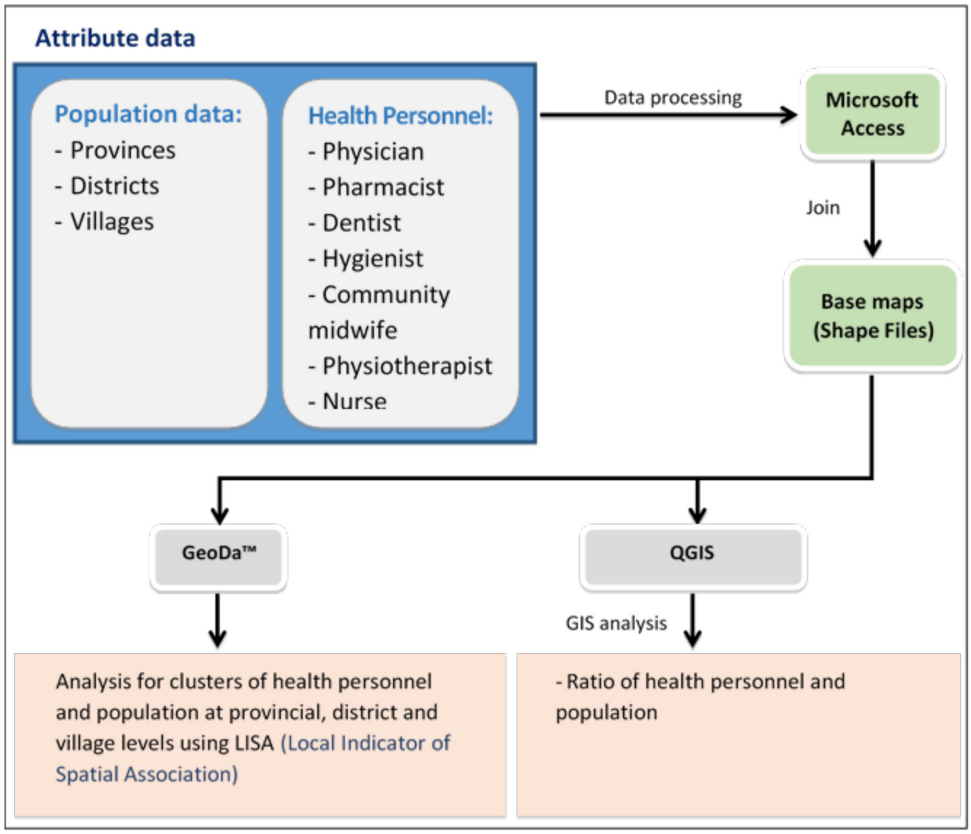

Fig 2–Conceptual frame work of the study.

number of medical doctors of all provinces (13.87 per 10,000 population), over 6 times as much as the surrounding provinces and was the only province with doctor density of more than 10 per 10,000 population. Of all provinces, only 3 had >3 doctors per 10,000 population. Nurse density was generally much higher than doctor density. Conversely, the highest nurse density was not found in Vientiane capital, but rather in Attapue and Sekong (14-to-16 nurses per 10,000 population). Excluding the two Southern provinces, variations of nurse density among all provinces were not so large (range: 6.29-11.17 nurses). As for midwives, most provinces had <1 midwives, with the exception of Sekong, Champasack, and Attapue (1.16, 1.2, and 1.27 per 10,000 population, respectively).

Cluster analysis of health workforces

The cluster analysis of health workforces at provincial level was first considered. Fig 4 shows the clustering of the ratios of health workforces to populations by province in 2012. There was no statistically significant cluster of all health workforces (Fig 4a) and medical doctors (Fig 4b) in any provinces of Lao PDR, suggesting equal distribution. Conversely, there was a significant Low-High cluster of nurses in Champasack Province, which was surrounded by provinces with high ratios of nurses (Fig 4c). For the midwives per 10,000 population (Fig 4d), two pat-

Table 1
Area and average mid-year population by province in 2005-2012.

Province		Area (km^2)	2005	2009	2010	2011	2012	Pop density/ km^2, 2012
1	Vientiane capital	3,920	698,318	754,384	768,743	783,032	797,130	203
2	Phongsaly	16,270	165,947	174,246	176,151	178,006	179,822	11
3	Luangnamtha	9,325	145,310	160,483	164,310	168,140	171,967	18
4	Udomxay	15,370	256,179	292,869	299,935	307,065	314,269	20
5	Bokeo	6,196	145,263	161,530	165,661	169,807	173,962	28
6	Luangprabang	16,875	407,039	439,504	447,541	455,532	463,485	27
7	Huaphanh	16,500	280,938	310,303	317,946	325,757	333,762	20
8	Xayabury	16,389	338,669	367,421	374,666	381,908	389,139	24
9	Xiengkhuang	16,358	229,596	263,697	269,887	276,242	282,769	17
10	Vientiane	22,554	388,895	46,745	480,440	493,593	506,881	22
11	Borikhamxay	14,863	225,301	256,371	264,513	272,794	281,207	19
12	Khammuane	16,315	337,390	367,904	375,504	383,099	390,701	24
13	Savannakhet	21,774	825,902	890,582	906,440	922,210	937,907	43
14	Saravane	10,691	324,327	358,041	366,723	375,517	384,438	36
15	Sekong	7,665	84,995	95,243	97,900	100,595	103,326	13
16	Champasack	15,415	607,370	643,686	652,552	661,358	670,112	43
17	Attapeu	10,320	112,120	124,194	127,285	130,402	133,545	13
	Whole country	236,800	5,621,982	6,127,910	6,256,197	6,385,057	6,514,432	28

terns of clustering were observed. There was a High-High cluster in Attapue Province, and 2 Low-Low clusters in Luangprabang and Xayabury Provinces.

Because no significant clusters of health workforce at provincial level were observed, clustering at district level was further examined. Fig 5a shows the locations of clusters of all health workforces per 10,000 population in 140 districts in 2011. Among 142 districts, 25 districts were in the significant clusters, of which 4 districts were in High-High clusters, 12 districts were in Low-Low clusters, 4 districts were in Low-High clusters, and 3 districts were in High-Low clusters. The results indicated the imbalanced distributions of health workforces at district level.

When considering only medical doctors, a noticeably unequal distribution was shown (Fig 5b). Twenty-five districts were in the significant clusters, where there were 13 districts in High-High clusters, 6 districts in Low-Low clusters, 1 district in Low-High clusters, and 3 districts in High-Low clusters. More medical doctors were occupied in the central districts of Lao PDR while districts in Northern and Southern regions had lower number of doctors. Nurses were also unevenly distributed (Fig 5c), high number was observed in Southern region and low in Central region. Twenty-two districts were in the significant clusters, *ie*, 5 districts in High-High clusters, 10 districts in Low-Low clusters, 3 districts in Low-High clusters, and 2 districts in High-Low clusters.

As for midwife density, there were 21 districts in the significant clusters; categorized as 5 districts in High-High clusters, 13 districts in Low-Low clusters,

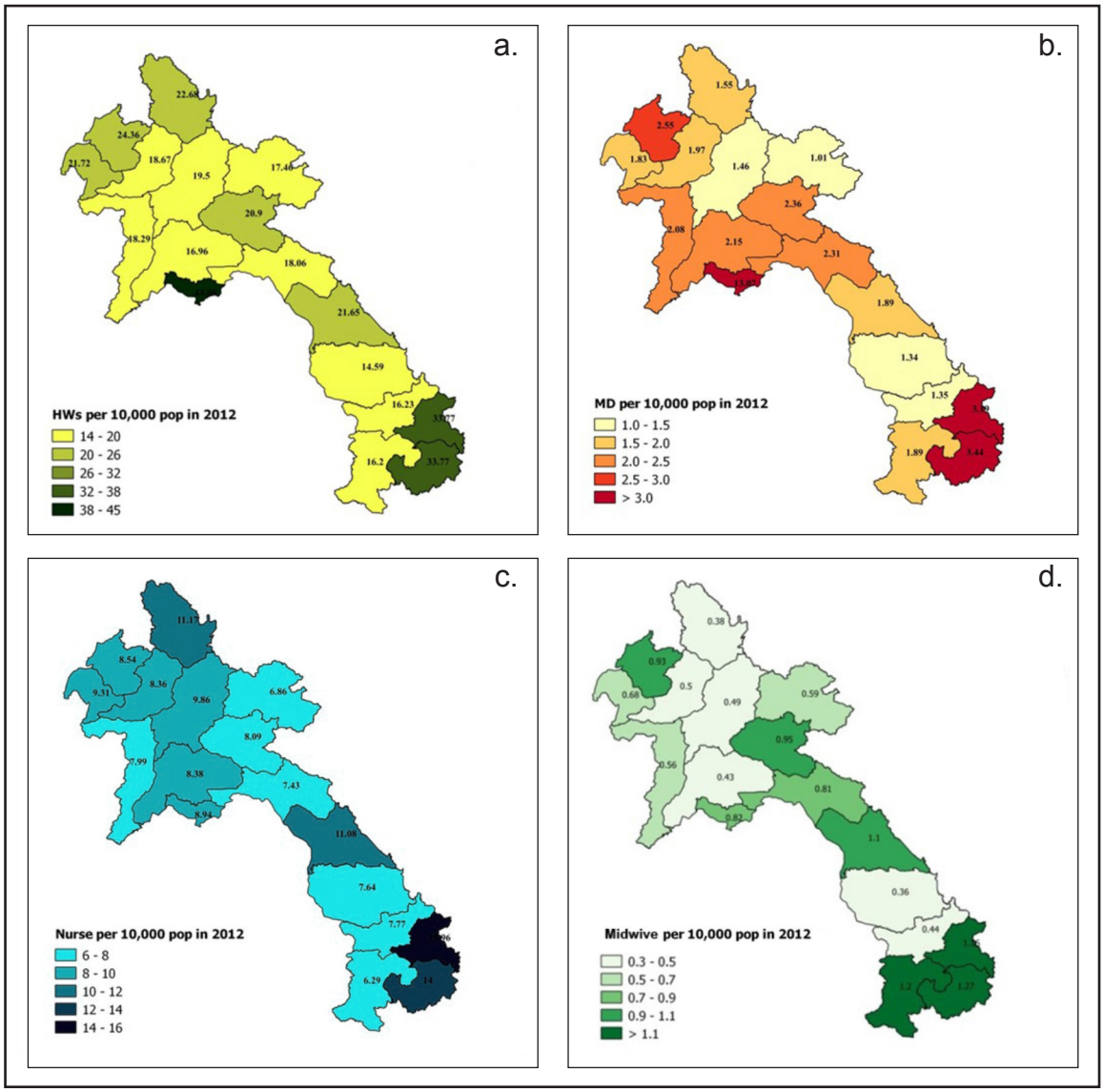

Fig 3–Density map of health workforces per 10,000 population at provincial level, Lao PDR in 2012: a) all health workforces , b) medical doctors , c) nurses, and d) midwives.

1 districts in Low-High clusters, and no districts in High-Low clusters (Fig 5d). Districts with low numbers of midwives were found in the Southern region, and surprisingly, 9 districts in Vientiane capital. Four districts in the Central region and 1 district in the Northern region had high numbers of midwives.

DISCUSSION

Health workforce plays an important role in ensuring proper healthcare system (Anand and Barnighausen, 2012); a shortage of workforce can hinder scale-up of health services and limit the capacity to absorb additional financial resources (Anand

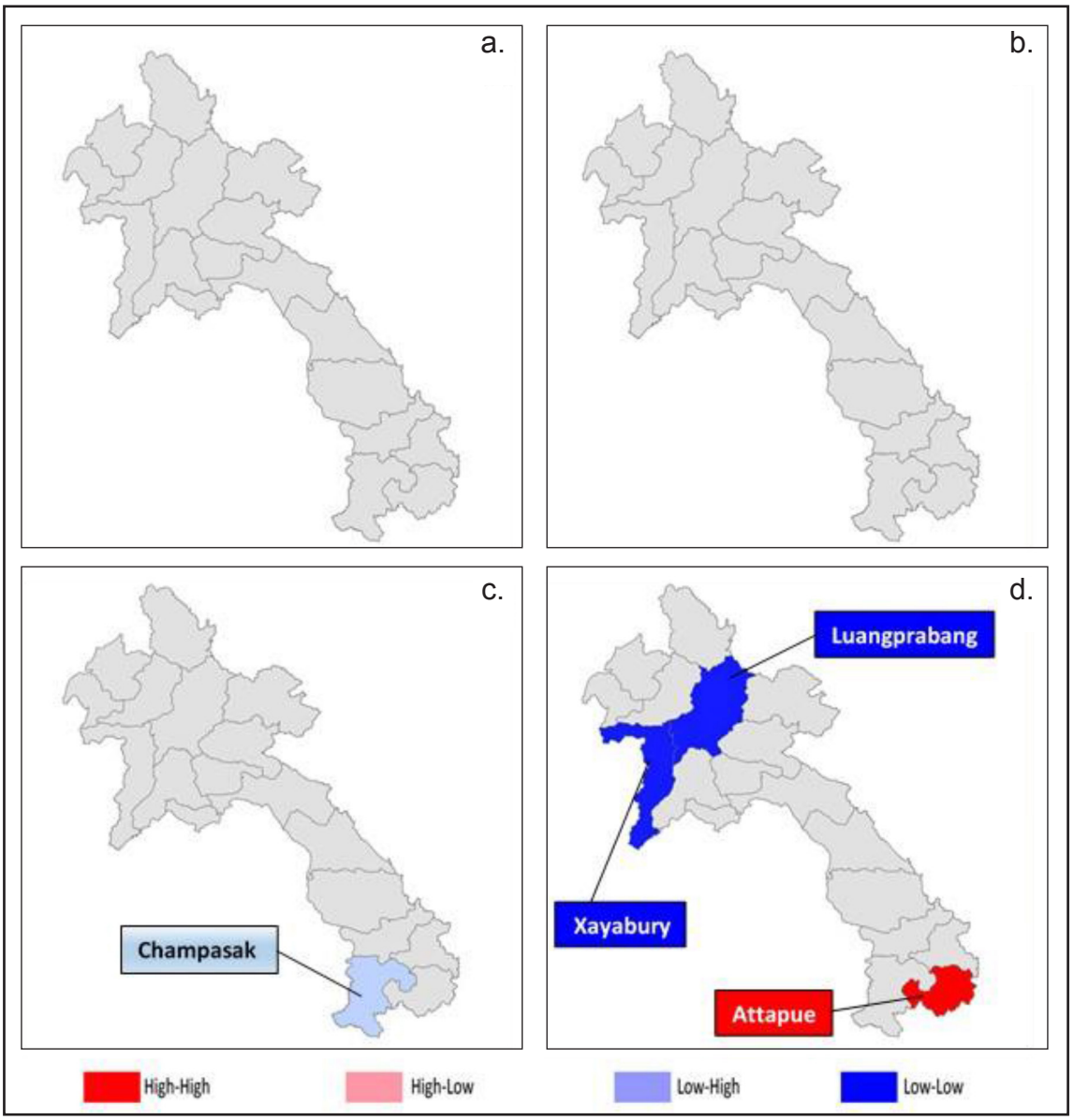

Fig 4–Cluster map of health workforces per 10,000 population at provincial level, Lao PDR in 2012 : a) all health workforces, b) medical doctors , c) nurses and d) midwives.

and Barnighausen, 2004). By having a clear understanding of the health workforce situation, workforce management policies can then be effectively developed. This study constructs the database system that incorporates information technology (IT) into health workforce at provincial and district levels of the country; illustrating the current situation of health workforce distribution. A health information system with a strong human resources component can provide evidence to allow planning appropriate distribution of health workers (WHO, 2010a).

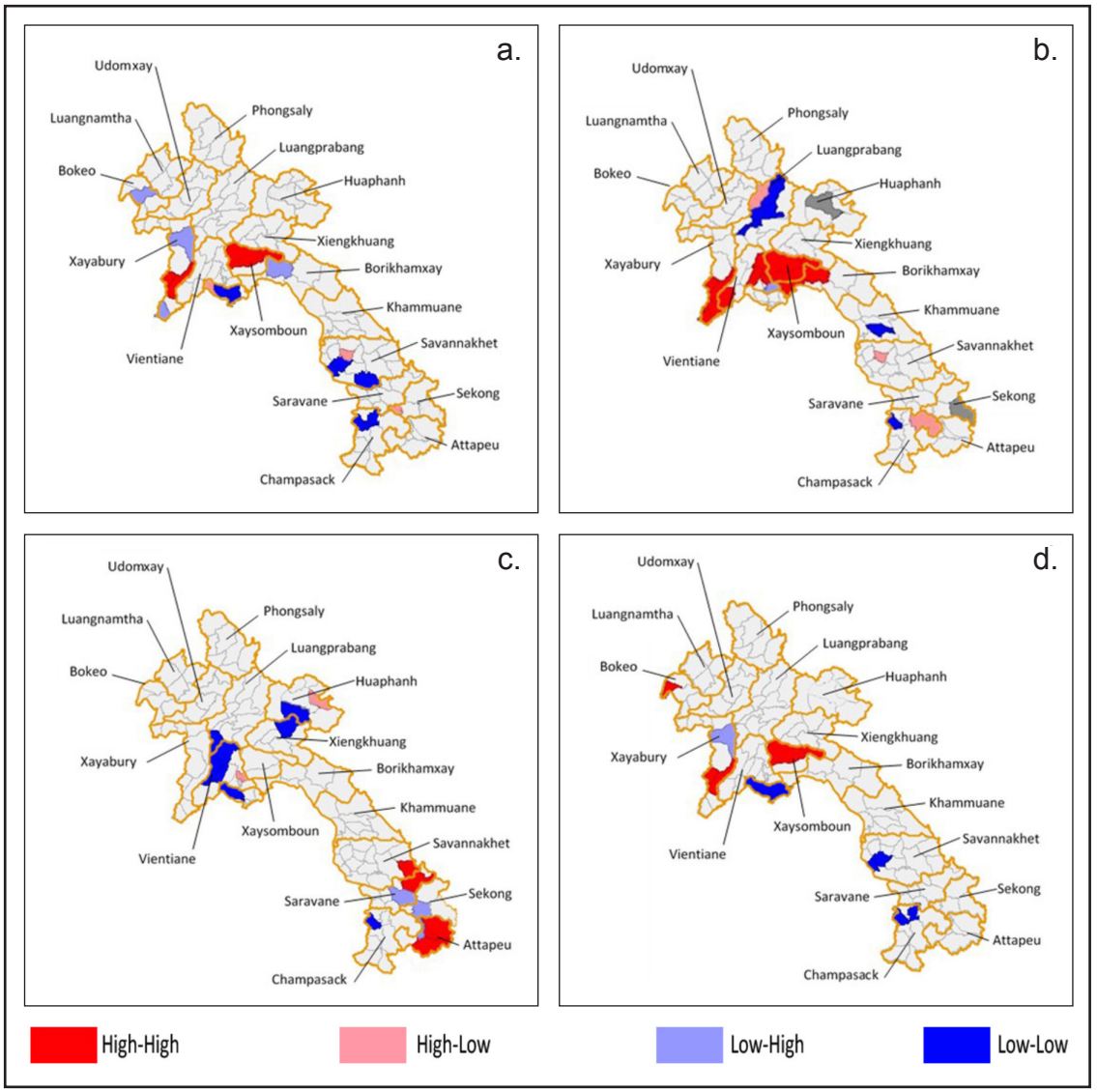

Fig 5–Cluster map of health workforces per 10,000 population at district level, Lao PDR in 2011 : a) all health workforces , b) medical doctors , c) nurses and d) midwives.

This study was the first to describe and display the geographical distribution of health workforces in Lao PDR by using GIS application. Findings depicted that Vientiane capital had the highest number of combined health workers, and also the highest number of medical doctors among all provinces of Lao PDR; whereas, the rest of the provinces had marginally similar numbers of doctors, with the lowest being Savannakhet. Excluding a few provinces, most did not meet the standard threshold of 23 combined health workers per 10,000 population (WHO, 2006) (Fig 3a). Furthermore, although the cluster analysis of all health workforces, and medical doctors per 10,000 population at provincial level showed no significant

clustering; however, there are markedly uneven clustering of health workforces at district level (Fig 5).

Therefore, policy makers should first prioritize sufficient relocation of medical doctors and higher quality medical staffs from economically endowed provinces to the Low-Low workforce districts cluster that tend to rely on low-level auxiliary nurses. Because less-developed provinces are likely to have lower levels of investments in health and health systems, training and recruitment and the retention of skilled health workers to rural and remote areas will remain a persistent challenge (Kanchanachitra *et al*, 2011; Hazarika, 2013). This illustrates the necessity of incentives for development of skilled health workers at the rural areas (Nishiura *et al*, 2004; Dussault *et al*, 2006; Dolea *et al*, 2010; Zhou *et al*, 2015).

Like other low-middle income countries, Lao PDR is facing common problems of unequal distribution of health workers density, especially doctors, nurses and midwives, which can be attributed to difference in health care facility infrastructure between regions, low production capacity, restricted capacity for employment of graduates, and inadequate financial incentives (Kanchanachitra *et al*, 2011). By providing generous annual vacation times and promising regular weekly work schedules (Thornton and Esposto, 2003), rather than increasing earnings, these conditions may ameliorate the shortage of primary care physicians and equalize the distribution in rural areas. In addition, collaborative actions between the government, stakeholders, professionals, and international partners should be taken to direct policies that will address key issues for human resource improvement (Tandi *et al*, 2015). These are in line with the recommended WHO measures for increasing access of health personnel to underserved areas (WHO, 2010b).

The limitations of the study must be noted. The health data obtained were recorded in paper-based form in the different departments under the MoH. The scattering of data made it difficult to track the resources accurately, and thus highlight the urgent need for the electronic version of those data. Furthermore, this study was limited to the health workforce in public sector. To represent the overall health systems, it is important to include other sectors such as private or non-governmental sectors (Tandi *et al*, 2015). Future study may well aim to complete the health information database of Lao PDR by collecting sufficiently large amounts of data from the private sectors through rigorous surveys.

This study developed the health workforce database of Lao PDR, which is a valuable health information system that display the current health delivery system in Lao PDR and can be useful for further management of workforce. The GIS was demonstrated to be effective at analyzing and displaying the health workforce indicators at both provincial and district levels of Lao PDR. Through the analysis of current socio-economic status and human resources for health development, and based on the policies and the strategies of the Ministry of Health, it is necessary to strengthen the skills and knowledge of all existing health personnel at all levels in the health care system. In particular, districts in rural and remote areas should aim to improve all health service in both preventive and curative ways, and to alleviate the poverty of Laos people. Hence, the priority with respect to health personnel in Lao PDR is not only to increase their quantity, but also improve the quality of the care they delivered. In addition,

there will need to be efforts to improve the distribution of health care workers, particularly to remote regions.

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