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RESEARCH ARTICLE

# Correspondence Analysis of the Global Epidemiology of Cutaneous and Visceral Leishmaniasis

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## ABSTRACT

Cutaneous leishmaniasis is mostly prevalent in the western and central Asia, North Africa, Southeastern Europe, Central and South America while visceral leishmaniasis is most prevalent in Central, South and Western Asia, the Mediterranean countries, East Africa, Southeastern Europe and South America. Result from the correspondence analysis showed that the number of reported cases of cutaneous leishmaniasis is increasing moderately while visceral leishmaniasis is increasing slightly. The plots showed that countries that are clustered together have similar trend while isolated countries have irregular trend.Correspondence analysis has helped to reveal many hidden patterns of the data and the models are significant even with though the model was able to explain small amount of variation of the data. The research concluded with some suggested policy statements and recommendation.

**Keywords:** Leishmaniasis, cutaneous, visceral, epidemiology, correspondence analysis, risk factors

## INTRODUCTION

**Disease Profile:** Leishmaniasis which can be mainly classified into cutaneous, mucocutaneous or visceral, is a disease caused by protozoan parasite of the genus *Leishmania* (which are of over 20 species), and spread by the bite of certain species of sandflies (W.H.O., 2015). Also contained in the W.H.O. (2015) is some basic information about leishmaniasis which states that Visceral leishmaniasis (VL) is the most serious form of the disease and is often known as *Kala-azar* while Cutaneous leishmaniasis (CL) is the most common. Mucocutaneous leishmaniasis (ML) can manifest in form of ulcers of the mouth, nose and the throat, cutaneous leishmaniasis can cause severe ulcers, skin

lesions and disability to the host, while visceral leishmaniasis has high fatality rate if left untreated and can manifest as fever, enlargement of the spleen and liver, anaemia, etc. (Barrett & Croft, 2012; W.H.O., 2015; Wikipedia, 2015).
The disease risk factors which have been on the increase include: poverty, illiteracy, malnutrition, rapid urbanization, deforestation, irrigation, construction of dams (Desjeux, 2001a, 2001b; W.H.O., 2015; Wikipedia, 2015). Suggested measures to reduce the exposure include sleeping with treated nets, spraying insecticides, and early diagnosis and treatment (W. H. O., 2015).

### Epidemiology

According to the World Health Organization fact file on leishmaniasis (2015).
a). An estimated 1.3 million cases of leishmaniasis and between 20,000 to 30,000 deaths occur annually.
b). 90% of new cases of visceral leishmaniasis occurs in 6 countries; Bangladesh, Brazil, Ethiopia, India, South Sudan and Sudan.c). 95% of new cases of cutaneous leishmaniasis occurs in the Americas, Mediterranean, the Middle East and Central Asia. The most endemic countries are Afghanistan, Algeria, Brazil, Colombia, Iran and Syria.

Yamey (2002) listed leishmaniasis as one of the neglected diseases. The disease is mainly endemic in tropical and subtropical regions. Many researchers have written about the epidemiology, outbreak, prevalence, monitoring, control, trend, distribution, management and treatment of leishmaniasis. Some selected epidemiologic chronologies of leishmaniasis are listed to highlight the prevalence and the review of the literature over time. The disease was reported in Greece (Malamos, 1946)**,**a review of the outbreak and prevalence of leishmaniasis in Africa (Kirk, 1956).The epidemiology of Leishmaniasis havebeen studied based on research findings of researchers at/from/in or on East Africa (Southgate, 1964), Sudan (Cahill, 1964), French Guiana (Pajut et al, 1982), Jordan (Schlein & Gunders, 1982), Nicaragua (Garfield, Frieden &Vermund, 1987), Syria (Ashford et al, 1993), Algeria (Harrat et al, 1995), Texas in the US (McHugh, Melby & LaFon, 1996), Turkey (Ok et al, 2002), West Bank (Abdeen et al, 2002), Burkina Faso (Guiguemdé et al, 2003), Iraq (Gani, Kadhum Hassan & Jassim, 2010), Spain (Gil-Prieto et al, 2011), Middle East (Salam, Al-Shaqha & Azzi, 2014) The Cutaneous leishmaniasis prevalence, outbreak and epidemiology have appear in many literature such as: the republic of Panama (Calero & Johnson, 1953), South Australia (Sanderson, 1961), Iran (Seyedi-Rashti & Nadim, 1967), Ethiopia (Lemma et al, 1969), Sudan (Abdalla et al, 1973), Afghanistan (Nadim & Rostami, 1974), Greece (Stratigos et al, 1980), Guyana (Low-Chee, Rose & Ridley, 1983), Saudi Arabia (Al-Gindan, Abdul-Aziz & Kubba, 1984), Egypt (Fryauff et al, 1993), Northeast Pakistan (Rowland et al, 1999),Venezuela (Rodriguez et al, 2002), Northern Tunisia (Belhadj et al, 2003), Morocco (Ramaoui, Guernaoui & Boumezzough, 2008), Iraq (AlSamarai & AlObaidi, 2009), Iran (Karami, Doudi & Setorki, 2013), Sri Lanka (Sandanayaka et al, 2014).Visceral leishmaniasis prevalence, outbreak and epidemiology have appear in many literature such as: the Mediterranean region (Pampiglione et al, 1974), Kenya (Ho et al, 1982),Italy (Gradoni et al, 1983), Ethiopia (Ayele & Ali, 1984),Colombia (Corredor et al, 1989), Northeast Brazil (Evans et al, 1992), Southern Sudan (Seaman, Mercer & Sondrop, 1996),France (Minodier et al, 1998), India (Bora, 1999), Malta (Grech et al, 2000), India (Singh et al, 2006), Bangladesh (Bern et al, 2007), Nepal (Bhattarai et al, 2010), Brazil (Marcondes & Rossi, 2014), Georgia (Babuadze et al, 2014), China (Zhao et al, 2015).

Rab, Frame and Evans (1995) observed that dogs play an important role in the epidemiology of visceral leishmaniasis. See Mohebali et al (2001) for the seroepidemiological study of visceral leishmaniasis among humans and animals. Leishmaniasis can be co-infected with HIV (Desjeux &Alvar, 2003)**.** Alvar et al (2012) reviewed the global incidence, prevalence and epidemiology of cutaneous and visceral leihmaniasis while Ready (2014) wrote extensively on the epidemiology of visceral leishmaniasis.

## METHODOLOGY

Statistical tools are indispensable in the understanding of epidemiology. An exploratory or inferential analysis of epidemiological or seroepidemiological data is used for the proper understanding of the causation, profiling,

prevalence, outbreak, isolation, monitoring and control of identified diseases. Statistical methods have been applied in the study of the epidemiology of diseases including cutaneous and visceral leishmaniasis. Some of the selected methods include: spatial analysis of CL and VL (Franke et al, 2002), spatial analysis for VL (Werneck et al, 2002; Correa Antonialli, et al, 2007), generalized linear spatial models in the epidemiology of CL (Ben-Ahmed, Bouratbine & El-Aroui, 2010), spatial distribution and cluster analysis of leishmaniasis outbreak of CL and VL (Barroso et al, 2015), spatial analysis for identification of priority areas (Barbosa et al, 2014), spectral analysis of epidemiological data (Cazelles et al, 2007), Muti-level modeling of VL (Werneck et al, 2007), Bayesian Geostatistical modeling (Karagiannis et al, 2013), prediction of high risk areas using remote sensing (Almeida & Werneck, 2014).
This research is concerned with the use of statistical method called correspondence analysis to explore the global epidemiology of cutaneous and visceral leishmaniasis. The reasons for the use of correspondence analysis for epidemiological data can be seen in the works of Sourial et al (2010) and Zalewska et al (2013). Multiple correspondence analysis (MCA) has been applied in the analysis of epidemiological data (Van der Burg, De Leeuw & Verdegaal, 1988). Loslever & Ranaivosoa (1993) applied multiple correspondence factor analysis to biomechanical and epidemiological data. Leibovici, Curtis & Ritchi ( 1995) applied factorial correspondence analysis to disability data obtained from epidemiological survey. Verzini et al (1995) advocated the use of multiple correspondence factorial analysis to detect risk groups in epidemiological research. Calavas et al (1998) realized a typology of clinical udder disease of nursing ewe flocks by using MCA and Ascending Clustering. Correspondence Factor analysis was applied to investigate the relationship between the age and gender of patients, and changes in their urinary stone compositions (Daudon et al, 2004). See (Rennie & Roberts, 2009) for the application of MCA to epidemiological study of tuberculosis. MCA was also to explore dietary patterns and their links to urinary tract tumors in a epidemiology study (Andreatta et al, 2010). Van Specht et al (2014) analyzed epidemiological data using multiple correspondences and Cluster analysis. MCA was used as a statistical method to establish typologies of epidemiological data of suicide prevalence (Ortega et al, 2014). Hendry et al, (2014) applied subset correspondence analysis to epidemiological data.

Details of the theory and applications of correspondence analysis can be found in Greenacre (1984), Clausen (1988), Benzecri (1992), Doey & Kurta (2011). The datawas retrieved from the World Health Organization repository at http://apps.who.int/gho/data/node.main.NTDLEISH?lang=en. The collected data was organized as the number of reported cases of the both types of the disease.

**Reasons for using correspondence analysis**

Not all the countries were selected for analysis; this is to a control against violating the strict conditions of correspondence analysis. See Doey & Kurta (2011) for details. For this reason, only 26 countries were selected for analysis for cutaneous leishmaniasis while 24 countries were selected for analysis for visceral leishmaniasis. This can be classified as subset correspondence analysis. The number of reported cases is discrete and the population is dichotomous; it is either that a case is reported or not. This can be analyzed as a yes or no questionnaire where the researcher may choose to analyze only yes or no separately. Even when the number of cases is continuous, the data may be discretized by classification. The correspondence model uses chi-square as the measure of distance which takes care of non-discretization. Correspondence analysis measures the trend taking into consideration of the variations of different dimensions, using only the descriptive to explain the trend may yield misleading results. Correspondence analysis is applied to this research to make sense out of the data that are big, confusing and vague.

## RESULTS

We are not looking at the relationship between the countries and the years, but a graphical interpretation of the trend and the general prevalence among the countries. For that reason, biplots are excluded from the analysis.

**Epidemiology of cutaneous leishmaniasis of the selected countries.**

The selected countries are Afghanistan AFG, Algeria ALG, Argentina ARG, Azerbaijan AZE, Brazil BRA, Colombia COL, Ecuador ECU, Guatemala GUA, Guyana GUY, Honduras HON, Iran (Islamic Republic) IRN, Iraq IRQ, Jordon JOR, Mexico MEX, Morocco MOR, Nicaragua NIC, Pakistan PAK, Panama PAN, Paraguay PAR, Peru PER, Saudi Arabia SAU, Syria SYR, Tunisia TUN, Uzbekistan UZB and Yemen YEM. Analysis from **table 1** shows that the model is highly significant at the 0.000 level with an alpha of 0.05 and chi-square value of 196919.22. The total variance explained is 12%. Dimensions 3 to 8 are almost insignificant because they account for little of the total inertia explained. The trend of the cutaneous leishmaniasis has been on a steady increase for the selected countries as shown in **figure1.**

The countries grouped together have a similar trend; for example looking at the W.H.O. data on cutaneous leishmaniasis, we discover that the number of reported cases of the disease is decreasing in the four countries grouped together in **Plot 1**; those countries are Algeria, Guatemala, Pakistan and Tunisia.

**Epidemiology of visceral leishmaniasis of the selected countries.**

The selected countries are Algeria ALG, Azerbaijan AZE, Bangladesh BAN, Brazil BRA, China CHI, Colombia COL, Ethiopia ETH, Greece GRE, India IND, Iran (Islamic Republic) IRN, Iraq IRQ, Italy ITA, Morocco MOR, Nepal NEP, Paraguay PAR, Portugal POR, Saudi Arabia SAU, South Sudan SSU, Sudan SUD, Syria SYR, Tajikistan TAJ, Tunisia TUN, Turkey TUR and Uzbekistan UZB.

The countries grouped together have a similar trend; for example looking at the W.H.O. data on visceral leishmaniasis, we discover that the number of reported cases of the disease is decreasing steadily in the two countries grouped together in **Plot 2**; those countries are Bangladesh and Colombia. The isolated South Sudan is because the data does not follow a particular trend.

**Epidemiology of cutaneous leishmaniasis in the continents**

All the 26 selected countries are grouped into 5 continents namely Africa AFR, Asia ASI, Europe EUR, North and Central America NCA and South America SAM.

Analysis from **table 3** shows that the model is highly significant at the 0.000 level with an alpha of 0.05 and chi-square value of 196919.22. The total variance explained is 4%. Dimensions 3 and 4 are almost insignificant because they account for little of the total inertia explained.

The data of Africa does not follow a particular trend while the number of reported cases is on decline in North and Central America and South America. The number of reported cases of cutaneous leishmaniasis is on the rise in Asia and Europe as shown in **Plot 3.**

**Epidemiology of visceral leishmaniasis in the continents**

All the 24 selected countries are grouped into 4 continents namely Africa AFR, Asia ASI, Europe EUR and South America SAM.

Analysis from **table 4** shows that the model is highly significant at the 0.000 level with an alpha of 0.05 and chi-square value of 30669.72. The total variance explained is 6.6%. Dimension 3 is insignificant because they account for little of the total inertia explained. The number of reported cases of VL is decreasing in Europe and South America. There is no particular trend in Africa and Asia as shown in **Plot 4.**

**The epidemiological study of the 6 most endemic countries of cutaneous leishmaniasis**

The 6 most endemic countries are Afghanistan AFG, Algeria ALG, Brazil BRA, Colombia COL, Iran (Islamic Republic) IRN and Syria SYR.

The number of reported cases of CL is decreasing steadily in Colombia and Brazil and increasing rapidly in Syria while decreasing rapidly in Algeria as shown in **Plot 5.**

**The epidemiological study of the 6 most endemic countries of visceral leishmaniasis**

The 6 most endemic countries are Bangladesh BAN, Brazil BRA, Ethiopia ETH, India IND, South Sudan SSU and Sudan SUD.

The number of reported cases of VL is decreasing slightly in Brazil and India and rapidly in Bangladesh while South Sudan does not follow a particular trend as shown in **Plot 6.**

**Some selected countries affected by both cases of leishmaniasis**

The selected countries that reported both cases of leishmaniasis are Algeria, Azerbaijan, Brazil, Colombia, Iran, Iraq, Morocco, Paraguay, Saudi Arabia, Syria, Tunisia, Turkey and Uzbekistan.

## DISCUSSION

The plots 1 to 6 are arranged in such a way that countries that are grouped together have similar trend; the trend may be constant, increasing rapidly, moderately or slightly or decreasing rapidly, moderately or slightly. Countries that are isolated in the plots have an irregular trend. The number of reported cases of CL is increasing while the number of reported cases of VL is increasing slightly after some years of decline and the same result was obtained when the countries were collapsed into 4 continents. The trend of the cutaneous leishmaniasis has been on a steady decrease for the continents of the selected countries but this result can be discarded since the total variance explained from the model is 4% compared with 12% when the data was analyzed from the countries without grouping them into the continents.The grouping had reduced the significant of the model. The reported cases of CL are also increasing in the 6 most endemic countries while the reported cases of VL are increasing slightly in the 6 most endemic countries. The trend is also on the decline for some countries that have reported both CL and VL.

**Policy Statements and Recommendations**

Efforts must be intensified to reduce the risk factors that act as breeding grounds for the diseases. The following statements can serve as policy and can serve as a guide to the policy makers of the most endemic countries. **Bangladesh:** Efforts should be intensify in providing quality education, reducing extreme poverty and distribution of treated nets to the remote rural areas. **Brazil:** Measures should be in place to reduce deforestation and illegal logging in the Amazon. The rapid urbanization and construction of more dams to meet the power needs of the rapidly growing economy is expected to increase the risk factors of both CL and VL in the country. **Ethiopia:** Draught, poverty, illiteracy, inadequate health facilities and increased irrigation because of draught are some of the factors that can determine the future trend of VL in the country. **India:** Rapid urbanization and increased irrigation to meet the demands of the increasing population are some of the major factors that may determine the trend of VL in the country **South Sudan and Sudan:** Poverty, illiteracy, lack of adequate health facilities as a result of political instability are the main risk factors. Also the volatile Darfur region is being plagued by draught, extreme deforestation and desertification. Internally displaced camps are also vulnerable

to all sorts of diseases, in some case, people sleep outside their tents without using treated nets. Massive irrigation at the Nile is also a major risk factor that can help in the spread of VL in the countries. Actual information on the actual prevalence may not be possible because of the ongoing civil war and political instability and researchers may use estimates which may not reflect the true picture of the prevalence of the disease. **Afghanistan:** Poverty, illiteracy, insecurity and inadequate health facilities as a result of extremism and political instability are major risk factors. Also refugee camps are also vulnerable to diseases because of bad sanitary conditions, overcrowding and dearth of qualified medical personnel.**Algeria:** Illiteracy, deforestation, insecurity, extreme poverty and malnutrition have to be tackled in order to reduce the trend. **Colombia:** Years of civil war have affected the medical facilities and lack of infrastructure in the remote villages cut off by the civil war is also a major risk factor. Also deforestation caused by pulling down trees as a source of fuel is a major risk factor here. **Iran:** Years of isolation and international sanctions have resulted to inadequate medical facilities and illiteracy, poverty and natural disasters have also contributed to the increased number of reported cases**Syria:** CL is expected to rise drastically if the crisis in the country is not controlled. Destruction of natural habitat, infrastructure, medical facilities and insecurity are the key risk factors. Also camps for displaced persons and refugees are also vulnerable because of insecurity, lack of treated nets, overcrowding, poor sanitary conditions and dearth of medical personnel. Also the countries hosting refugees from Syria are expected to have an increase of the reported cases

## CONCLUSION

Correspondence analysis is used to explore the epidemiology of Cutaneous and visceral leishmaniasis. Different trends and prevalence of the disease were shown and some policy statements were made as recommendations on possible ways to reduce the number of reported cases of the disease.

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**Table 1. Summary table for CL of the selected countries.**

| Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dimension | Singular Value | Inertia | Chi Square | Sig. | Proportion of Inertia | | Confidence Singular Value | |
| | | | | | Accounted for | Cumulat-ive | Standard Deviation | Correlation 2 |
| 1 | .258 | .067 | | | .552 | .552 | .001 | .158 |
| 2 | .181 | .033 | | | .269 | .821 | .001 | |
| 3 | .096 | .009 | | | .076 | .897 | | |
| 4 | .071 | .005 | | | .041 | .938 | | |
| 5 | .059 | .004 | | | .029 | .967 | | |
| 6 | .046 | .002 | | | .017 | .984 | | |
| 7 | .035 | .001 | | | .010 | .995 | | |
| 8 | .025 | .001 | | | .005 | 1.000 | | |
| Total | | .121 | 196919.122 | .000[a] | 1.000 | 1.000 | | |
| a. 200 degrees of freedom | | | | | | | | |

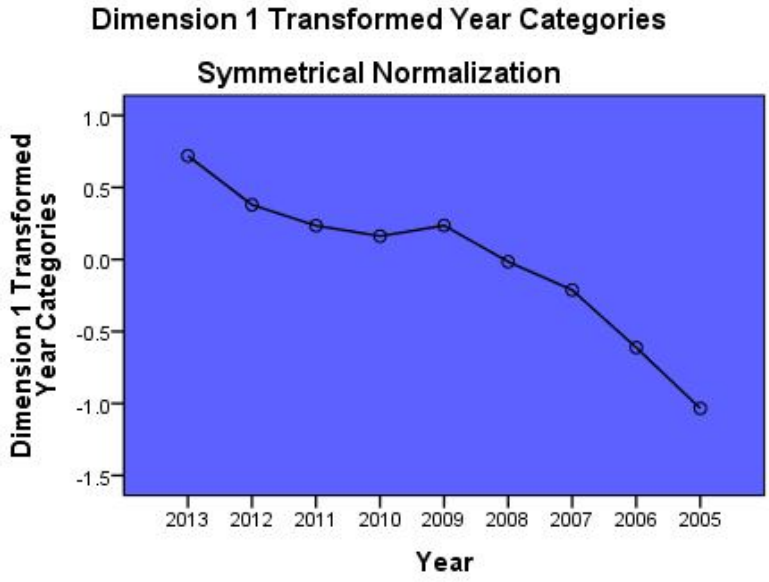
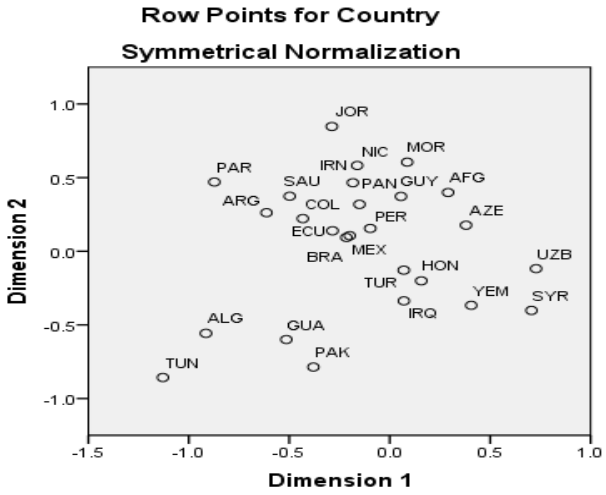



Figure 1. The trend of CL of the selected countries.

**Figure 1.The trend of the cutaneous leishmaniasis has been on a steady increase for the selected countries**




Plot 1 A plot of the CL of the selected countries.

**Table 2 Summary table for VL of the selected countries**.

| Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dimension | Singular Value | Inertia | Chi Square | Sig. | Proportion of Inertia | | Confidence Singular Value | |
| | | | | | Accounted for | Cumulative | Standard Deviation | Correlation 2 |
| 1 | .291 | .085 | | | .740 | .740 | .001 | .087 |
| 2 | .127 | .016 | | | .140 | .880 | .001 | |
| 3 | .090 | .008 | | | .072 | .952 | | |
| 4 | .056 | .003 | | | .028 | .979 | | |
| 5 | .038 | .001 | | | .013 | .992 | | |
| 6 | .025 | .001 | | | .005 | .997 | | |
| 7 | .014 | .000 | | | .002 | .999 | | |
| 8 | .009 | .000 | | | .001 | 1.000 | | |
| Total | | .114 | 53508.515 | .000[a] | 1.000 | 1.000 | | |
| a. 184 degrees of freedom | | | | | | | | |
| Analysis from **table 2** shows that the model is highly significant at the 0.000 level with an alpha of 0.05 and chi-square value of 53508.5. The total variance explained is 11%. Dimensions 3 to 8 are almost insignificant because they account for little of the total inertia explained. | | | | | | | | |

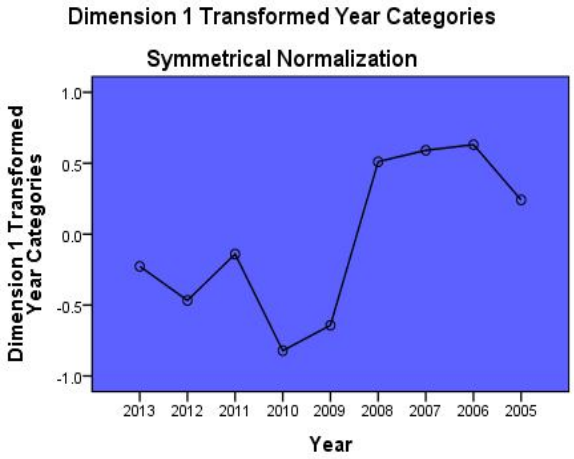
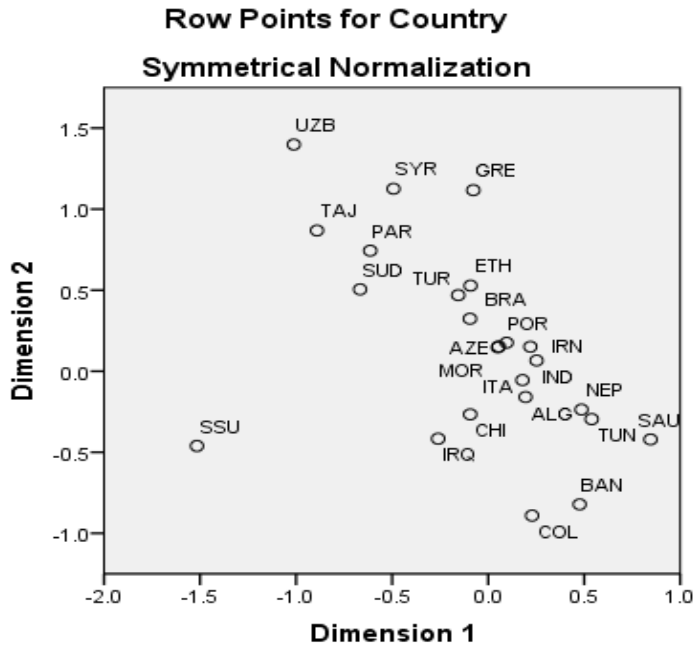



Figure 2 The trend of VL of the selected countries.

**Figure 2.The trend of the visceral leishmaniasis has been on a slight increase after some years of sharp decrease for the selected countries.**




Plot 2 A plot of the VL of the selected countries.

**Table 3 Summary table of CL of the continents.**

| Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dimension | Singular Value | Inertia | Chi Square | Sig. | Proportion of Inertia | | Confidence Singular Value | |
| | | | | | Accounted for | Cumulative | Standard Deviation | Correlation 2 |
| 1 | .195 | .038 | | | .859 | .859 | .001 | .090 |
| 2 | .069 | .005 | | | .109 | .968 | .001 | |
| 3 | .034 | .001 | | | .025 | .993 | | |
| 4 | .017 | .000 | | | .007 | 1.000 | | |
| Total | | .044 | 71773.809 | .000[a] | 1.000 | 1.000 | | |
| a. 32 degrees of freedom | | | | | | | | |

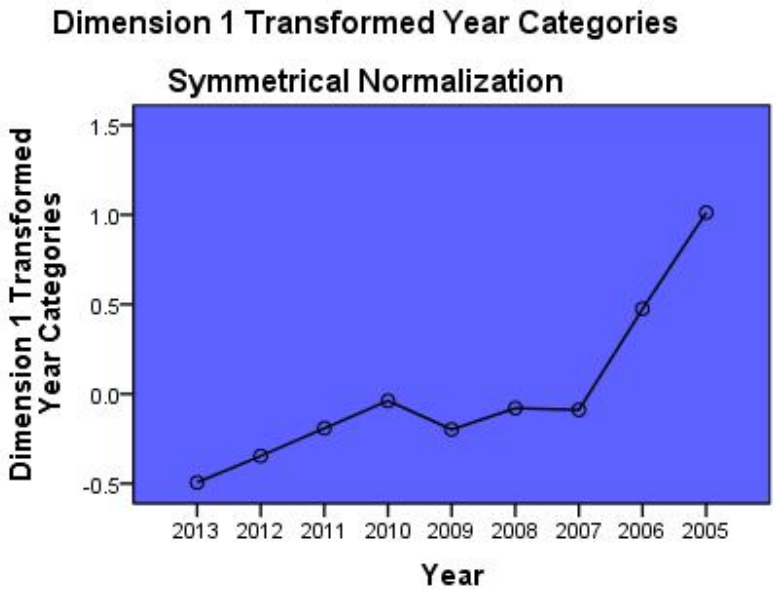
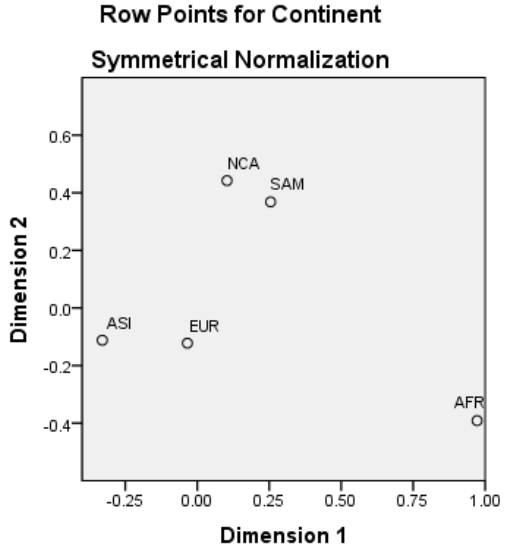



Figure 3 The trend of CL for the continents

**Figure 3.The trend of the cutaneous leishmaniasis has been on a steady decrease for the continents of the selected countries**




Plot 3 A plot of the CL for the continents.

**Table 4. Summary table of VL of the continents.**

| Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dimension | Singular Value | Inertia | Chi Square | Sig. | Proportion of Inertia | | Confidence Singular Value | |
| | | | | | Accounted for | Cumulative | Standard Deviation | Correlation 2 |
| 1 | .250 | .062 | | | .950 | .950 | .001 | .022 |
| 2 | .056 | .003 | | | .048 | .998 | .002 | |
| 3 | .012 | .000 | | | .002 | 1.000 | | |
| Total | | .066 | 30669.721 | .000[a] | 1.000 | 1.000 | | |
| a. 24 degrees of freedom | | | | | | | | |

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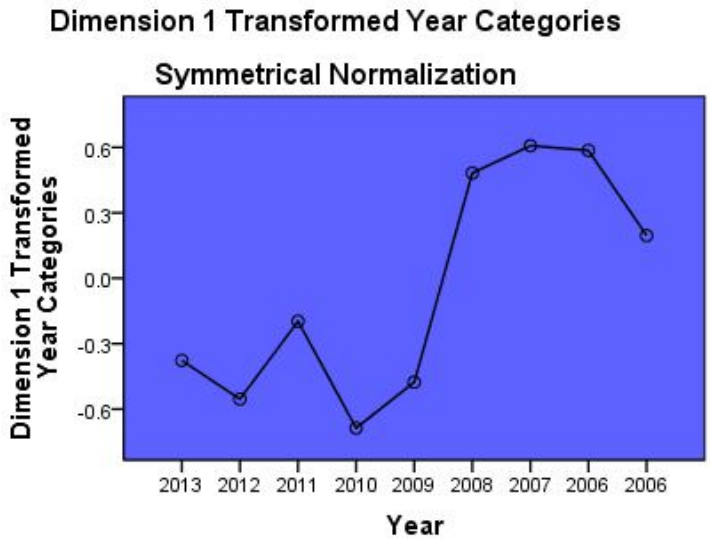
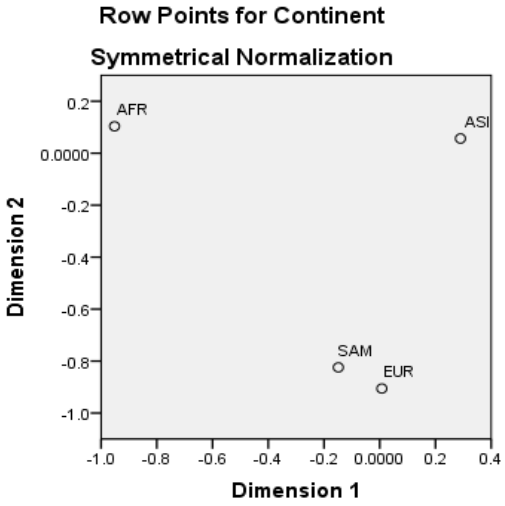



Figure 4 The trend of VL for the continents.

**Figure 4.The trend of the visceral leishmaniasis has been on a slight increase after many years of steady decline across the continents of the selected countries.**




Plot 4 A plot of the VL for the continents.

**Table 5 Summary table of the countries mostly affected by CL.**

| Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dimension | Singular Value | Inertia | Chi Square | Sig. | Proportion of Inertia | | Confidence Singular Value | |
| | | | | | Accounted for | Cumulative | Standard Deviation | Correlation 2 |
| 1 | .267 | .072 | | | .694 | .694 | .001 | .198 |
| 2 | .165 | .027 | | | .264 | .957 | .001 | |
| 3 | .048 | .002 | | | .022 | .980 | | |
| 4 | .043 | .002 | | | .018 | .997 | | |
| 5 | .017 | .000 | | | .003 | 1.000 | | |
| Total | | .103 | 126897.685 | .000[a] | 1.000 | 1.000 | | |

a. 40 degrees of freedom

Analysis from **table 5** shows that the model is highly significant at the 0.000 level with an alpha of 0.05 and chi-square value of 126897.6. The total variance explained is 10%. Dimensions 3 to 5 are almost insignificant because they account for little of the total inertia explained.

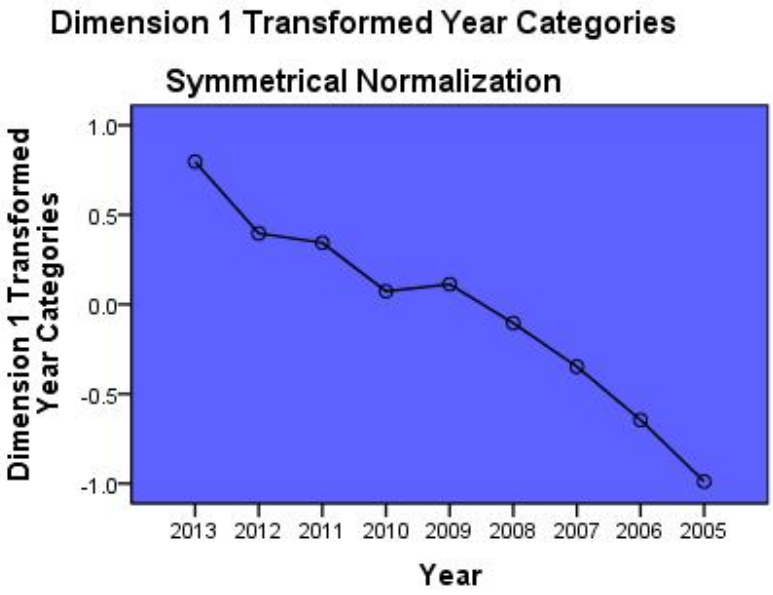
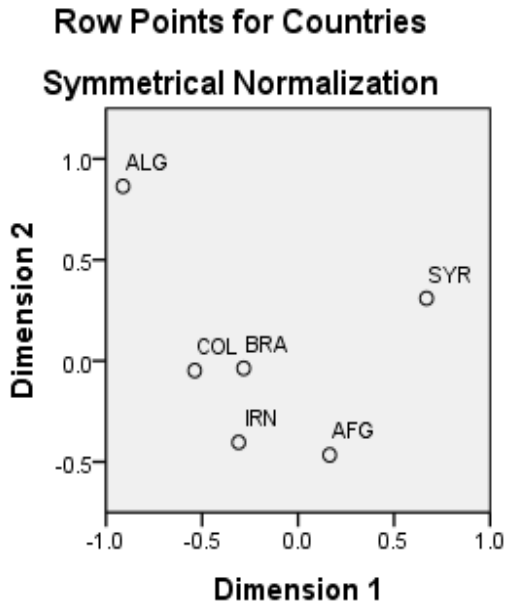



Figure 5 The trend of the CL of 6 most endemic countries.

**Figure 5.The trend of the cutaneous leishmaniasis of the 6 most endemic countries has been on a steady increase.**




Plot 5 A plot of CL of 6 most endemic countries.

**Table 6 Summary table of 6 countries mostly affected by VL.**

| Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dimension | Singular Value | Inertia | Chi Square | Sig. | Proportion of Inertia | | Confidence Singular Value | |
| | | | | | Accounted for | Cumulative | Standard Deviation | Correlation 2 |
| 1 | .296 | .088 | | | .764 | .764 | .001 | .100 |
| 2 | .126 | .016 | | | .137 | .901 | .001 | |
| 3 | .088 | .008 | | | .067[b] | .967 | | |
| 4 | .052 | .003 | | | .023 | .991 | | |
| 5 | .032 | .001 | | | .009 | 1.000 | | |
| Total | | .115 | 50253.869 | .000[a] | 1.000 | 1.000 | | |

a. 40 degrees of freedom

Analysis from **table 6** shows that the model is highly significant at the 0.000 level with an alpha of 0.05 and chi-square value of 50253.87. The total variance explained is 12%. Dimensions 3 to 5 are almost insignificant because they account for little of the total inertia explained.

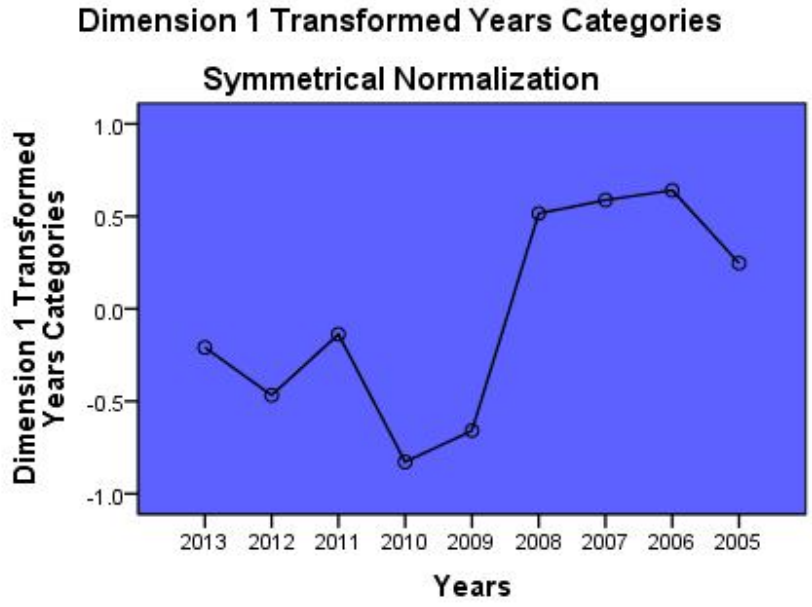
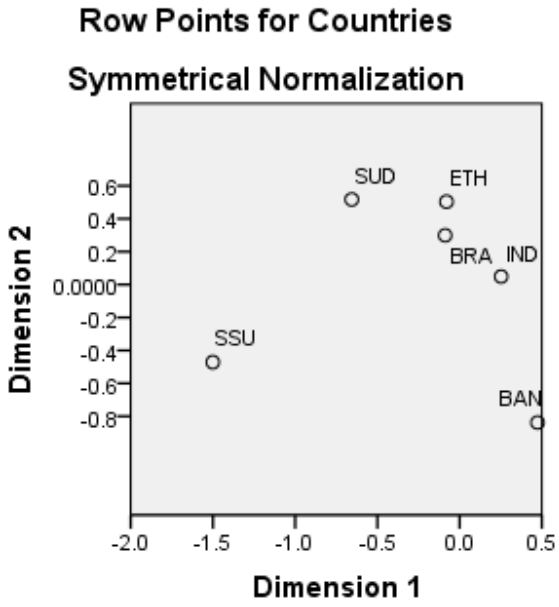



Figure 6 The trend of VL of 6 most endemic countries.

**Figure 6.The trend of the visceral leishmaniasis of 6 most endemic countries has been on a slight increase after some years of sharp decrease.**




Plot 6 A plot of the VL of 6 most endemic countries.

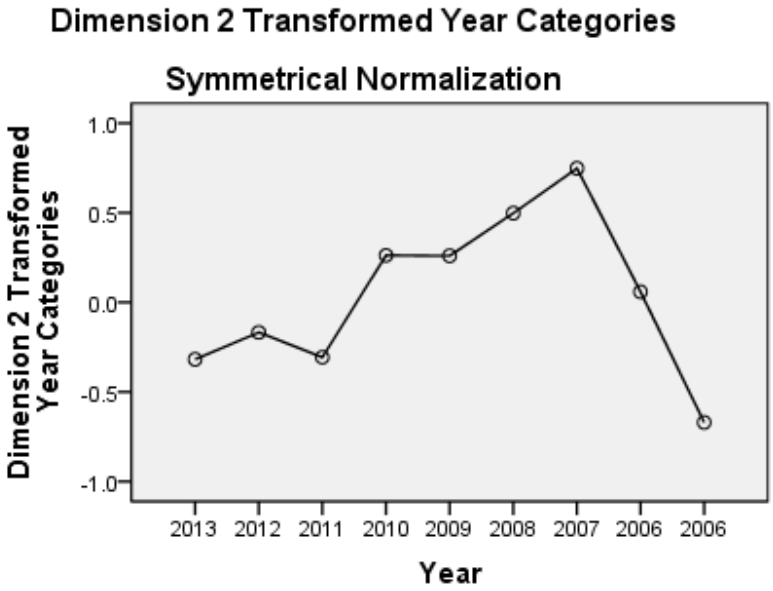



Figure 7 The countries affected by both CL and VL (Trend).

**Figure 7.The trend of the cutaneous and visceral leishmaniasis of countries being affected by both has been on a steady decrease for the continents.**