Leishmaniasis Worldwide and Global Estimates of Its Incidence

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Abstract

As part of a World Health Organization-led effort to update the empirical evidence base for the leishmaniasis, national experts provided leishmaniasis case data for the last 5 years and information regarding treatment and control in their respective countries and a comprehensive literature review was conducted covering publications on leishmaniasis in 98 countries and three territories (see Leishmaniasis Country Profiles Text S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S22, S23, S24, S25, S26, S27, S28, S29, S30, S31, S32, S33, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43, S44, S45, S46, S47, S48, S49, S50, S51, S52, S53, S54, S55, S56, S57, S58, S59, S60, S61, S62, S63, S64, S65, S66, S67, S68, S69, S70, S71, S72, S73, S74, S75, S76, S77, S78, S79, S80, S81, S82, S83, S84, S85, S86, S87, S88, S89, S90, S91, S92, S93, S94, S95, S96, S97, S98, S99, S100, S101†). Additional information was collated during meetings conducted at WHO regional level between 2007 and 2011. Two questionnaires regarding epidemiology and drug access were completed by experts and national program managers. Visceral and cutaneous leishmaniasis incidence ranges were estimated by country and epidemiological region based on reported incidence, underreporting rates if available, and the judgment of national and international experts. Based on these estimates, approximately 0.2 to 0.4 cases and 0.7 to 1.2 million VL and CL cases, respectively, occur each year. More than 90% of global VL cases occur in six countries: India, Bangladesh, Sudan, South Sudan, Ethiopia and Brazil. Cutaneous leishmaniasis is more widely distributed, with about one-third of cases occurring in each of three epidemiological regions, the Americas, the Mediterranean basin, and western Asia from the Middle East to Central Asia. The ten countries with the highest estimated case counts, Afghanistan, Algeria, Colombia, Brazil, Iran, Syria, Ethiopia, North Sudan, Costa Rica and Peru, together account for 70 to 75% of global estimated CL incidence. Mortality data were extremely sparse and generally represent hospital-based deaths only. Using an overall case-fatality rate of 10%, we reach a tentative estimate of 20,000 to 40,000 leishmaniasis deaths per year. Although the information is very poor in a number of countries, this is the first in-depth exercise to better estimate the real impact of leishmaniasis. These data should help to define control strategies and reinforce leishmaniasis advocacy.

Introduction

Although estimated to cause the ninth largest disease burden among individual infectious diseases, leishmaniasis is largely ignored in discussions of tropical disease priorities [1,2]. This consignment to critical oblivion results from its complex epidemiology and ecology, the lack of simple, easily-applied tools for case management and the paucity of current incidence data, and often results in a failure on the part of policy-makers to recognize its importance [3,4]. Based on the World Health Assembly Resolution 2007/60.13, the World Health Organization (WHO) convened the Expert Committee on Leishmaniasis in March 2010, which subsequently issued the first updated technical report on leishmaniasis in more than 20 years [5,6]. Both the WHA Resolution and the Expert Committee report highlighted the need to update the epidemiological evidence base in order to plan appropriate approaches to the control of leishmaniasis.

Estimates of disease burden are widely used by policy-makers and funding organizations to establish priorities [7,8,9,10]. These estimates are most commonly expressed as disability-adjusted life-
years (DALYs) lost, a measurement first promoted in the 1993 World Development Report and the focus of intense scrutiny ever since [11,12,13]. The accuracy of this measure depends on the reliability of the incidence, duration, severity and mortality data for a given condition, as well as the underlying assumptions used in the calculations [7,14]. Although a new round of global disease burden estimation is currently underway, empirical data collection and field validation are neither included nor supported as part of the exercise [15].

The evidence base for the neglected tropical diseases (NTDs) is acknowledged to be particularly problematic [9,16]. Leishmaniasis, like many other NTDs, occurs in a focal distribution and in remote locations, making extrapolation from official data sources difficult [4]. Visceral leishmaniasis (VL) results in death if not treated, the majority of leishmaniasis deaths go unrecognized, and even with treatment access, VL may result in case-fatality rates of 10–20% [17,18,19,20,21,22]. Reported leishmaniasis case figures are widely acknowledged to represent gross underestimates of the true burden, but studies that measure the degree of underreporting are rare [23]. As part of the WHO effort to update the leishmaniasis evidence base, a series of regional meetings were held. National program managers and expert professionals were asked to provide detailed information on epidemiology, ecology, geographical distribution and trends, drug access and management of leishmaniasis for their respective countries. These data, accompanied by literature reviews, are compiled in extensive profiles of each endemic country or territory in the Annex of this publication (see ‘Leishmaniasis Country Profiles Text S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S22, S23, S24, S25, S26, S27, S28, S29, S30, S31, S32, S33, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43, S44, S45, S46, S47, S48, S49, S50, S51, S52, S53, S54, S55, S56, S57, S58, S59, S60, S61, S62, S63, S64, S65, S66, S67, S68, S69, S70, S71, S72, S73, S74, S75, S76, S77, S78, S79, S80, S81, S82, S83, S84, S85, S86, S87, S88, S89, S90, S91, S92, S93, S94, S95, S96, S97, S98, S99, S100, S101’). This paper focuses on an analysis of the findings, and estimates of leishmaniasis incidence derived from the epidemiological data.

### Methods

From 2007 to 2010, WHO organized a series of regional meetings (EMRO countries, Geneva 2007; PAHO countries, Medellin 2008; EURO countries, Istanbul 2009; AFRO countries, Addis Ababa 2010; SEARO countries, Paro 2011). In preparation for each meeting, country representatives were asked to provide yearly reported VL and cutaneous leishmaniasis (CL) incidence data for at least the last 5 years prior to the meeting. In addition, an electronic epidemiological questionnaire was sent to the national control program managers and/or to reputable national scientists to fill information gaps. Data collected included administrative divisions affected, whether VL and CL case notification is mandatory, characteristics of known reservoirs and vector control programs, estimated and reported case numbers, and outbreaks in the previous 5 years.

A comprehensive literature search was also conducted, and the resulting information was used as an independent validation of

| Table 1. Reported and estimated incidence of visceral leishmaniasis in the American region. |
|---------------------------------------------|-----------------|-----------------|-----------------|
| Reported VL cases/year | Years of report | Estimated annual VL incidence |
|------------------------|-----------------|-----------------------------|
| Argentina              | 8               | 2004–2008                   | 20              | to 30\(^1\) |
| Bolivia                | 0               | 2008                        |                 |             |
| Brazil                 | 3481            | 2003–2007                   | 4200            | to 6300\(^2\) |
| Colombia               | 60              | 2004–2008                   | 70              | to 110\(^3\) |
| El Salvador            |                 | no data                     |                 |             |
| Guatemala              | 15              | 2004–2008                   | 20              | to 30\(^2\) |
| Honduras               | 6               | 2004–2008                   | 7               | to 10\(^4\) |
| Mexico                 | 7               | 2004–2008                   | 8               | to 12\(^2\) |
| Nicaragua              | 3               | 2003–2007                   | 3               | to 5\(^2\) |
| Paraguay               | 48              | 2004–2008                   | 100             | to 200\(^1\) |
| Venezuela              | 40              | 2004–2008                   | 50              | to 70\(^2\) |
| Region                 | 3668            | 4500                        | 6800            |             |

\(^1\) Underreporting considered moderate (2–4-fold) based on recent introduction of VL into the country.

\(^2\) Underreporting considered mild (1.2–1.8-fold) based on data from Brazil [25].

| Table 2. Reported and estimated incidence of visceral leishmaniasis in the sub-Saharan African region. |
|---------------------------------------------|-----------------|-----------------|
| Reported VL cases/year | Years of report | Estimated annual VL incidence |
|------------------------|-----------------|-----------------------------|
| Central African Republic | no data                |                             |
| Cameroon               | no data                     |                             |
| Chad                   | no data                     |                             |
| Cote d’Ivoire          | 0               | 2004–2008                   |                             |
| DR Congo               | 0               | 2004–2008                   |                             |
| Gambia                 | no data                      |                             |
| Mauritania             | no data                      |                             |
| Niger                  | no data                      |                             |
| Nigeria                | 1               | 2004–2008                   |                             |
| Senegal                | 0               | 2004–2008                   |                             |
| Zambia                 | no data                      |                             |
| Region                 | 1               |                             |                             |
these data. We reviewed the literature based on MEDLINE searches using the terms leishmaniasis and epidemiology with the name of each endemic country or territory. For the initial search, we included all articles listed in MEDLINE in English, French,

### Table 3. Reported and estimated incidence of visceral leishmaniasis in the East African region.

| Country     | Reported VL cases/year | Years of report | Estimated annual VL incidence |
|-------------|------------------------|-----------------|-------------------------------|
| Djibouti    | no data                |                 |                               |
| Eritrea     | 100                    | 2008            | 200 to 400                    |
| Ethiopia    | 1860                   | 2004–2008       | 3700 to 7400                  |
| Kenya       | 145                    | 2004–2008       | 610 to 1200                   |
| Somalia     | 679                    | 2009            | 1400 to 2700                  |
| Sudan       | 3742                   | 2005–2009       | 15,700 to 30,300               |
| South Sudan | 1756                   | 2004–2008       | 7400 to 14,200                |
| Uganda      | 288                    | 2004–2008       | 350 to 520                    |
| Region      | 8569                   | 29,400          | 56,700                        |

1: Underreporting considered moderate (2–4-fold).
2: Underreporting considered severe (4.2–8.1-fold).
3: Underreporting considered mild (1.2–1.8).

### Table 4. Reported and estimated incidence of visceral leishmaniasis in the Mediterranean region.

| Country         | Reported VL cases/year | Years of report | Estimated annual VL incidence |
|-----------------|------------------------|-----------------|-------------------------------|
| Albania         | 114                    | 2004–2008       | 140 to 210                    |
| Algeria         | 111                    | 2004–2008       | 130 to 200                    |
| Bosnia and Herzegovina | 2          | 2002–2005       | 2 to 3                       |
| Bulgaria        | 7                      | 2004–2008       | 8 to 12                      |
| Croatia         | 5                      | 2004–2008       | 6 to 8                       |
| Cyprus          | 2                      | 2008            | 2 to 4                       |
| Egypt           | 1                      | 2008            | 1 to 2                       |
| France          | 18                     | 2004–2008       | 20 to 30                     |
| Greece          | 42                     | 2004–2008       | 50 to 80                     |
| Israel          | 2                      | 2003–2007       | 3 to 4                       |
| Italy           | 134                    | 2003–2007       | 160 to 240                   |
| Jordan          | 0                      | 2004–2008       | 0 to 0                       |
| Lebanon         | 0                      | 2004–2008       | 0 to 0                       |
| Libya           | 3                      | 2004–2008       | 5 to 10                      |
| Macedonia       | 7                      | 2005–2009       | 9 to 13                      |
| Malta           | 2                      | 2002–2005       | 3 to 4                       |
| Monaco          | no data                |                 |                               |
| Montenegro      | 3                      | 2004–2008       | 4 to 5                       |
| Morocco         | 152                    | 2004–2008       | 300 to 610                   |
| Palestine       | 5                      | 2004–2008       | 10 to 20                     |
| Portugal        | 15                     | 2003–2007       | 20 to 30                     |
| Slovenia        | no data                |                 |                               |
| Spain           | 117                    | 2004–2008       | 140 to 210                   |
| Syria           | 14                     | 2004–2008       | 30 to 60                     |
| Tunisia         | 89                     | 2004–2008       | 110 to 160                   |
| Turkey          | 29                     | 2003–2007       | 60 to 120                    |
| Region          | 875                    | 2003–2007       | 1200 to 2000                 |

1: Underreporting considered mild (1.2–1.8-fold).
2: Underreporting considered moderate (2–4-fold).

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Spanish or Russian up to October 2010, when the search was conducted. We selected articles that explicitly addressed incidence, geographic distribution, surveillance and/or trends over time, and preferably chose articles published since 2000 if available. For countries with sparse data on leishmaniasis, we broadened the review to include all articles that shed light on the occurrence of the disease within that country. We reviewed titles for all references, abstracts when available for those whose titles were not sufficient to lead us to exclude the paper, and the full article when the abstract indicated possible relevance. The search for country-specific literature yielded 3242 potentially relevant articles, of which 340 were retained based on our selection criteria. Five recent review articles were also included. Twenty-six additional unpublished reports were provided by national or international experts. The literature was reviewed by at least 2 authors and regular meetings were held among the authors to discuss the findings in depth.

A MEDLINE search was also performed using the terms *leishmaniasis* and *underreporting* to identify articles that would aid in making incidence estimates. This search yielded 8 articles of which 5 presented data on the magnitude of leishmaniasis underreporting. One additional article was identified from author literature collections, yielding 3 articles with empirical data regarding VL and 3 for CL underreporting [24,25,26,27,28,29]. These articles were used to establish probable degrees of underreporting for the countries in which their analyses were performed, and were also used for estimates in countries judged similar in their degree of underreporting. National and international experts provided their judgements of the magnitude of underreporting. In addition, for countries where reporting is sparse, but surveys have been performed, the published data were used as a basis to select the

| Table 5. Reported and estimated incidence of visceral leishmaniasis in the Middle East to Central Asia. |
|---------------------------------------------------------------|
| **Reported VL cases/year** | **Years of report** | **Estimated annual VL incidence** |
| Afghanistan | no data |  |
| Armenia | 7 | 2004–2008 | 10 to 30<sup>1</sup> |
| Azerbaijan | 28 | 2004–2008 | 60 to 110<sup>1</sup> |
| China | 378 | 2004–2008 | 760 to 1500<sup>1</sup> |
| Georgia | 164 | 2004–2008 | 330 to 660<sup>1</sup> |
| Iran (Islamic Republic of) | 149 | 2004–2008 | 300 to 600<sup>1</sup> |
| Iraq | 1711 | 2004–2008 | 3400 to 6800<sup>1</sup> |
| Kazakhstan | 1 | 2004–2008 | 2 to 4<sup>1</sup> |
| Kyrgyzstan | 0 | 2004–2008 |  |
| Oman | 1 | 2004–2008 | 2 to 4<sup>1</sup> |
| Pakistan | no data |  |
| Saudi Arabia | 34 | 2004–2008 | 40 to 60<sup>2</sup> |
| Tajikistan | 15 | 2004–2008 | 30 to 60<sup>1</sup> |
| Turkmenistan | 0 | 2004–2008 |  |
| Ukraine | 2 | 2005–2008 | 4 to 7<sup>1</sup> |
| Uzbekistan | 7 | 2004–2008 | 10 to 30<sup>1</sup> |
| Yemen | 0 | 2004–2008 | 20 to 50<sup>1</sup> |
| Region | 2496 |  | 5000 to 10,000 |

<sup>1</sup> Underreporting considered moderate (2–4-fold).  
<sup>2</sup> Underreporting considered mild (1.2–1.8).  
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| Table 6. Reported and estimated incidence of visceral leishmaniasis in the Indian subcontinent and Southeast Asia. |
|---------------------------------------------------------------|
| **Reported VL cases/year** | **Years of report** | **Estimated annual VL incidence** |
| Bangladesh | 6224 | 2004–2008 | 12,400 to 24,900<sup>1</sup> |
| Bhutan | 2 | 2005–2009 | 10 to 20<sup>1</sup> |
| India | 34,918 | 2004–2008 | 146,700 to 282,800<sup>3</sup> |
| Nepal | 1477 | 2004–2008 | 3000 to 5900<sup>1</sup> |
| Sri Lanka | no data | 6 | 10<sup>4</sup> |
| Thailand | 2 | 2006–2010 | 5 to 10<sup>5</sup> |
| Region | 42,623 |  | 162,100 to 313,600 |

<sup>1</sup> Underreporting considered moderate (2.0–4.0-fold; based on lower proportion of cases treated in private sector compared to India).  
<sup>2</sup> Underreporting range based on 2 assessments in Bihar [27,28].  
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appropriate degree of underreporting [30]. Wherever possible, estimated plausible VL and CL incidence ranges were assigned by country and/or region based on reported incidence and multiplication by the probable underreporting factors. Estimates less than 20 were retained as the precise product of the reported case number times the underreporting factor, those between 20 and 1000 were rounded to the nearest 10 and those over 1000 were rounded to the nearest 100. Where reporting was absent but

### Table 7. Reported and estimated incidence of cutaneous leishmaniasis in the American region.

|                  | Reported CL cases/year | Years of report | Estimated annual CL incidence |
|------------------|------------------------|-----------------|------------------------------|
| Argentina        | 261                    | 2004–2008       | 730                          |
| Belize           | 26086                  | no data         |                              |
| Bolivia          | 2647                   | 2004–2008       | 7400                         |
| Brazil           | 26,008                 | 2003–2007       | 72,800                        |
| Colombia         | 17,420                 | 2005–2009       | 48,800                        |
| Costa Rica       | 1249                   | 2002–2006       | 3500                          |
| Dominican Republic| no data                |                 |                              |
| Ecuador          | 1724                   | 2004–2008       | 4800                          |
| El Salvador      | 811                    | 2004–2008       | 2300                          |
| French Guiana    | 233                    | 2004–2008       | 650                           |
| Guatemala        | 684                    | 2004–2008       | 1900                          |
| Guyana           | 16                     | 2006–2008       | 50                            |
| Honduras         | 1159                   | 2006–2008       | 3200                          |
| Mexico           | 811                    | 2004–2008       | 2300                          |
| Nicaragua        | 3222                   | 2003–2007       | 9000                          |
| Panama           | 2188                   | 2005–2009       | 6100                          |
| Paraguay         | 431                    | 2004–2008       | 1200                          |
| Peru             | 6405                   | 2004–2008       | 17,900                        |
| Suriname         | 3                      | 2005–2007       | 8                            |
| Venezuela        | 2480                   | 2004–2008       | 6900                          |
| REGION           | 66,941                 |                 | 187,200                       |

1Underreporting considered mild (2.8–4.6-fold) based on data from Argentina [29].

### Table 8. Reported and estimated incidence of cutaneous leishmaniasis in the sub-Saharan African region.

|                  | Reported CL cases/year | Years of report | Estimated annual CL incidence |
|------------------|------------------------|-----------------|------------------------------|
| Burkina Faso     | no data                |                 |                              |
| Cameroon         | 55                     | 2007–2009       | 280                          |
| Chad             | 1                      | 2004–2008       | 5                            |
| Cote d’Ivoire    | 0                      | 2009            |                              |
| DR Congo         | 27                     | 2004–2008       | 140                          |
| Guinea           | no data                |                 |                              |
| Guinea-Bissau    | no data                |                 |                              |
| Mali             | 58                     | 2004–2008       | 290                          |
| Mauritania       | no data                |                 |                              |
| Namibia          | no data                |                 |                              |
| Niger            | no data                |                 |                              |
| Nigeria          | 5                      | 2004–2008       | 30                           |
| Senegal          | 8                      | 2004–2008       | 40                           |
| South Africa     | no data                |                 |                              |
| REGION           | 155                    | 2004–2008       | 790                          |

1Underreporting considered moderate (5–10-fold).
incidence was known to be substantial, estimates were assigned based on the judgment of national and international experts. The regional estimates represent the sum of the country estimates followed by the same rounding process. Similarly, the global estimates represent the sum of the regional estimates followed by rounding as described above. In order to facilitate expert judgment regarding the probable accuracy of the figures presented here, we defined geographical regions consistent with the major ecological foci of leishmaniasis transmission, rather than official WHO regions [31,32,33].

Table 9. Reported and estimated incidence of cutaneous leishmaniasis in the East African region.

| Country     | Reported CL cases/year | Years of report | Estimated annual CL incidence |
|-------------|------------------------|-----------------|------------------------------|
| Djibouti    | no data                |                 |                              |
| Eritrea     | 50                     | 2008            | 250 to 500                   |
| Ethiopia    | no data                |                 | 20,000 to 50,000             |
| Kenya       | no data                |                 |                              |
| Sudan       | no data                |                 | 15,000 to 40,000             |
| South Sudan | no data                |                 |                              |
| REGION      | 50                     |                 | 35,300 to 90,500             |

1 Underreporting considered moderate (5–10-fold).
2 Based on conference report (Armauer Hansen Research Institute, Federal Ministry of Health of Ethiopia and World Health Organization. Consultative meeting for the control of cutaneous leishmaniasis in Ethiopia; June 4–5, 2011; Addis Ababa, Ethiopia).
3 Based on estimates by Dr. Nuha Hamid, national project officer, WHO-Khartoum, Sudan (see Annex).

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Table 10. Reported and estimated incidence of cutaneous leishmaniasis in the Mediterranean.

| Country          | Reported CL cases/year | Years of report | Estimated annual CL incidence |
|------------------|------------------------|-----------------|------------------------------|
| Albania          | 6                      | 2004–2008       |                              |
| Algeria          | 44,050                 | 2004–2008       | 123,300 to 202,600           |
| Bosnia and Herzegovina | 0                  | 2008            |                              |
| Bulgaria         | 0                      | 2008            |                              |
| Croatia          | 2                      | 2004–2008       | 6 to 10                      |
| Cyprus           | 1                      | 2006–2008       |                              |
| Egypt            | 471                    | 2008            | 1300 to 2200                 |
| France           | 2                      | 2004–2008       | 6 to 10                      |
| Greece           | 3                      | 2004–2008       | 8 to 13                      |
| Israel           | 579                    | 2003–2007       | 1600 to 2700                 |
| Italy            | 49                     | 2003–2007       | 140 to 230                   |
| Jordan           | 227                    | 2004–2008       | 630 to 1000                  |
| Lebanon          | 0                      | 2004–2008       |                              |
| Libya            | 3540                   | 2004–2008       | 9900 to 16,300               |
| Macedonia        | 0                      | 2008            |                              |
| Malta            | 0                      | 2008            |                              |
| Monaco           | 0                      | 2008            |                              |
| Montenegro       | 0                      | 2008            |                              |
| Morocco          | 3430                   | 2004–2008       | 9600 to 15,800               |
| Palestine        | 218                    | 2005–2009       | 610 to 1000                  |
| Portugal         | 0                      | 2004–2008       |                              |
| Slovenia         | 0                      | 2004–2008       |                              |
| Spain            | 0                      | 2004–2008       |                              |
| Syria            | 22,882                 | 2004–2008       | 64,100 to 105,300            |
| Tunisia          | 7631                   | 2004–2008       | 21,400 to 35,100             |
| Turkey           | 2465                   | 2003–2007       | 6900 to 11,300               |
| REGION           | 85,555                 |                 | 239,500 to 393,600           |

1 Underreporting considered mild (2.8–4.6) [29].

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A second questionnaire addressed access to antileishmanial medicines, and included specific questions: whether the public sector provides health care free of charge; the existence of a national program for control of leishmaniasis; inclusion of antileishmanial medicines in the National Essential Drug List; the number of different medicines purchased for the public sector or donations received in the last two years; sale of antileishmanial drugs in the private sector and price per tablet or vial; percentage of people using the for-profit private sector versus public sector for leishmaniasis treatment; health care level providing treatment in the public sector; presence of NGOs or other non-profit agencies providing leishmaniasis treatment; and barriers to access for treatment of leishmaniasis. Basic social and health data from each country were obtained from the websites of the relevant international agencies [34,35,36,37,38].

The epidemiological data were used to produce maps with 2008 as the reference year using ArcGIS 9.3– Desktop (Esri, Redlands, CA) and following WHO guidelines for GIS usage. The numbers of confirmed cases by clinical form (VL, CL, mucocutaneous leishmaniasis) were mapped by official first level administrative division. These data were used to calculate annual incidence rates. A single standard range of values was used for each clinical form to facilitate visual comparison between countries. Draft maps were shared with data providers and other leishmaniasis experts for validation. The following maps were developed for each country: situational map with neighbouring countries and world globe, maps of cases by clinical form, and maps of incidence per 10,000 inhabitants. All maps follow a consistent set of characteristics: five categories of colours in a yellow-to-red scale were chosen for the maps of cases, and six categories of colours in blue tones scale were chosen for the maps of incidence. The sparse information in a few countries required the use of \textit{ad hoc} scales. Only WHO GIS shapfile databases were used; the maps follow the administrative limits and frontiers recognized by United Nations conventions.

The parasitological information has been reproduced from the WHO Technical Report Series 949 (http://whqlibdoc.who.int/trs/WHO_TRS_949_eng.pdf) published in 2010.

### Table 11. Reported and estimated incidence of cutaneous leishmaniasis in the Middle East to Central Asia.

| Country                         | Reported CL cases/year | Years of report | Estimated annual CL incidence |
|---------------------------------|------------------------|-----------------|-------------------------------|
| Afghanistan                     | 22,620                 | 2003–2007       | 113,100 to 226,200            |
| Armenia                         | 0                      | 2008            |                               |
| Azerbaijan                      | 17                     | 2004–2008       | 50 to 80                      |
| China                           | 0                      | 2004–2008       |                               |
| Georgia                         | 5                      | 2004–2008       |                               |
| Iran (Islamic Republic of)      | 24,630                 | 2004–2008       | 69,000 to 113,300             |
| Iraq                            | 1655                   | 2004–2008       | 8300 to 16,500                |
| Kazakhstan                      | 15                     | 2004–2008       | 40 to 70                      |
| Kyrgyzstan                      | 0                      | 2004–2008       |                               |
| Mongolia                        | no data                |                 |                               |
| Oman                            | 5                      | 2004–2008       | 15 to 20                      |
| Pakistan                        | 7752                   | 2004–2008       | 21,700 to 35,700              |
| Saudi Arabia                    | 3445                   | 2004–2008       | 9600 to 15,800                |
| Tajikistan                      | 25                     | 2007–2008       | 125 to 250                    |
| Turkmenistan                    | 99                     | 2004–2008       | 490 to 990                    |
| Ukraine                         | 2                      | 2004–2008       | 10 to 20                      |
| Uzbekistan                      | 142                    | 2004–2008       | 710 to 1400                   |
| Yemen                           | 603                    | 2005–2009       | 3000 to 6000                  |
| REGION                          | 61,013                 |                 | 226,200 to 416,400            |

1 Underreporting considered moderate (5–10-fold) based on estimates of incidence from population-based surveys [30].
2 Underreporting considered mild (2.8–4.6) [29].
3 Underreporting considered moderate (5–10-fold).

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### Table 12. Reported and estimated incidence of cutaneous leishmaniasis in the Indian subcontinent.

| Country | Reported CL cases/year | Years of report | Estimated annual CL incidence |
|---------|------------------------|-----------------|-------------------------------|
| India   | 156                    | 2005–2009       | 1000 to 2000                  |
| Sri Lanka | 322                  | 2004–2008       | 900 to 1500                   |
| REGION  | 478                    | 1900            | 3500                          |

1 Based on estimates by Dr RA Bumb, Department of Skin, STD and Leprosy, SP Medical College, Bikaner, Rajasthan, India.
2 Underreporting considered mild (2.8–4.6) [29].

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Basic social and health data, results of literature reviews, data on the magnitude of underreporting, maps, data regarding epidemiology, case load, access to treatment and access to drugs, and parasitological information are presented in a series of extensive Profiles of each endemic individual country and territory and are presented in the Annex of this publication (see ‘Leishmaniasis Country Profiles Text S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S22, S23, S24, S25, S26, S27, S28, S29, S30, S31, S32, S33, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43, S44, S45, S46, S47, S48, S49, S50, S51, S52, S53, S54, S55, S56, S57, S58, S59, S60, S61, S62, S63, S64, S65, S66, S67, S68, S69, S70, S71, S72, S73, S74, S75, S76, S77, S78, S79, S80, S81, S82, S83, S84, S85, S86, S87, S88, S89, S90, S91, S92, S93, S94, S95, S96, S97, S98, S99, S100, S101’).

Results

A total of 98 countries and 3 territories on 5 continents reported endemic leishmaniasis transmission (Tables 1, 2, 3, 4, 5, 6 and 7, 8, 9, 10, 11, 12). In total, official case counts totalled more than 58,000 VL cases and 220,000 CL cases per year (Tables 13 and 14). However, only about two-thirds of countries had reported incidence data for a five-year period; data were sparsest for the foci in Africa. A number of countries are listed here as endemic despite the lack of reported human cases, usually reflecting an absence of surveillance or other investigations. [39] For example, although Mongolia has not reported human CL cases, L. major genetically identical to that found in countries with proven endemic transmission has been isolated on multiple occasions from gerbils. [40] Only countries with circulating species known to be pathogenic to humans are included as endemic. For this reason, Australia is not considered endemic despite reports of CL among red kangaroos caused by a newly described leishmanial species. [41] Human infections due to lower trypanosomatids are also excluded. [42].

There are few published empirical assessments of underreporting in official surveillance data. Two studies from Bihar, India, compared VL case numbers ascertained through active house-to-house surveys to those reported in the official surveillance system; official figures were shown to be 4.2-fold and 8.1-fold lower than the incidence found by active case detection in the two studies, respectively. [27,28] A study in Brazil used the capture-recapture method to estimate underreporting of VL, based on data from 3 different sources; the degree of underreporting was found to be 1.3- to 1.7-fold. [25] Data from one province in Argentina estimated the degree of CL underreporting to be 2.0 to 4.0-fold; however, studies from Guatemala and Jordan indicate that CL incidence may be underestimated by 40- to 47-fold in national surveillance data. [24,26,29] Based on these publications, country-level VL underreporting magnitude was categorized as follows: mild (1.2- to 1.8-fold based on data from Brazil [25]); severe (4.0- to 8.0-fold based on data from India [27,29]); and an intermediate category of moderate (2.0 to 4.0-fold) underreporting. Despite the high published range of CL underreporting [24,26], we chose conservative multipliers: mild (2.8 to 4.6-fold based on data from Argentina [29]) and moderate (5.0- to 10.0-fold). No estimates could be made for most countries in sub-Saharan Africa, where almost no data were available.

Based on these estimates, approximately 0.2 to 0.4 million VL cases and 0.7 to 1.2 million CL cases occur each year. More than

Table 13. Global reported and estimated incidence of visceral leishmaniasis.

| Region                | Reported VL cases/year | Countries with 5 years of data | Estimated annual VL incidence |
|-----------------------|------------------------|--------------------------------|-------------------------------|
| Americas              | 3662                   | 8/11 (73%)                     | 4500 to 6800                  |
| Sub-Saharan Africa    | 1                      | 3/11 (27%)                     |                               |
| East Africa           | 8569                   | 5/8 (63%)                      | 29,400 to 56,700              |
| Mediterranean         | 875                    | 21/26 (81%)                    | 1200 to 2000                  |
| Middle East to Central Asia | 2496                | 14/17 (82%)                    | 5000 to 10,000                |
| South Asia            | 42,623                 | 3/6 (50%)*                     | 162,100 to 313,600            |
| Global total          | 58,227                 | 54/79 (68%)                    | 202,200 to 389,100            |

*3/3 (100%) of high burden countries (India, Bangladesh, Nepal) reported 5 years of data. Reports incomplete for Sri Lanka, Bhutan and Thailand.

Table 14. Global reported and estimated incidence of cutaneous leishmaniasis.

| Region                | Reported CL cases/year | Countries with 5 years of data | Estimated annual CL incidence |
|-----------------------|------------------------|--------------------------------|-------------------------------|
| Americas              | 66,941                 | 14/20 (70%)                    | 187,200 to 307,800            |
| Sub-Saharan Africa    | 155                    | 5/15 (33%)                     | 770 to 1500                   |
| East Africa           | 50                     | 0/6 (0%)                       | 35,300 to 90,500              |
| Mediterranean         | 85,555                 | 17/26 (65%)                    | 239,500 to 393,600            |
| Middle East to Central Asia | 61,013              | 16/18 (89%)                    | 226,200 to 416,400            |
| South Asia            | 322                    | 2/2 (100%)                     | 1900 to 3500                  |
| Global total          | 214,036                | 53/87 (61%)                    | 690,900 to 1,213,300          |
90% of global VL cases occur in just six countries: India, Bangladesh, Sudan, South Sudan, Brazil and Ethiopia (Table 13). Cutaneous leishmaniasis is more widely distributed, with about one-third of cases occurring in each of three regions, the Americas, the Mediterranean basin, and western Asia from the Middle East to Central Asia (Table 14). The ten countries with the highest estimated case counts, Afghanistan, Algeria, Colombia, Brazil, Iran, Syria, Ethiopia, North Sudan, Costa Rica and Peru, together account for 70 to 75% of global estimated CL incidence.

Mortality data are extremely sparse and generally represent hospital-based deaths only. The reported case-fatality rate for VL in Brazil in 2006 was 7.2%. In the Indian subcontinent, the focus responsible for the largest proportion of global VL cases, reported case-fatality rates ranged from 1.5% (93 deaths/6224 VL cases from 2004–2008) in Bangladesh to 2.4% (853/34,918) in India and 6.2% (91/1477) in Nepal. However, community-based studies that included active searches for deaths due to kala-azar estimate case-fatality rates of more than 10%, while data from a village-based study in India suggest that as many as 20% of VL patients, disproportionately poor and female, died before their disease was recognized. [43,44,45] In South Sudan, one community-based longitudinal study demonstrated a case-fatality rate of 20% in a settled village in peace time; in areas of conflict, famine or population displacement mortality rates are much higher. [22,46] A recent study from South Sudan estimated that 91% of all kala-azar deaths went unrecognized. [47] Using an overall case-fatality rate of 10% and assuming that virtually all deaths are from VL, we reach a tentative estimate of 20,000 to 40,000 leishmaniasis deaths per year, in line with previous WHO estimates. [10]

Discussion

The data presented here and in the accompanying Annex (see ‘Leishmaniasis Country Profiles Text S1–S101’) represent the first update of the empirical database for leishmaniasis since 1991. [48,49] We are acutely cognizant of the uncertainties inherent in the data, and for that reason, have presented rough ranges rather than single estimates for each outcome. We deliberately used conservative assumptions for the underreporting rates and resultant multipliers; true leishmaniasis incidence rates may be substantially higher. Due to the lack of data, we made no estimates for post-kala-azar dermal leishmaniasis, mucocutaneous leishmaniasis, and other less frequent forms of leishmaniasis. Our mortality estimate contains even more uncertainty than the incidence estimate, because studies affirm that a large proportion of kala-azar deaths occur outside of health facilities and the cause likely never recognized, precluding the possibility of accurate passive reporting. [43,45,47].

The limitations of these data are obvious: surveillance and vital records reporting in the countries most affected by leishmaniasis are incomplete, and we have very sparse data on which to base correction factors for underreporting. The figures in this report should not be considered precise and should be interpreted with caution. Nevertheless, these data include a more comprehensive review of leishmaniasis incidence than any previous publication, and represent a major improvement in the evidence base for one of the most neglected diseases. [30] Better surveillance systems are urgently needed, in particular in disease foci targeted for more intensive control or elimination. [4,31] Many key measures of progress, such as validation of trends seen in surveillance data and accurate case-fatality rates, can only be obtained through the active collection of community-based data. [4,52] We hope the data presented here will allow a more nuanced interpretation of published disease burden estimates, and the uncertainties in these data will spur activities to improve the evidence base for leishmaniasis and other neglected diseases.

Supporting Information

Text S1 Leishmaniasis Country Profiles, Afghanistan.

(DOCX)

Text S2 Leishmaniasis Country Profiles, Albania.

(DOCX)

Text S3 Leishmaniasis Country Profiles, Algeria.

(DOCX)

Text S4 Leishmaniasis Country Profiles, Argentina.

(DOCX)

Text S5 Leishmaniasis Country Profiles, Armenia.

(DOCX)

Text S6 Leishmaniasis Country Profiles, Azerbaijani.

(DOCX)

Text S7 Leishmaniasis Country Profiles, Bangladesh.

(DOCX)

Text S8 Leishmaniasis Country Profiles, Belize.

(DOCX)

Text S9 Leishmaniasis Country Profiles, Bhutan.

(DOCX)

Text S10 Leishmaniasis Country Profiles, Bolivia.

(DOCX)

Text S11 Leishmaniasis Country Profiles, Bosnia.

(DOCX)

Text S12 Leishmaniasis Country Profiles, Brazil.

(DOCX)

Text S13 Leishmaniasis Country Profiles, Bulgaria.

(DOCX)

Text S14 Leishmaniasis Country Profiles, Burkina Faso.

(DOCX)

Text S15 Leishmaniasis Country Profiles, Cameroon.

(DOCX)

Text S16 Leishmaniasis Country Profiles, Central African Republic.

(DOCX)

Text S17 Leishmaniasis Country Profiles, Chad.

(DOCX)

Text S18 Leishmaniasis Country Profiles, China.

(DOCX)

Text S19 Leishmaniasis Country Profiles, Colombia.

(DOCX)

Text S20 Leishmaniasis Country Profiles, Costa Rica.

(DOCX)

Text S21 Leishmaniasis Country Profiles, Cote d’Ivoire.

(DOCX)

Text S22 Leishmaniasis Country Profiles, Croatia.

(DOCX)

Text S23 Leishmaniasis Country Profiles, Cyprus.

(DOCX)
Text S75 Leishmaniasis Country Profiles, Romania. (DOCX)

Text S76 Leishmaniasis Country Profiles, Saudi Arabia. (DOCX)

Text S77 Leishmaniasis Country Profiles, Senegal. (DOCX)

Text S78 Leishmaniasis Country Profiles, Slovakia. (DOCX)

Text S79 Leishmaniasis Country Profiles, Somalia. (DOCX)

Text S80 Leishmaniasis Country Profiles, South Africa. (DOCX)

Text S81 Leishmaniasis Country Profiles, South Sudan. (DOCX)

Text S82 Leishmaniasis Country Profiles, Spain. (DOCX)

Text S83 Leishmaniasis Country Profiles, Sri Lanka. (DOCX)

Text S84 Leishmaniasis Country Profiles, Sudan. (DOCX)

Text S85 Leishmaniasis Country Profiles, Suriname. (DOCX)

Text S86 Leishmaniasis Country Profiles, Syrian Arab Republic. (DOCX)

Text S87 Leishmaniasis Country Profiles, Taiwan. (DOCX)

Text S88 Leishmaniasis Country Profiles, Tajikistan. (DOCX)

Text S89 Leishmaniasis Country Profiles, Thailand. (DOCX)

Text S90 Leishmaniasis Country Profiles, The Former Yugoslav Republic of Macedonia. (DOCX)

Text S91 Leishmaniasis Country Profiles, Tunisia. (DOCX)

Text S92 Leishmaniasis Country Profiles, Turkey. (DOCX)

Text S93 Leishmaniasis Country Profiles, Turkmenistan. (DOCX)

Text S94 Leishmaniasis Country Profiles, Uganda. (DOCX)

Text S95 Leishmaniasis Country Profiles, Ukraine. (DOCX)

Text S96 Leishmaniasis Country Profiles, United States of America. (DOCX)

Text S97 Leishmaniasis Country Profiles, Uzbekistan. (DOCX)

Text S98 Leishmaniasis Country Profiles, Venezuela. (DOCX)

Text S99 Leishmaniasis Country Profiles, West Bank and Gaza Strip. (DOCX)

Text S100 Leishmaniasis Country Profiles, Yemen. (DOCX)

Text S101 Leishmaniasis Country Profiles, Zambia. (DOCX)

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Disclaimer: The boundaries and names shown and the designations used on the maps presented in this paper do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Author Contributions

Wrote the paper: JA IV CB MdB. Performed surveys to obtain Individual Country Data: JA IV MdB. Supported Regional Meetings to obtain Individual Country Data: JA IV MH JJ MdBB. In addition to these authors the WHO Leishmaniasis Control Team should be mentioned, this consists of Daniel Argaw (WHO/HQ), Sujit Bhattacharya (WHO/SEARO), Mikhail Ejov (WHO/EURO), Ana Nicole Ekhouri (WHO/PAHO), José Antonio Ruiz-Postigo (WHO/EMRO), and Josep Serrano (WHO/HQ). Critical editing of Individual Country Data: PD. Map Design: JC.

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