Chapter 11: International Comparisons

- In 2016, as seen over the past decade, Taiwan, the United States, and the Jalisco region of Mexico reported the highest incidence of treated ESRD, with rates of 493, 378, and 355 patients per million general population (PMP; Figure 11.2), respectively. Nearly 40% of countries had incidence rates of treated ESRD <120 patients PMP, with South Africa reporting the lowest incidence rate of 22 treated ESRD patients PMP in 2016.
- Incidence rates of treated ESRD have remained relatively stable in approximately half of countries since 2003, either declining modestly or rising by only 1% or less per year from 2003 to 2016 in countries which reported data over this time period. In contrast, treated ESRD incidence rates rose an average of 2% to 4% per year in nearly 30% of countries (including the United States at 2% per year), and rose an average of 6% to 19% per year from 2003-2016 in Thailand, Malaysia, the Republic of Korea, the Jalisco region of Mexico, Singapore, the Philippines, and Taiwan (Figure 11.3.b).
- In 2016, large variation was seen across countries in whether diabetes mellitus (DM) was the primary cause of ESRD among incident treated ESRD patients, ranging from: approximately 66% of incident treated ESRD patients in Malaysia, Singapore, and the Jalisco region of Mexico, to less than 16% in Norway, Latvia, and Romania (Figure 11.4.b). From 2003 to 2016, the Jalisco region of Mexico and Malaysia had the highest average yearly increases overall in the rates of ESRD incidence due to diabetes (Figure 11.5).
- In 2016, among young adults (aged 20-44 years), the United States reported the highest ESRD incidence rate at 134 PMP, followed by Malaysia at 111 PMP, with most countries having treated ESRD incidence rates <50 PMP in this young age group (Figure 11.7.a).
- Taiwan, Japan, the United States, and Singapore had the highest reported prevalence of treated ESRD in 2016, at 3,392, 2,599, 2,196, and 2,076 PMP (Figure 11.9). In contrast, 13%, 50%, and 31% of countries had a prevalence of treated ESRD PMP of <500, 500-999, and 1,000-1,999, respectively.
- From 2003 to 2016, Taiwan and Thailand reported the highest average yearly increase in the prevalence of treated ESRD PMP (Figure 11.11.b) with prevalence rising by 122 and 106 persons PMP per year, respectively. In comparison, 44%, 33%, and 17% of countries had an average yearly increase in the prevalence of treated ESRD of <25, 25-48, and 53-84 persons PMP per year over the time period from 2003 to 2016.
- Large international variation exists in the use of the different renal replacement therapies (RRT; Figure 11.12). In approximately one-fourth of countries, 50-70% of treated ESRD patients are living with a kidney transplant—particularly in northern European countries. In contrast, in approximately one-third of countries, less than 20% of treated ESRD patients are living with a kidney transplant. In most nations, in-center hemodialysis (HD) was the predominant RRT modality.
- Among dialysis patients, in-center HD was the chosen modality for greater than 80% of dialysis in 79% of countries (Figure 11.15). In 2016, the highest utilization of peritoneal dialysis (PD) occurred in Hong Kong (71%), the Jalisco region of Mexico (61%), Guatemala (57%), New Zealand (30%), Thailand (28%), and Qatar (27%); for the remaining countries, PD utilization was less than 22% of dialysis patients.
- In 2016, the Jalisco region of Mexico, Spain, the United States, and the Netherlands reported the highest rates of kidney transplantation, with 59-79 transplants PMP (Figure 11.16.a). When expressed relative to the size of the prevalent dialysis population, the highest rates of kidney transplantation per 1,000 dialysis patients occurred in Kazakhstan (171 per 1,000), Belarus (167 per 1,000), Norway (162 per 1,000), the Netherlands, Finland, and Scotland (from 119 to 152 per 1,000). Thirty-one percent of countries indicated less than 30 kidney transplants per 1,000 dialysis patients (Figure 11.16.b).

Introduction

This chapter examines international trends in the treatment of end-stage renal disease (ESRD). The number of countries and regions represented in this year's Annual Data Report (ADR) increased to 79, with the addition of Iraq. We welcome our newest contributor.

This work is made possible by the substantial efforts of many individuals from all participating countries, through collecting and contributing data for this international collaboration. We sincerely thank all the country registries for their dedicated efforts in providing their data for this effort. Specific contributors to this effort are listed at the end of the chapter. The information in this chapter is designed to serve as a resource for the worldwide ESRD community—to inform health care policies, while stimulating meaningful research designed to improve care of ESRD patients.

Our goal is for the presented comparisons to increase awareness of the international trends, similarities, and differences in key ESRD treatment measures. Participating countries provide data through completion of a standardized survey form. Actual data collection methods vary considerably across countries; therefore any direct comparisons require caution.

In some countries (e.g., United States), data are based in part upon claims submitted for billing purposes; such data tends to provide nearly 100% ascertainment of ESRD. However, countries using other data collection methods have also been very successful in identifying ESRD in their populations. In some countries/registries, however, 100% ascertainment of persons treated for ESRD may not be feasible.

The international comparisons presented in this chapter do not adjust for demographic differences. Most European countries, Japan, and other nations have rapidly aging populations. As ESRD rates tend to rise with age, such nations may report higher rates of ESRD as compared to those with younger populations, although many other factors play a role (mortality rates, acceptance rates to an ESRD program, etc.). This chapter is intended to broadly characterize (i.e., provide descriptive data on) the populations receiving renal replacement therapy around the world. Thus whether a registry achieves 90%, 95%, or >99% ascertainment of ESRD within their country, the key messages in this chapter remain very relevant.

The degree of unrecognized ESRD and access to renal replacement therapy (RRT) varies widely across countries. Where access to RRT is limited, reported ESRD incidence and prevalence may substantially underestimate the true rates of irreversible kidney failure. On the other hand, in some countries where RRT is widely available, when patients decline dialysis or transplantation true ESRD incidence may also be underestimated. The term "conservative kidney management" is used to describe patients who choose to forego or postpone RRT while continuing active medical care by nephrologists and other providers (Robinson et al., 2016). The information presented in this chapter reflects only patients who are currently on dialysis or have received a kidney transplant. Thus, the data and trends reported represent "treated ESRD."

The United States Renal Data System (USRDS) welcomes any suggestions to further improve the content of this chapter for the benefit of the international community, and invites all renal registries to participate in this data collection and collaboration. Feel free to contact us via email at USRDS@usrds.org – as there are many countries not yet represented. Efforts to increase international engagement and enhance the content will continue to be a focus of this chapter. We also wish to make readers aware of the Share-RR initiative (SHARing Expertise to support the set-up of Renal Registries), which is an advocacy effort supported by the International Society of Nephrology (ISN), with collaboration by many different national renal registries. The goal of Share-RR is to develop informational resources that can be used by leaders to help develop a renal registry in their country (https://www.theisn.org/advocacy/share-rr). Through this effort, a survey recently has been distributed to registries in >90 countries to understand the types of processes used for registry

data collection within each country; its goal is to inform current and future registries regarding different approaches used for registry data collection. We are also excited by the development of a newly established international pediatric registry, the *International Pediatric Nephrology Association Global RRT Registry,* which is very useful for understanding numerous aspects of ESRD among pediatric patients across many countries (*http://ipna-online.org/content/registry-0*).

Methods

The findings presented in this chapter result from analyses of each country's aggregate data provided in response to a request by the USRDS for a country's registry to complete a data collection form indicating various aspects of patients receiving RRT for ESRD. A copy of the Data Collection Form is available on the *USRDS website*.

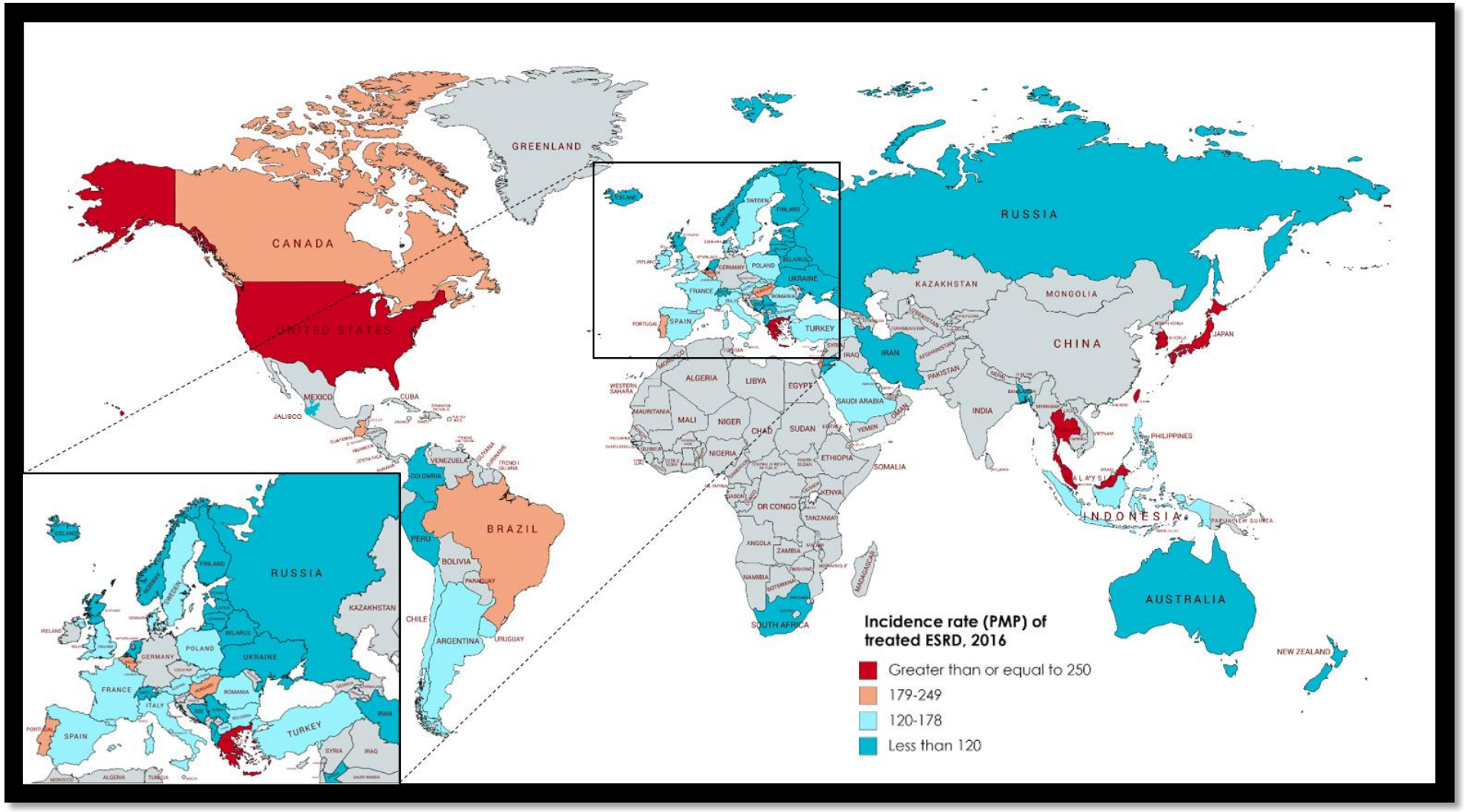
Data tables formerly presented within the content of this chapter are now located in *Reference Table N.* For an explanation of the analytical methods used to generate the study cohorts, figures, and tables in this chapter, see the section on *Chapter 11* in the *ESRD Analytical Methods* chapter. Downloadable Microsoft Excel and PowerPoint files containing the data and graphics for these figures are available on the *USRDS website*.

Incidence of Treated ESRD

In 2016, reported incidence rates of treated ESRD varied greatly across countries (Figures 11.1 and 11.2). Taiwan, the United States, the Jalisco region of Mexico, and Thailand reported the highest incidence of treated ESRD, at 493, 378, 355, and 346 individuals per million general population (PMP). The next highest rates, ranging from 200–333 PMP, were reported by Singapore, the Republic of Korea, Japan, Malaysia, Greece, Portugal, Hungary and Canada. The lowest treated ESRD incidence rates, ranging from 22 to 85 PMP, were reported by South Africa, Ukraine, Belarus, Bangladesh, Russia, Jordan, Peru, Colombia, Iran, Albania, and Estonia.

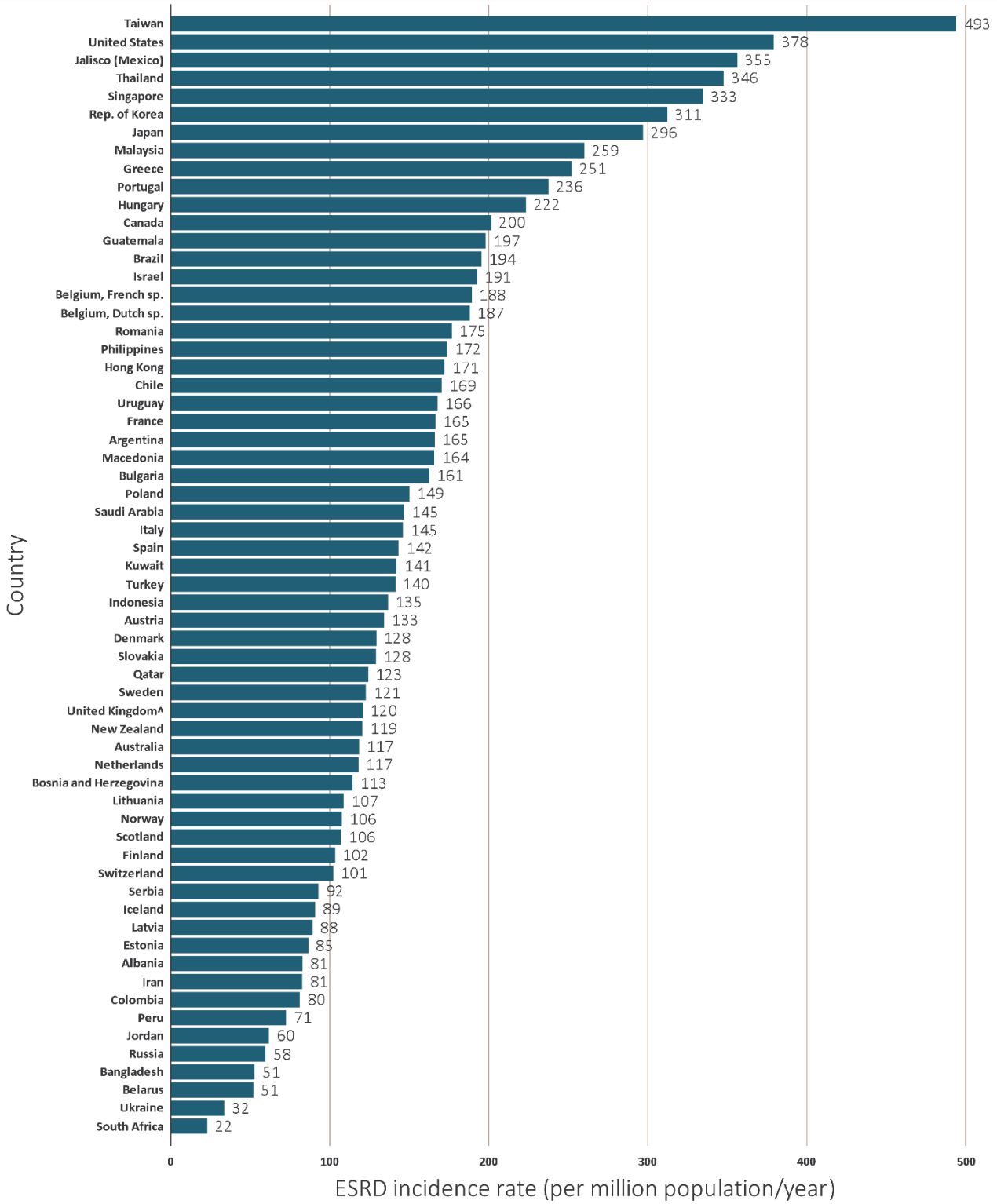
Trends in the incidence of treated ESRD from 2003 to 2016 also varied greatly across countries, as shown in Figure 11.3. Incidence rates of treated ESRD have remained relatively stable in approximately half of countries since 2003, either declining modestly or rising ≤1.0% per year from 2003 to 2016 in countries which reported data over this time period. In contrast, treated ESRD incidence rates rose an average of 2% to 4.1% per year in nearly 30% of countries (including the U.S. at 2.2% per year), and rose an average of 6% to 19% per year from 2003-2016 in Thailand, Malaysia, the Republic of Korea, the Jalisco region of Mexico, Singapore, the Philippines, and Taiwan.

vol 2 Figure 11.1 Geographic variation in the incidence rate of treated ESRD (per million population), by country, 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data unavailable for countries pictured above in gray. All rates are unadjusted. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Guatemala exclude pediatric ESRD patients and patients receiving non-institutional RRT. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Japan includes dialysis patients only. Data from Latvia representative of 80% of ESRD patient population. Data for Serbia approx. 30% less than reported in 2015 due to incomplete reporting. United Kingdom: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviation: ESRD, end-stage renal disease; PMP, per million population; RRT, renal replacement therapy. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.2 Incidence rate of treated ESRD (per million population), by country, 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. All rates are unadjusted. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Guatemala exclude pediatric ESRD patients and patients receiving non-institutional RRT. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Japan includes dialysis patients only. Data from Latvia representative of 80% of ESRD patient population. Data for Serbia approx. 30% less than reported in 2015 due to incomplete reporting. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: ESRD, end-stage renal disease; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.3 Trends in the incidence rate of treated ESRD (per million population/year), by country, 2003-2016

(a) Ten countries having the highest percent increase in ESRD incidence rate in 2003/04 versus that in 2015/16, plus the United States

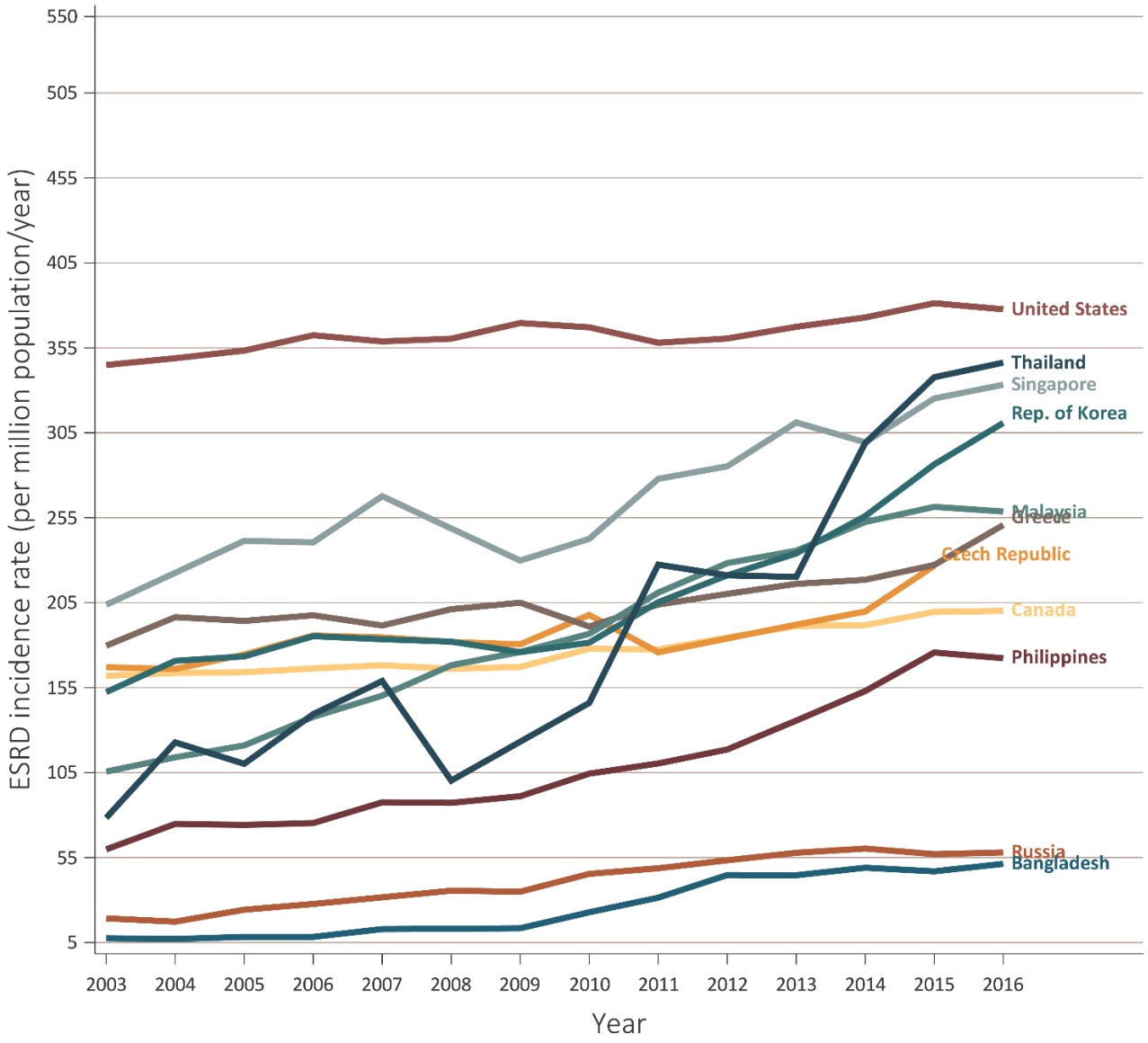
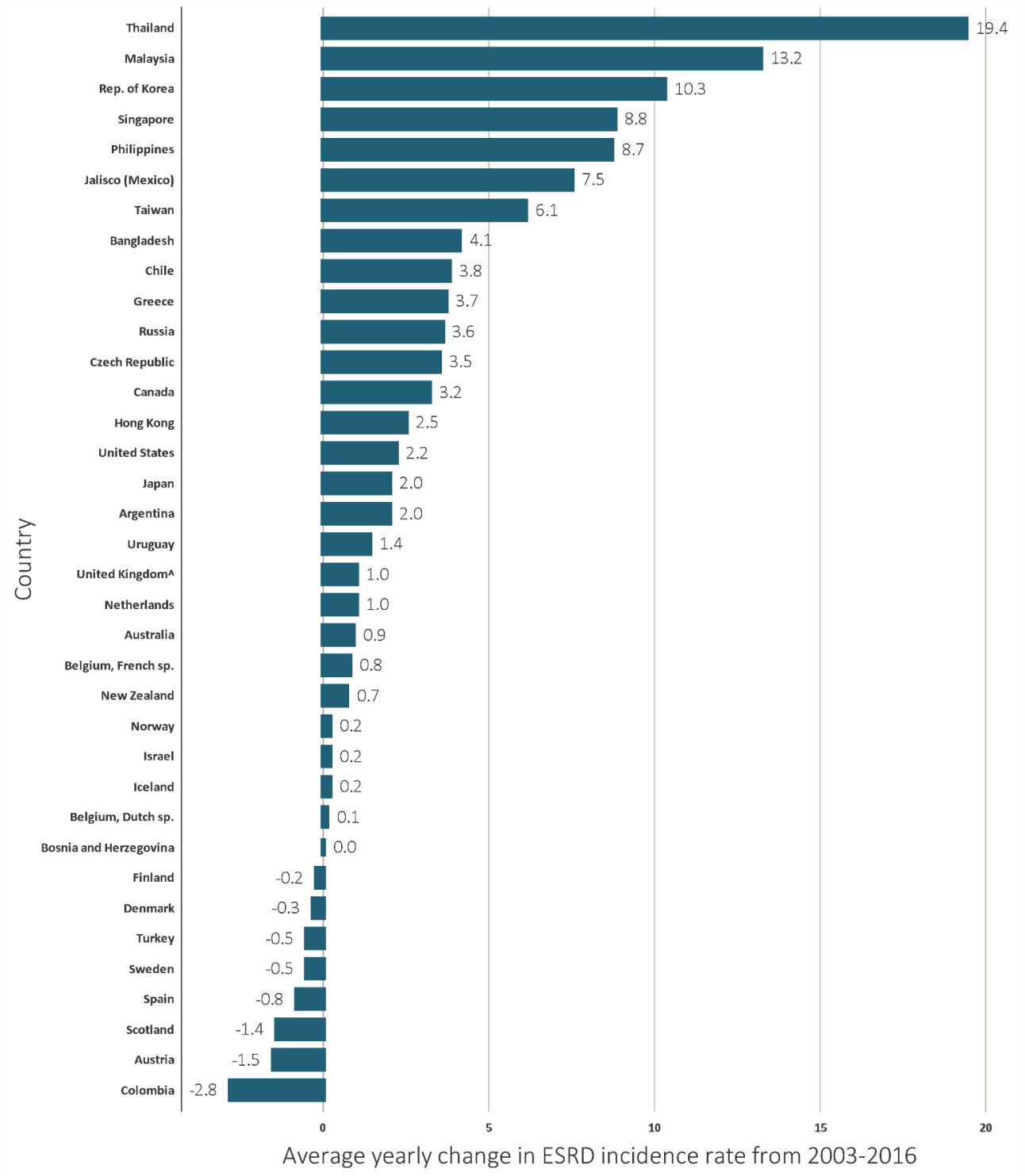


Figure 11.3 continued on next page.

vol 2 Figure 11.3 Trends in the incidence rate of treated ESRD (per million population/year), by country, 2003-2016 (continued)

(b) Average yearly change in the treated ESRD incidence rate from 2003-2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information were available. All rates are unadjusted. (a) Ten countries having the highest percentage rise in 2015-2016 versus that in 2003-2004, plus the United States. (b) Estimates derived from linear regression. Abbreviation: ESRD, end-stage renal disease. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

Diabetes as Primary Cause of End-Stage Renal Disease in Incident Patients

In this section, we highlight diabetes mellitus (DM) as the predominant likely underlying cause of treated ESRD worldwide. It should be noted that many other etiologies of kidney disease and ESRD exist, including hypertension, a variety of glomerulonephritides, tubulointerstitial disorders, inherited or congenital disorders, cancer, environmental toxins or drug toxicity, and other dietary or environmental factors that may be particularly relevant in some regions.

Nearly 71% of the countries participating in this report provided data on the incidence of treated ESRD with assigned primary cause being DM—a key contributor to the global burden of kidney disease and ESRD. In 2016, Malaysia, Singapore, and the Jalisco region of Mexico reported the highest proportions of patients with new ESRD due to DM, at 67%, 66%, and 65% (Figure 11.4.a). Furthermore, DM was listed as the primary cause of new ESRD for 40-50% of patients in Brazil, Slovakia, Uruguay, Hungary, Thailand, Jordan, Japan, Qatar, Kuwait, Taiwan, the U.S., Indonesia, Chile, New Zealand, Hong Kong, Israel, and the Republic of Korea. In contrast, in 2016, DM was the primary cause of ESRD for 20% or less of new ESRD patients in Albania, South Africa, the Netherlands, Russia, Italy, Estonia, Lithuania, Iceland, Norway, Latvia, and Romania.

In 2016, the Jalisco region of Mexico had the highest ESRD incidence rate due to DM, at nearly 231 new ESRD patients PMP (Figure 11.4.b). Thirty countries provided incidence rates of ESRD due to DM for the entire period from 2003 to 2016 (Figure 11.5) These data indicate an overall rise in the incidence of treated ESRD due to DM in most, but not all, of these nations. The greatest average yearly increase in diabetes-related ESRD incidence rates from 2003 to 2016 has occurred in the Jalisco region of Mexico and Malaysia where incidence rates of treated ESRD due to diabetes have increased an average of 7.8 and 9.5 patients PMP per year, respectively, over this 14 year time period. In some countries, the overall percent increase from 2003 to 2016 has been especially large—from 50% to 360% (Figure 11.6). These included Hong Kong, Australia, the United Kingdom, Bosnia and Herzegovina, Singapore, the Republic of Korea, Malaysia, the Philippines, Iceland, and Russia. Furthermore, in Thailand the incidence of ESRD due to DM has more than doubled since 2010.

It is conceivable that the practice of assigning primary cause of ESRD may have changed in some countries over this reporting period, and thus methodology rather than true trends may have contributed to the observed changes. However, we currently have no information regarding the extent of this possibility for any of the countries.

vol 2 Figure 11.4 Incidence of treated ESRD due to diabetes as the assigned primary cause of ESRD cause, by country, 2016

(a) Percentage of incident ESRD patients

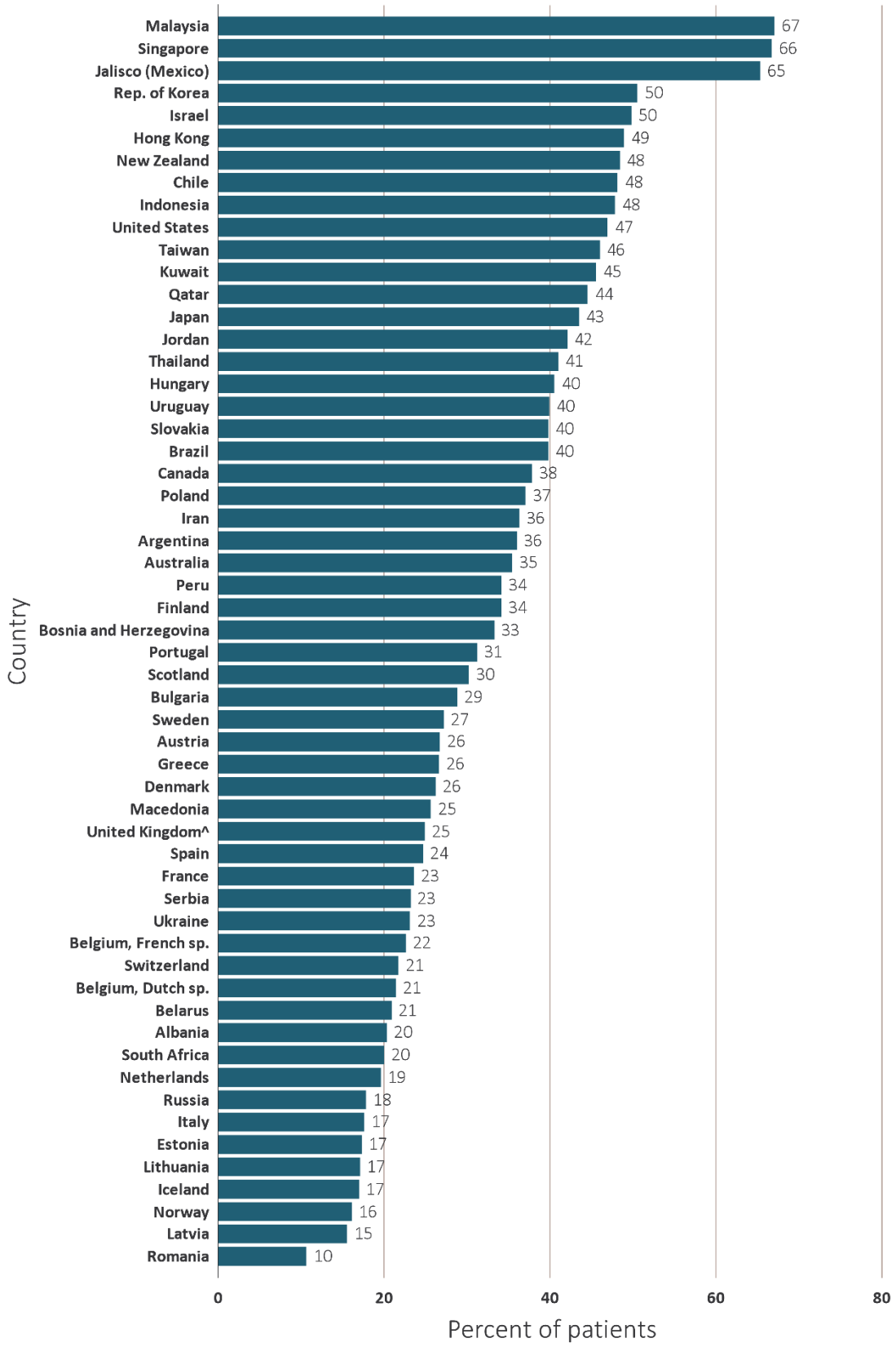
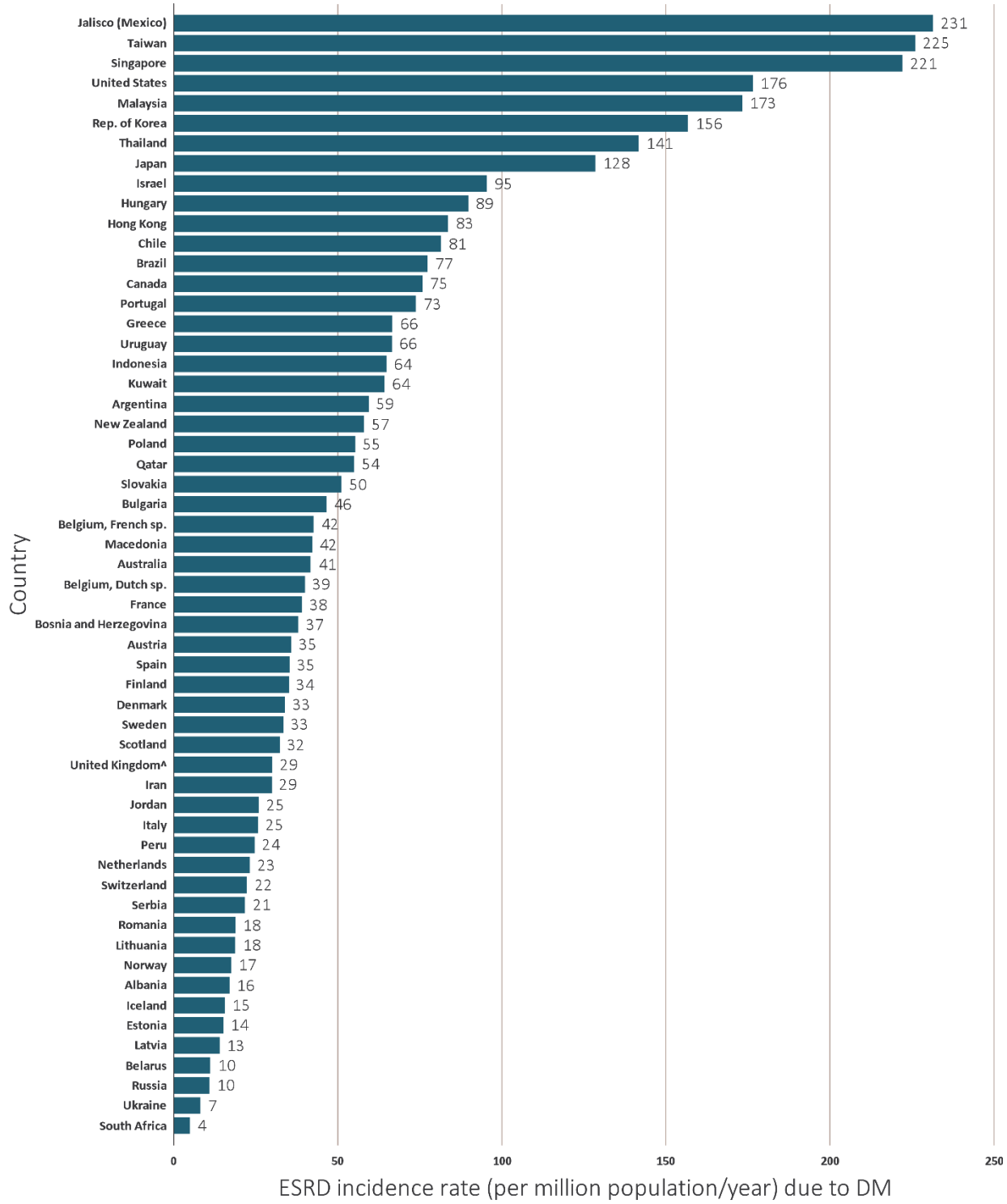


Figure 11.4 continued on next page.

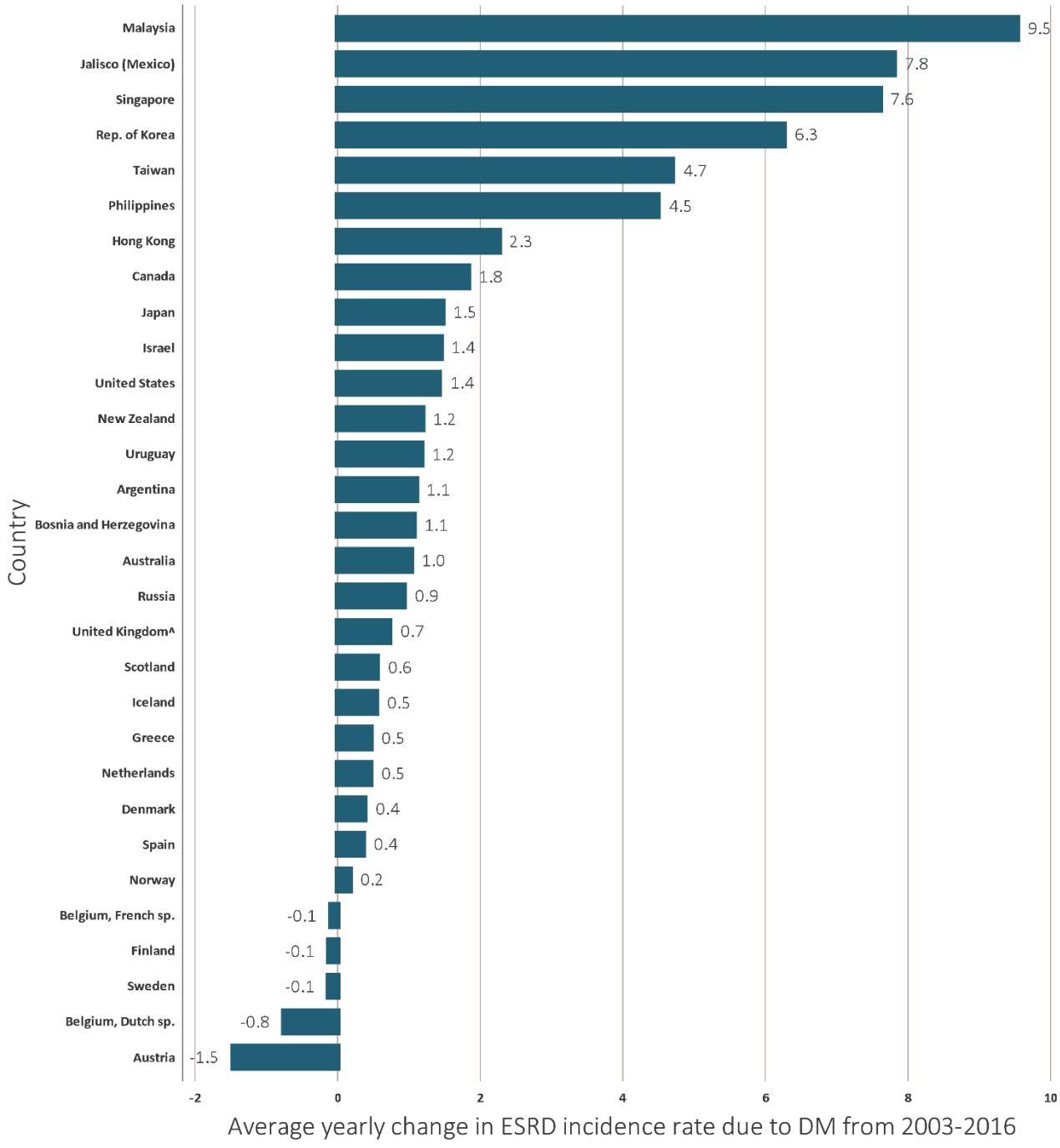
vol 2 Figure 11.4 Incidence of treated ESRD due to diabetes as the assigned primary cause of ESRD cause, by country, 2016 (continued)

(b) Incidence rate of treated ESRD (per million population)



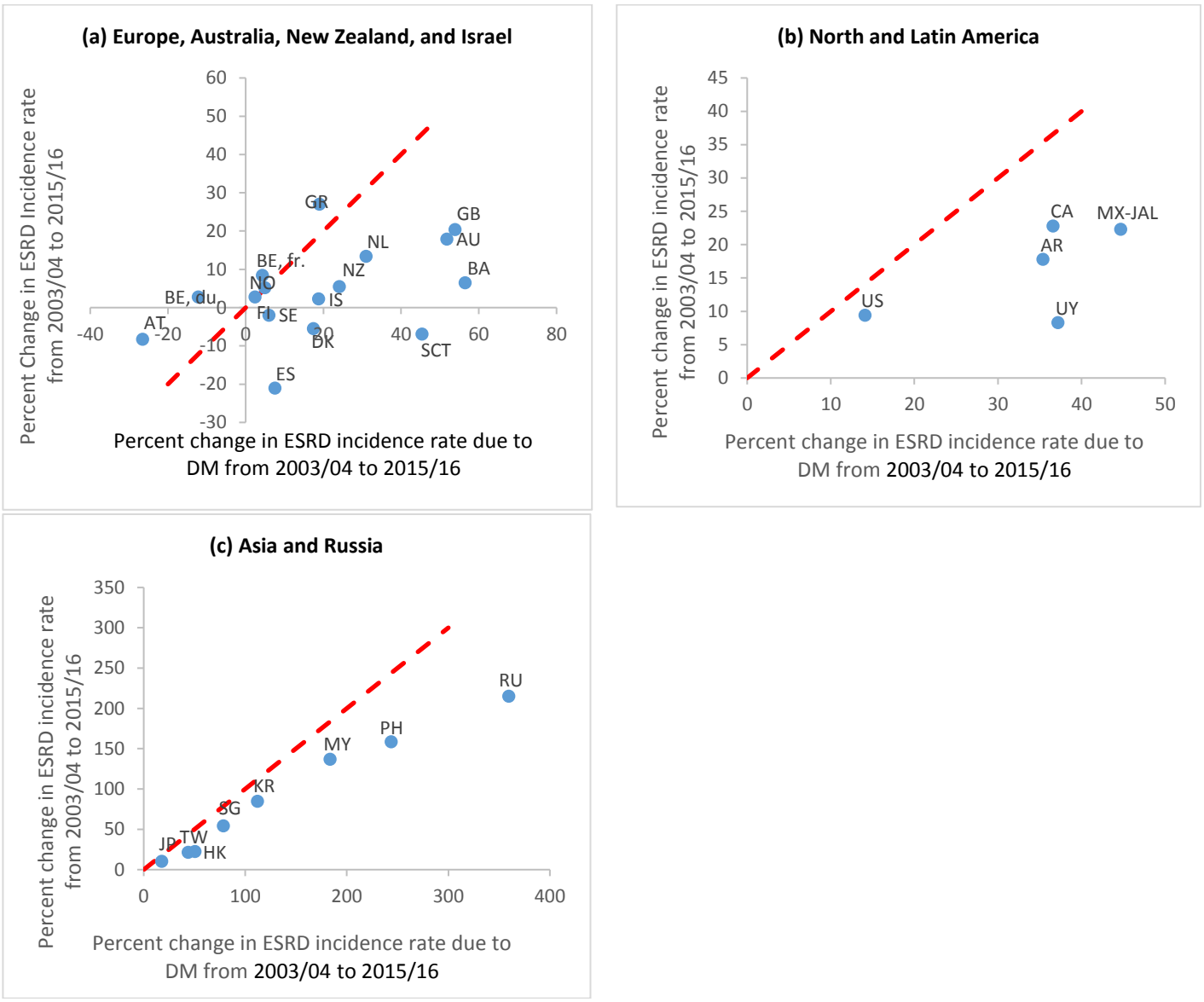
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information were available. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Japan includes dialysis patients only. Data from Latvia representative of 80% of ESRD patient population. Data for Serbia approx. 30% less than reported in 2015 due to incomplete reporting. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: ESRD, end-stage renal disease; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.5 Average yearly change in the incidence rate of treated ESRD due to diabetes as the assigned primary ESRD cause (per million population/year), by country, 2003-2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information were available. Estimates derived from linear regression. Abbreviation: ESRD, end-stage renal disease; Rep., Republic; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.6 Country-level correlation of the percentage change in ESRD incidence with the percentage change in ESRD incidence due to diabetes, from 2003-2016, with countries displayed by region



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Reference line (in red) represents 1:1 ratio of percentage change in ESRD incidence rate due to diabetes and percentage change in ESRD incidence rate from 2003/04-2015/16. Countries listed in order of lowest to highest percentage change in ESRD incidence due to diabetes in each panel. (a) Europe, Australia, New Zealand, and Israel: (-27-57%) Austria (AT), Belgium, Du. speaking (BE, du.), Finland (FI), Belgium, fr. speaking (BE, fr.), Norway (NO), Sweden (SE), Spain (ES), Denmark (DK), Israel (IS), Greece (GR), New Zealand (NZ), Netherlands (NL), Scotland (SCT), Australia (AU), United Kingdom (GB), and Bosnia and Herzegovina (BA); (b) North and Latin America: (2-45%) Uruguay (UY), United States (US), Argentina (AG) Canada (CA), Jalisco (Mexico, MX-JAL); (c) Asia and Russia: (18-360%) Japan (JP), Taiwan (TW), Hong Kong (HK), Singapore (SG), Rep. of Korea (KR), Malaysia (MY), Philippines (PH), Russia (RU). Abbreviation: du., Dutch; ESRD, end-stage renal disease; fr., French; Rep., Republic. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

Incidence of Treated ESRD Disease by Age Group and Sex

Figure 11.7 presents the 2016 incidence of treated ESRD by age group. In all Western and the majority of Northern European countries, Canada, the United States, Japan, Taiwan, Austria, Macedonia, and Greece, treated ESRD incidence rates were highest among patients aged 75 years or older, with the highest rates in this age group occurring in Taiwan, with 2,869 PMP/year followed by the United States at 1360 PMP/year. In contrast, the incidence of treated ESRD was 8-60% lower in the population aged 75 years or older, as compared to those aged 65-74 years in Australia, New Zealand, the South American countries (Argentina, Peru, and Uruguay), in a majority of the Eastern European countries (Albania, Belarus, Latvia, Romania, Serbia, and Slovakia), and in Jordan, Estonia, Iceland, Hong Kong, Russia and Malaysia. In 2016, among the population of younger adults aged 20-44 years, relative to other countries, the United States reported the highest ESRD incidence rate at 134 PMP, followed by Malaysia at 111 PMP, but with many countries having treated ESRD incidence rates <50 PMP in this young age group of adults 20-44 years old.

In Figure 11.8, we compare the incidence of treated ESRD by sex. In almost every country except Jordan, the rate was substantially higher for males than for females. ESRD incidence was at least two times higher for males in Estonia, Austria, Japan, Denmark, Spain, Serbia, Finland, Lithuania, and Greece, and was 1.0-1.9 times higher for males in most other countries. The ratio of male to female ESRD incidence in Jordan was 0.74. In the United States, males had a higher ESRD incidence rate, despite CKD being less prevalent among males than females, as reported in Volume 1, Chapter 1: *CKD in the General Population*.

The considerably lower ESRD incidence for females in nearly all countries shown in Figure 11.8 is consistent with published data from 12 countries participating in the Dialysis Outcomes and Practice Patterns Study (DOPPS) (Hecking et al., 2014) as well as the higher lifetime risk of ESRD among males in all race groups, based on a detailed analysis of U.S. ESRD and Census data (Albertus et al., 2016). The observed sex differences in incidence rates from the vast majority of countries, including the United States, raises the question of whether the explanation is mostly biological or environmental, or whether it might also represent a sociocultural or healthcare disparity.

vol 2 Figure 11.7 Incidence rate of treated ESRD (per million population/year), by age group and country, 2016

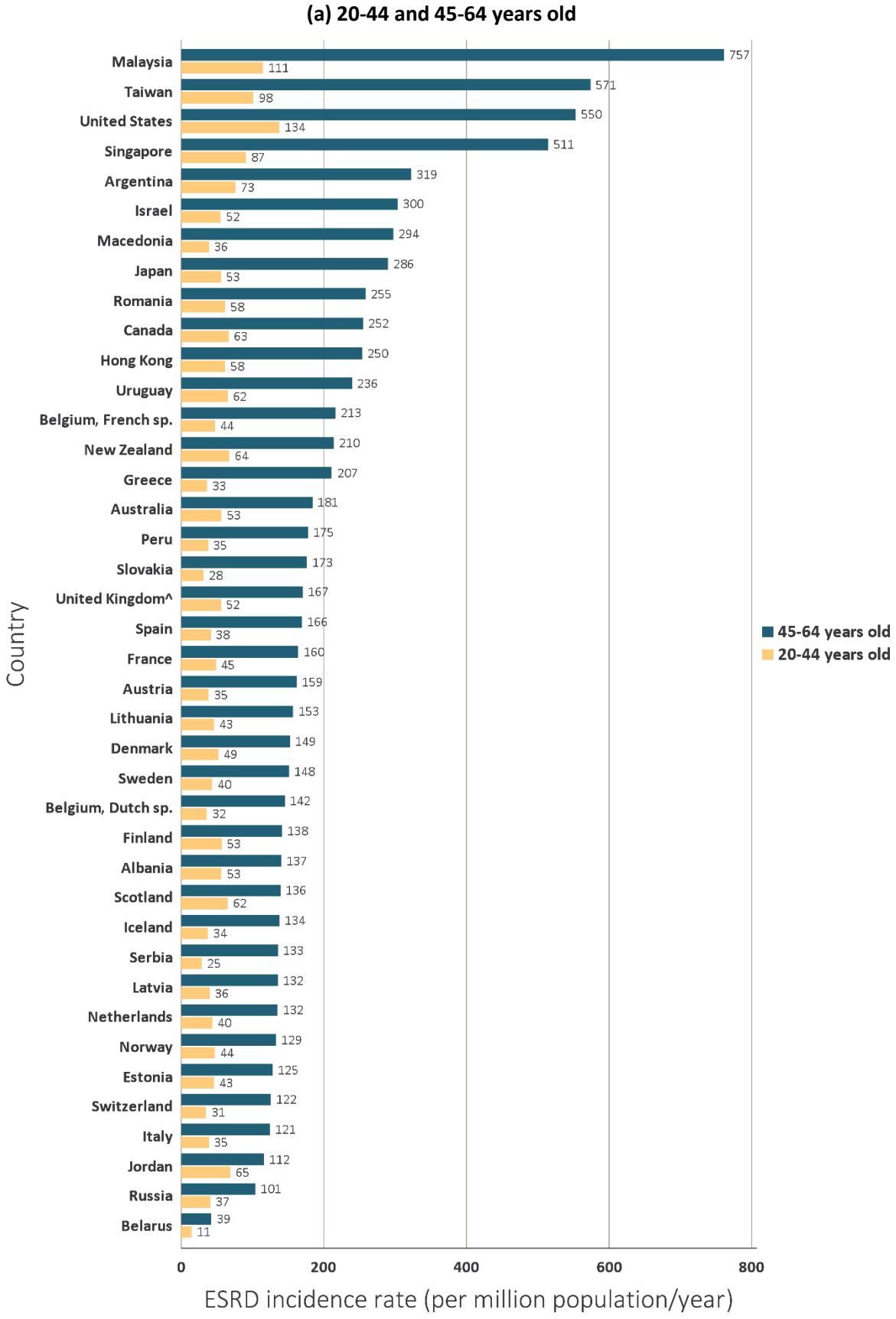
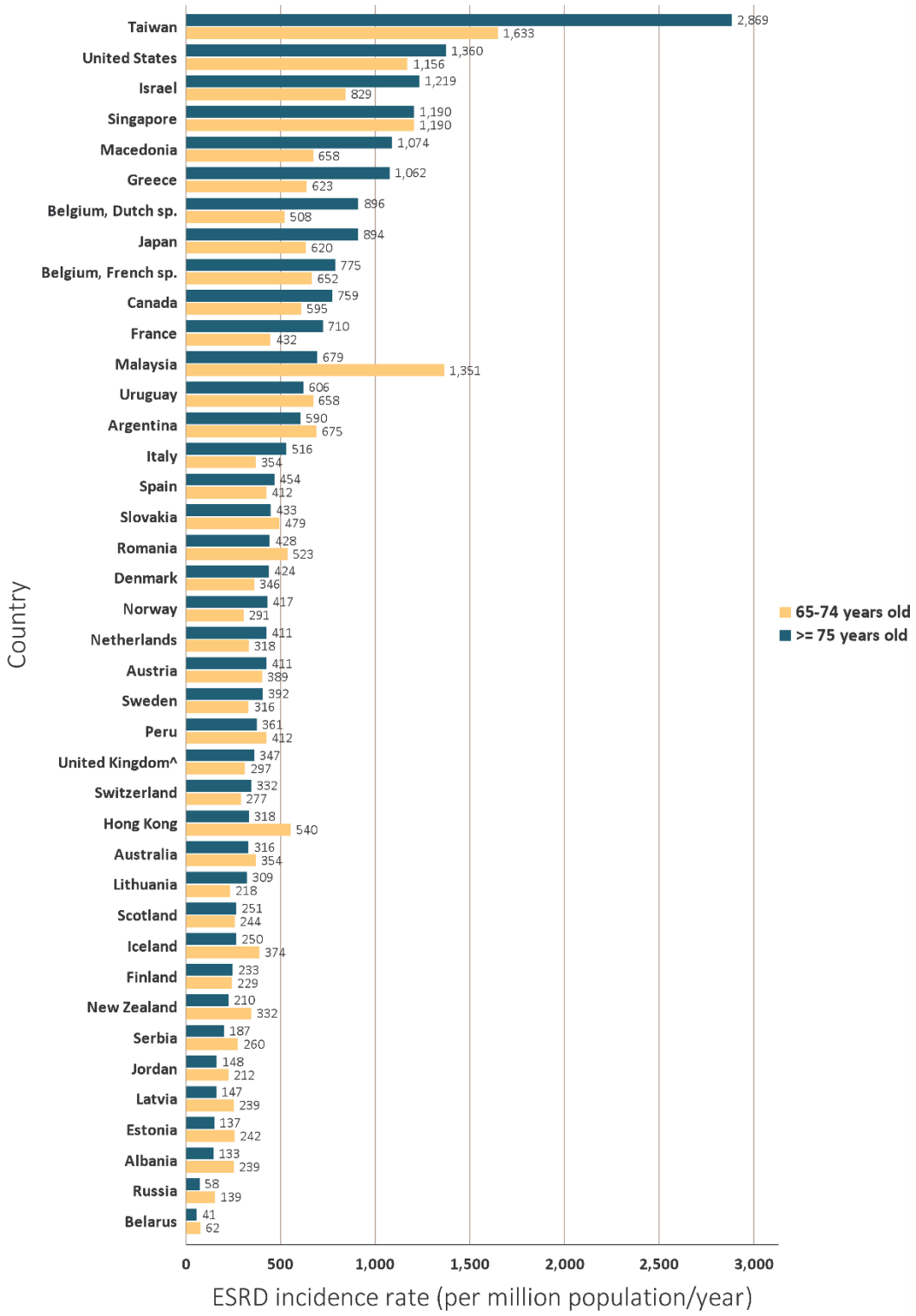


Figure 11.7 continued on next page.

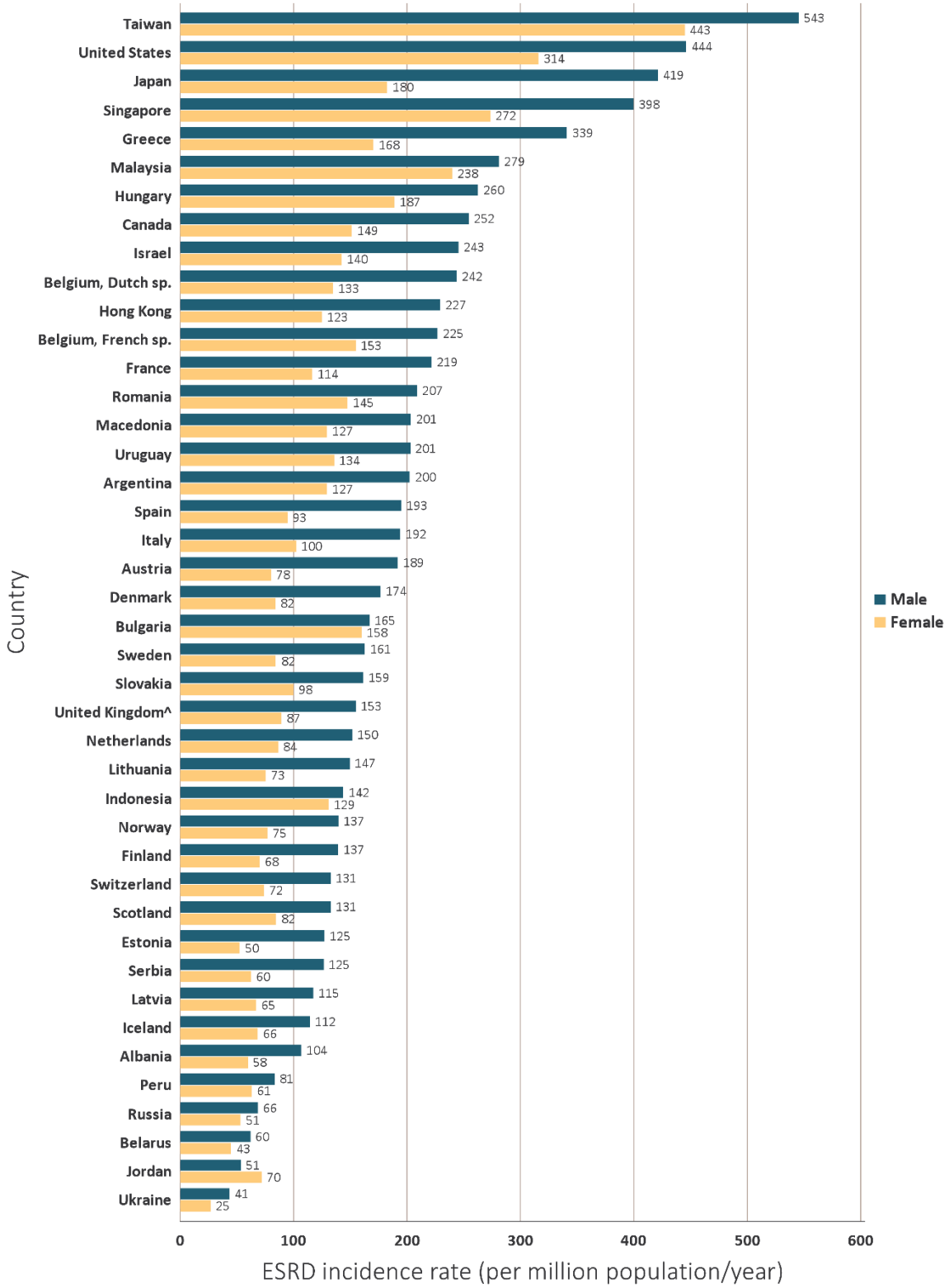
vol 2 Figure 11.7 Incidence rate of treated ESRD (per million population/year), by age group and country, 2016 (continued)

(b) 65-74 and ≥75 years old



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Japan includes dialysis patients only. Data from Latvia representative of 80% of ESRD patient population. Data for Serbia approx. 30% less than reported in 2015 due to incomplete reporting. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). For graph (a), data for Spain include patients 15-64 years old, and data for the United States include patients 22-64 years old. Abbreviations: ESRD, end-stage renal disease; fr., French; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.8 Incidence rate of treated ESRD (per million population/year), by sex and country, 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Japan includes dialysis patients only. Data from Latvia representative of 80% of ESRD patient population. Data for Serbia approx. 30% less than reported in 2015 due to incomplete reporting. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

Prevalence of ESRD

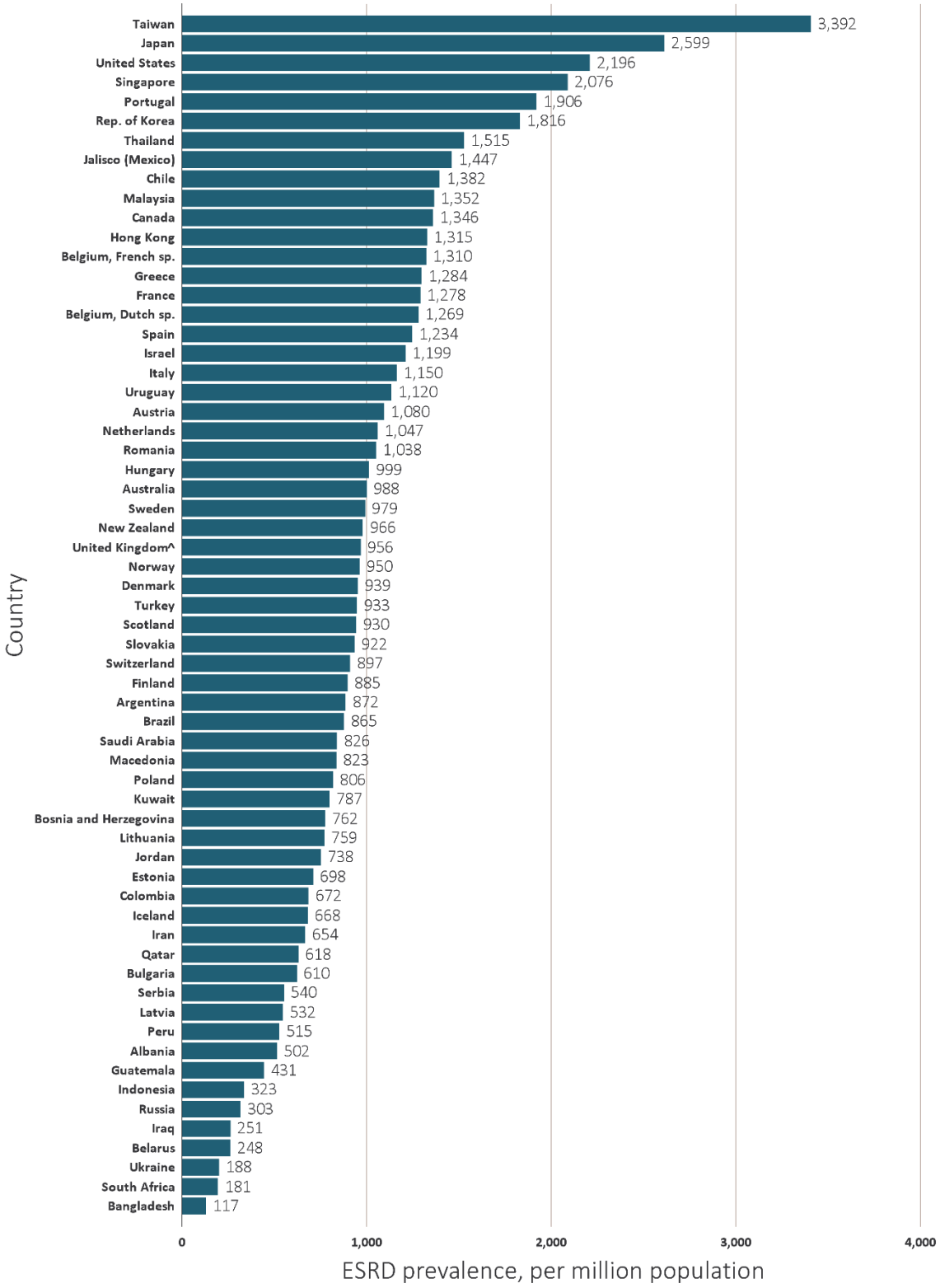
In 2016, 2,455,004 patients were treated for ESRD across all reporting countries. The number was by far the highest in the United States, with 709,501 treated patients accounting for 29% of the total, and followed by Japan and Brazil with approximate cohorts of 328,000 and 180,000 prevalent patients (*Reference Table N.4.a*). Iran, Spain, the United Kingdom., Turkey, Taiwan, France, the Republic of Korea, and Thailand reported between 52,000 and 100,000 treated ESRD patients in 2016, while all other countries indicated smaller populations (range 224 in Iceland to 44,544 in Russia, with approximately 9,800 treated patients in the median country of Hungary).

In 2016, ESRD prevalence varied nearly 30-fold across represented countries (Figure 11.9). Taiwan reported the highest treated ESRD prevalence of 3,392 PMP, followed by Japan (2599 PMP) and the United States (2196 PMP). Singapore, Portugal, the Republic of Korea, Thailand, and the Jalisco region of Mexico also reported a very high prevalence, ranging from 1447-2076 PMP. In just over one-quarter of countries, prevalence ranged from 1,000 to 1,500 PMP, while approximately 45% reported 600 to 999 prevalent ESRD patients PMP. These included many countries in Western, Central, and Eastern Europe, Australia and New Zealand, the South American countries of Argentina, Colombia, and Brazil, and the Middle Eastern nations of Qatar, Iran, Kuwait, Jordan, and Saudi Arabia. Lowest prevalence rates ranging from 117 to 540 PMP were reported by Bangladesh, South Africa, Ukraine, Belarus, Iraq, Russia, Indonesia, Guatemala, Albania, Peru, Latvia, Serbia, and Bulgaria.

Although ESRD incidence rates have been stable or decreasing in many countries during recent years, ESRD prevalence PMP has steadily increased in all 36 countries that provided data from 2003 to 2015 and/or 2016 (Figures 11.11.a and 11.11.b). Over this period, the median percent increase in ESRD prevalence was 43%, varying from an 11% to a 548% rise. These trends support the increasing worldwide need for additional dialysis and kidney transplantation services to meet the health needs of individuals with ESRD. The largest proportionate increases in ESRD prevalence between 2003/04 and 2015/16 were observed in the Jalisco region of Mexico, Thailand, and the Philippines, ranging from 213% to 548%, followed by rises of 113% to 212% in the Republic of Korea, Turkey, Brazil, Malaysia, and Russia. In the United States, ESRD prevalence increased 42% overall from 2003/04 to 2015/16, with a nearly average annual increase of 53.3 patients PMP per year. When overall absolute yearly change in ESRD prevalence PMP was calculated for each country over the time period from 2003 to 2016 (Figure 11.11b), average annual increases in prevalence PMP ranged from 4 in Bangladesh to 122 in Taiwan (median average rise = 26 PMP/year). The 8 countries with the highest average annual increases in ESRD prevalence were Taiwan (122), Thailand (106), the Jalisco region of Mexico (84), the Republic of Korea, Malaysia, Japan, and Singapore (61-76), and the United States (53).

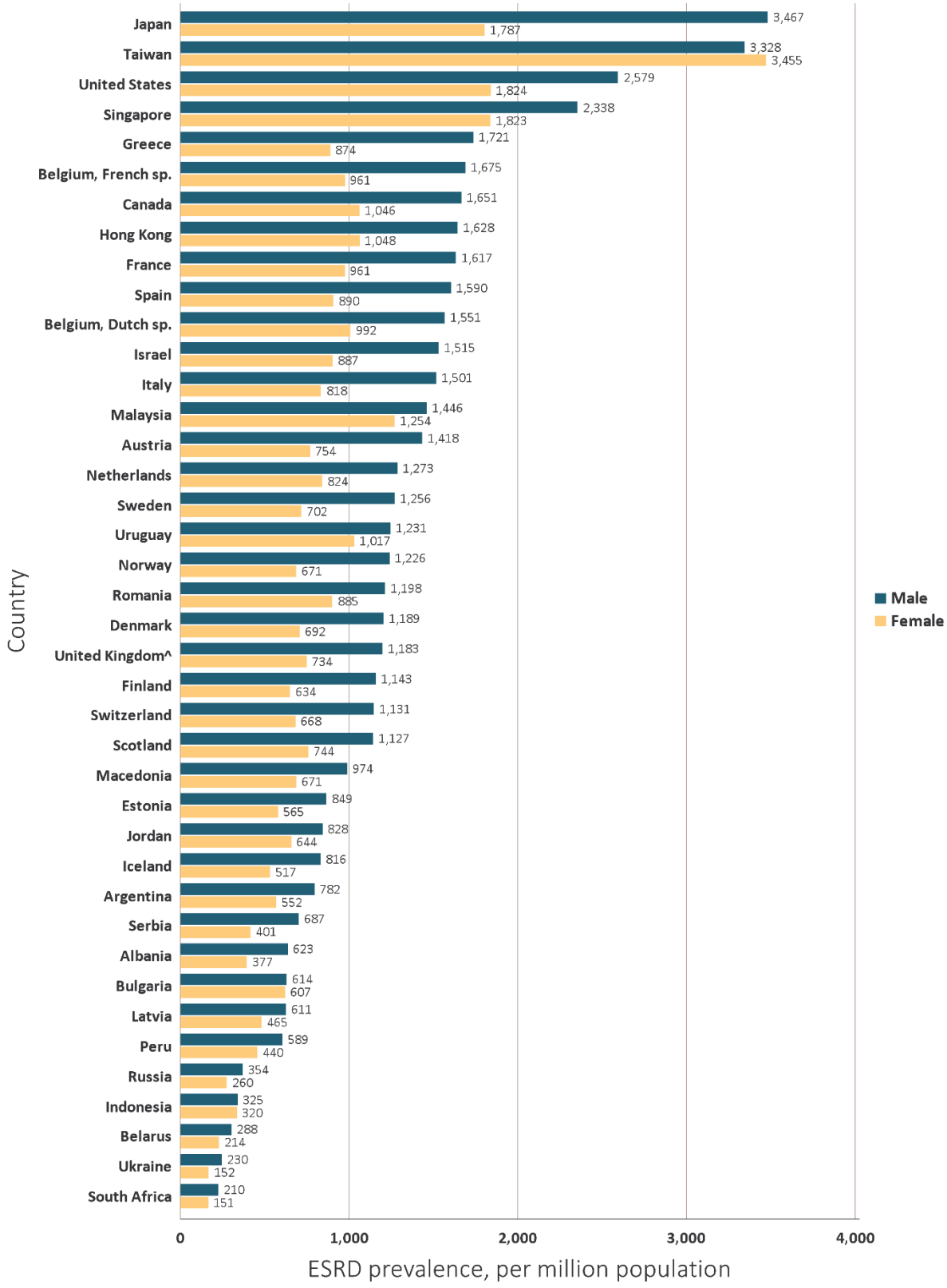
Similar to incidence of ESRD typically being higher among males than females in nearly every country, prevalence of ESRD PMP was higher for males than females in every country except in Taiwan (Figure 11.10).

vol 2 Figure 11.9 Prevalence of treated ESRD (per million population), by country, 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Guatemala exclude pediatric ESRD patients and patients receiving non-institutional RRT. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Data from Latvia representative of 80% of ESRD patient population. Prevalent functioning graft data for Slovakia only available for prevalent transplant patients. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.10 Prevalence of treated ESRD (per million population), by sex and country, 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Data from Latvia representative of 80% of ESRD patient population. Prevalent functioning graft data for Slovakia only available for prevalent transplant patients. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.11 Trends in the prevalence of treated ESRD (per million population), by country, 2003-2016

(a) Ten countries having the highest percentage rise in ESRD prevalence rate in 2003/04 versus that in 2015/16, plus the United States

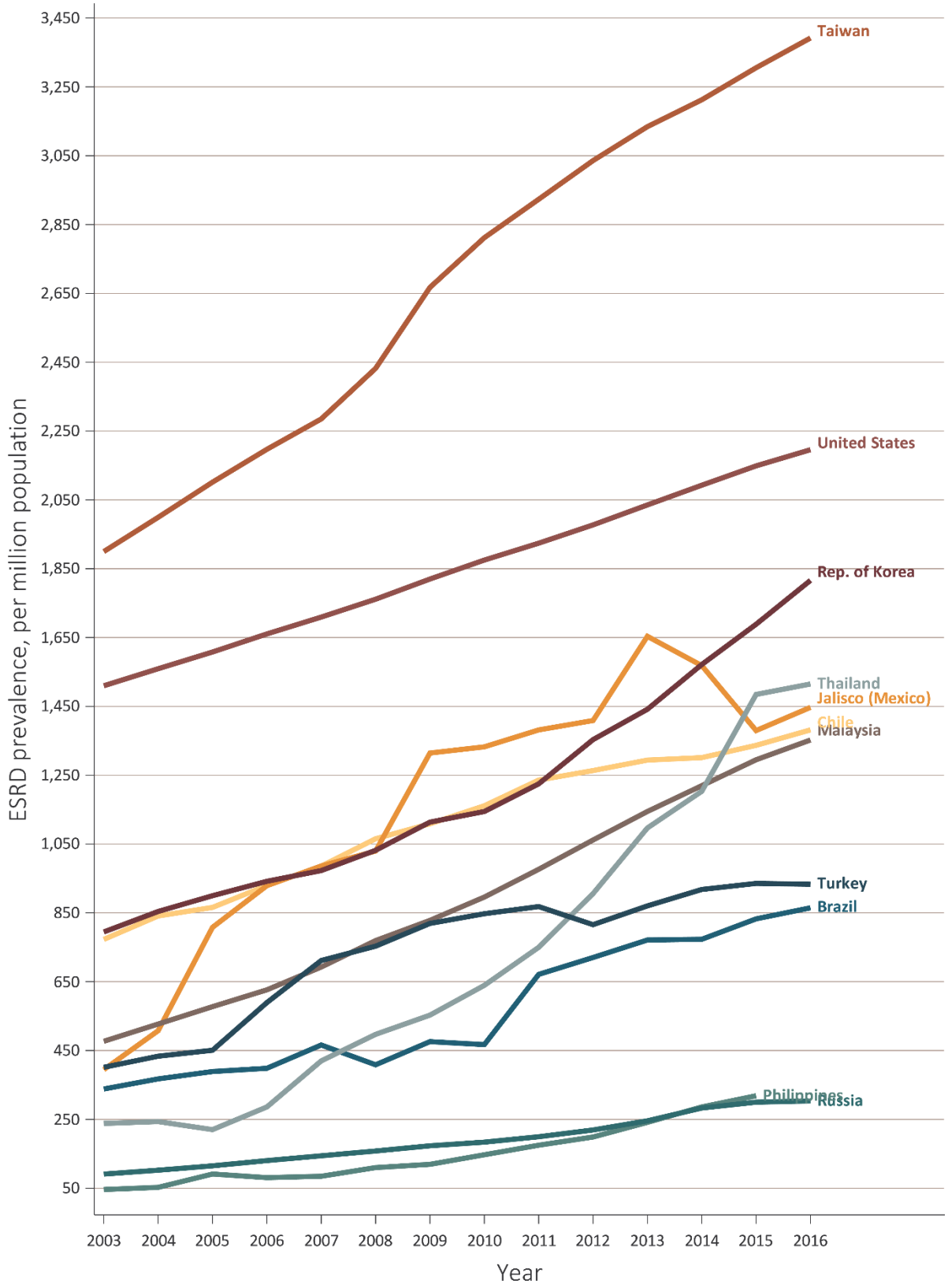
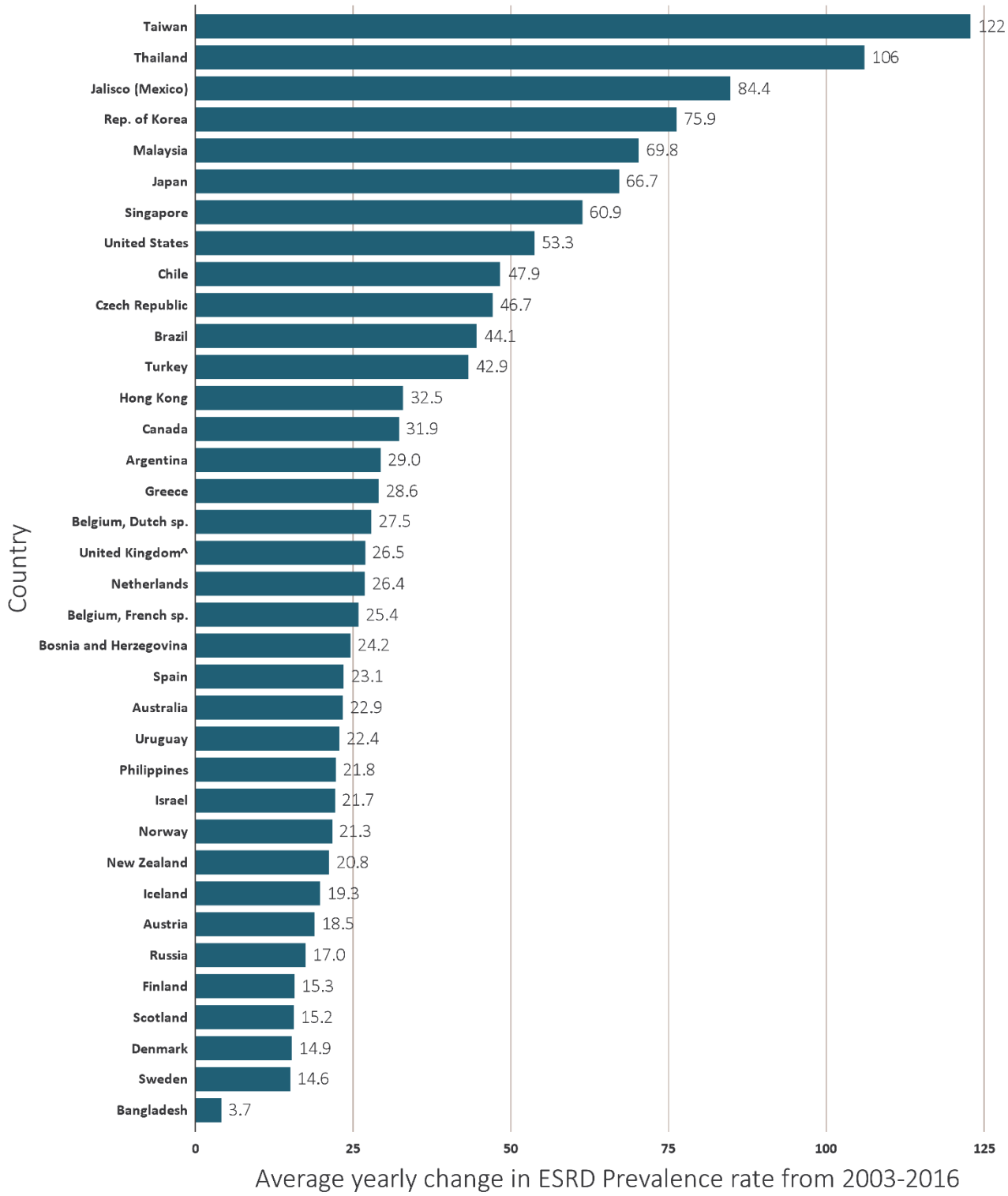


Figure 11.11 continued on next page

vol 2 Figure 11.11 Trends in the prevalence of treated ESRD per million population, by country, 2003-2016 (continued)

(b) Average yearly change in ESRD prevalence rate from 2003-2016



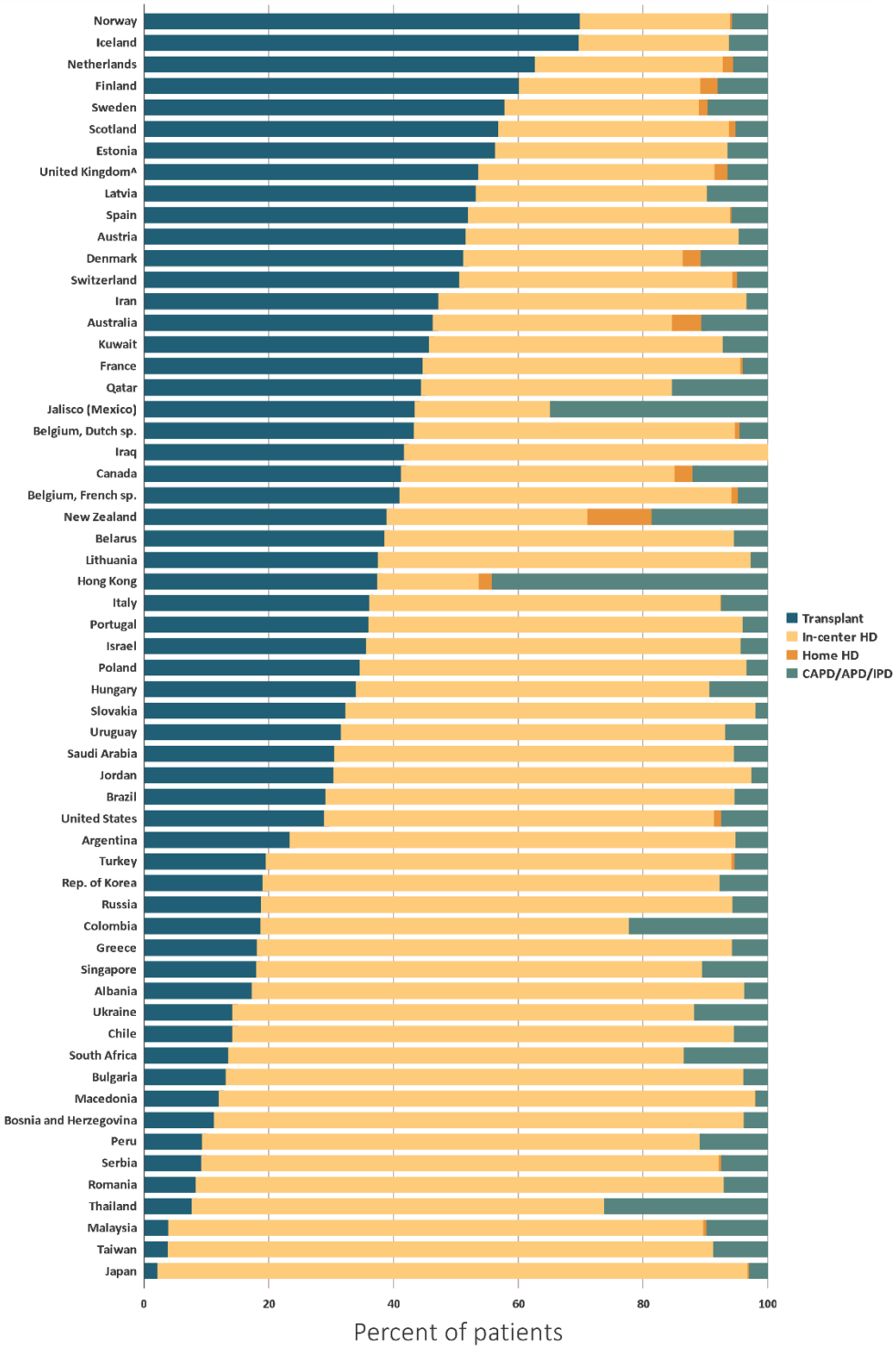
Data source: Special analyses, USRDS ESRD Database. (a)*Ten countries having the highest percentage rise in ESRD prevalence: 2015/16 versus that in 2003/04, plus the United States ESRD prevalence is unadjusted. United States is shown for comparison purposes. (b) Estimates derived from linear regression. Abbreviation: ESRD, end-stage renal disease Rep., Republic; sp., speaking;. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.*

Variations in Use of Different Renal Replacement Therapies for ESRD

In-center HD, home HD, PD, and kidney transplantation are the RRT options available for persons with ESRD. As shown in Figure 11.12, the proportionate use of the different RRT forms varies considerably across countries. Dialysis is more commonly utilized than kidney transplantation as a therapeutic approach for treatment of ESRD in the majority of countries. Many eligible ESRD patients view kidney transplantation as their first choice due to substantially higher quality of life and longer median survival as compared with dialysis therapy.

In 2016, transplantation for patients with ESRD ranged from less than 10% in Peru, Serbia, Romania, Thailand, Malaysia, Taiwan, and Japan to greater than 50% in the Nordic countries of Denmark, Finland, Iceland, Norway, and Sweden, and in Estonia, Latvia, the Netherlands, Switzerland, the United Kingdom (including Scotland), Spain, and Austria (Figure 11.12). Not surprisingly, countries with the highest proportion of kidney transplants among ESRD patients also tended to have lower treated ESRD incidence rates of approximately 85 (Estonia) to 142 (Spain) PMP/year (Figure 11.2). Hong Kong, the Jalisco region of Mexico, Iceland, and Norway had the lowest use of in-center HD (16% to 24%) to treat ESRD patients (Figure 11.12); this was achieved through a combination of greater use of kidney transplantation and/or home dialysis.

vol 2 Figure 11.12 Percentage distribution of type of renal replacement therapy modality used by ESRD patients, by country, in 2016



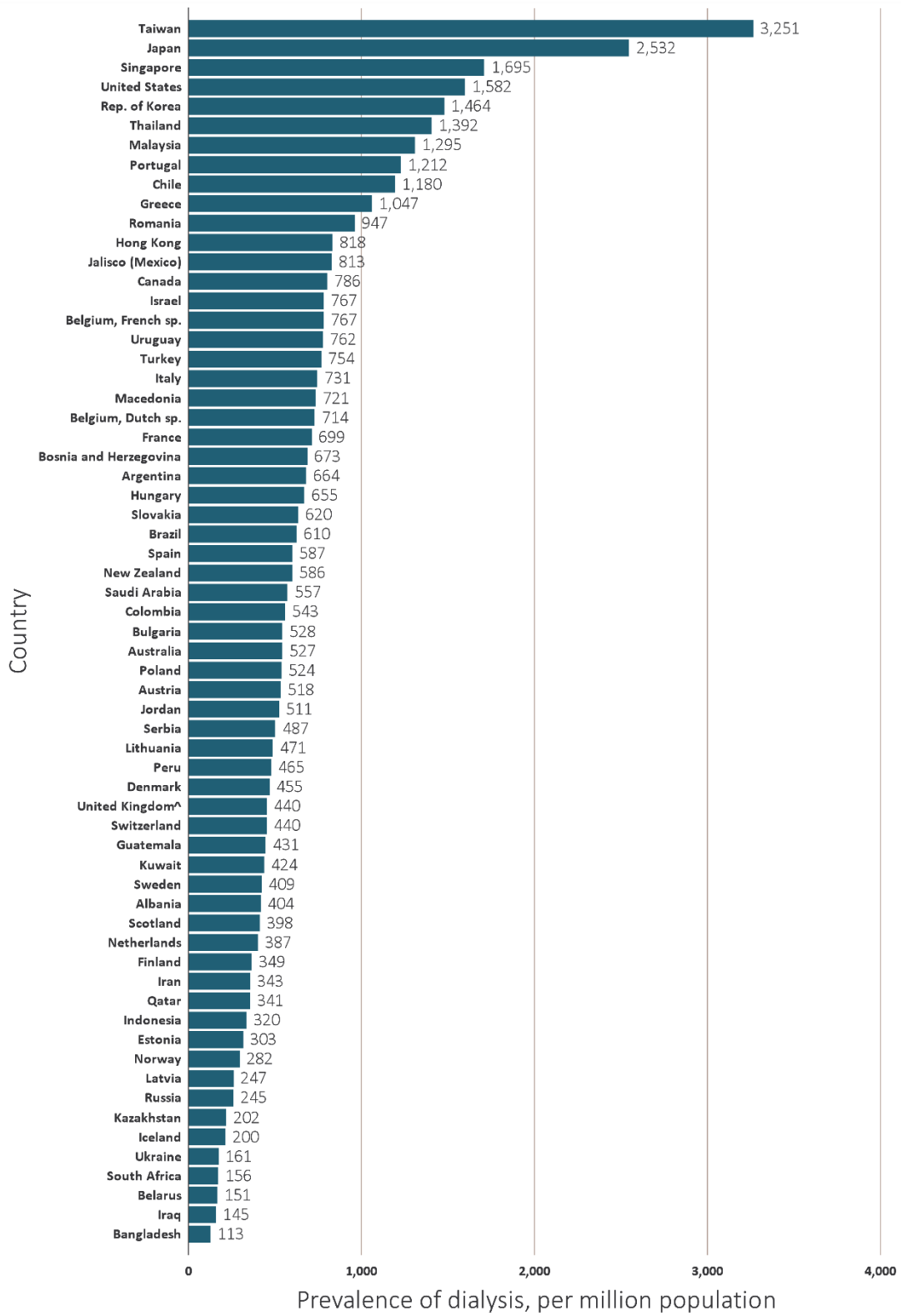
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Denominator is calculated as the sum of patients receiving HD, PD, Home HD, or treated with a functioning transplant; does not include patients with other/unknown modality. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Data from Latvia representative of 80% of ESRD patient population. Prevalent functioning graft data for Slovakia only available for prevalent transplant patients. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; APD, automated peritoneal dialysis; IPD, intermittent peritoneal dialysis; ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

Dialysis Therapy for ESRD

In 2016, the number of ESRD patients receiving dialysis PMP varied nearly 30-fold across countries, from 113 to 200 in Bangladesh, Iraq, Belarus, South Africa, Ukraine, and Iceland to 2,532 in Japan and 3,251 in Taiwan (Figure 11.13). Some countries have experienced very large rises in the prevalence of dialysis since 2003/04, with an approximate increase of 486% in the Philippines and 551% in Thailand, and a rise ranging from 119% to 231% reported by the Republic of Korea, Malaysia, and Russia (Figure 11.14.a, *Reference Table N.6.b*).

When overall absolute yearly change in the prevalence of number of dialysis patients PMP was calculated for each country over the time period from 2003 to 2016, average annual increases in dialysis patients PMP ranged from -0.6 in Denmark to 109 in Taiwan (median average rise = 16 PMP/year) (Figure 11.14.b). The 6 countries with the highest yearly change in the prevalence of number of dialysis patients PMP from 2003-2016 were Taiwan (109) and Thailand (98), followed by Malaysia, the Republic of Korea, Japan, and Singapore (54-70 PMP/year). Hemodialysis continues to be the most common form of dialysis therapy in nearly all countries (Figure 11.15). In nearly four-fifths of reporting countries, at least 80% of chronic dialysis patients were receiving in-center HD in 2016. However, in 2016, PD was used by 71% of dialysis patients in Hong Kong, by 61% in the Jalisco region of Mexico, and by 57% of patients in Guatemala (Figure 11.15). Furthermore, 27-30% PD use was reported in Qatar, Colombia, Thailand, and New Zealand with 18% to 22% PD use seen in Norway, Finland, Australia, Iceland, Canada, Latvia, Denmark, and Sweden. Since 2007, an overall trend of increasing PD use as a percentage of all chronic dialysis has been seen in the countries of Argentina, Canada, Chile, Oman, Spain, Thailand, and the United States. (*Reference Table N.7.e*). In contrast, PD use has declined over this same time period in countries such as Australia, Belgium, Bosnia and Herzegovina, Brazil, Colombia, Finland, France, Greece, Hong Kong, Israel, Japan, the Netherlands, New Zealand, the Philippines, the Republic of Korea, Romania, Scotland, Singapore, Sweden, Turkey, and the United Kingdom. In 2016, home HD therapy was provided to 9% and 17% of dialysis patients in Australia and New Zealand (Figure 11.15). Home HD was also used by 2% to 7% of dialysis patients in the United States, the French-speaking region of Belgium, Scotland, Hong Kong, Sweden, the United Kingdom, the Netherlands, Canada, Denmark, and Finland. However, in all other countries, home HD was either not provided, or was used by fewer than 2% of dialysis patients.

vol 2 Figure 11.13 Prevalence of dialysis (per million population), by country, 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. ESRD prevalence is unadjusted and reflects prevalence at the end of 2016. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Guatemala exclude pediatric ESRD patients and patients receiving non-institutional RRT. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Data from Latvia representative of 80% of ESRD patient population. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviation: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.14 Trends in the prevalence of dialysis (per million population), by country, 2003-2016

(a) Ten countries having the highest percentage rise in dialysis prevalence rate in 2003/04 versus that in 2015/16, plus the United States

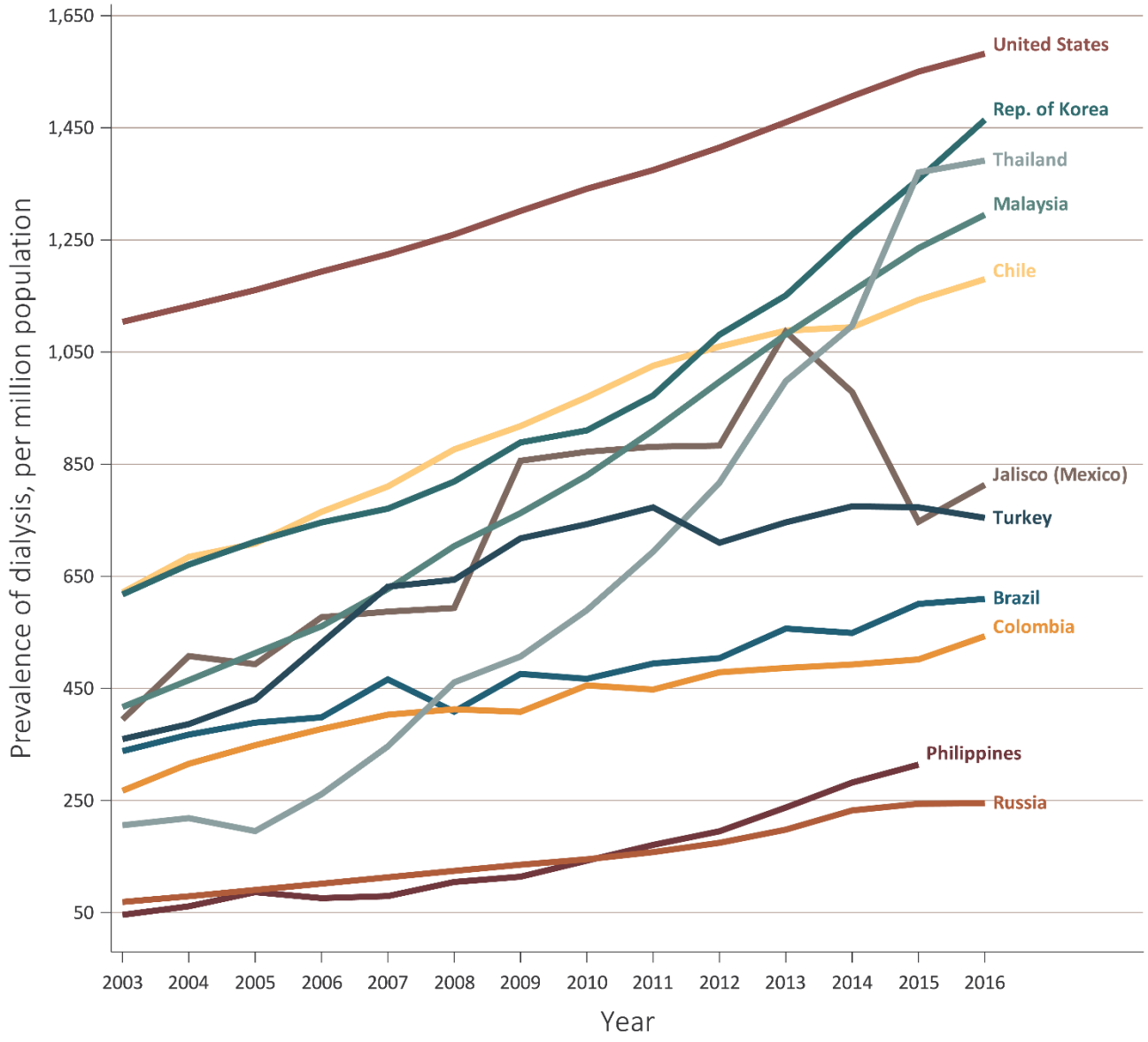
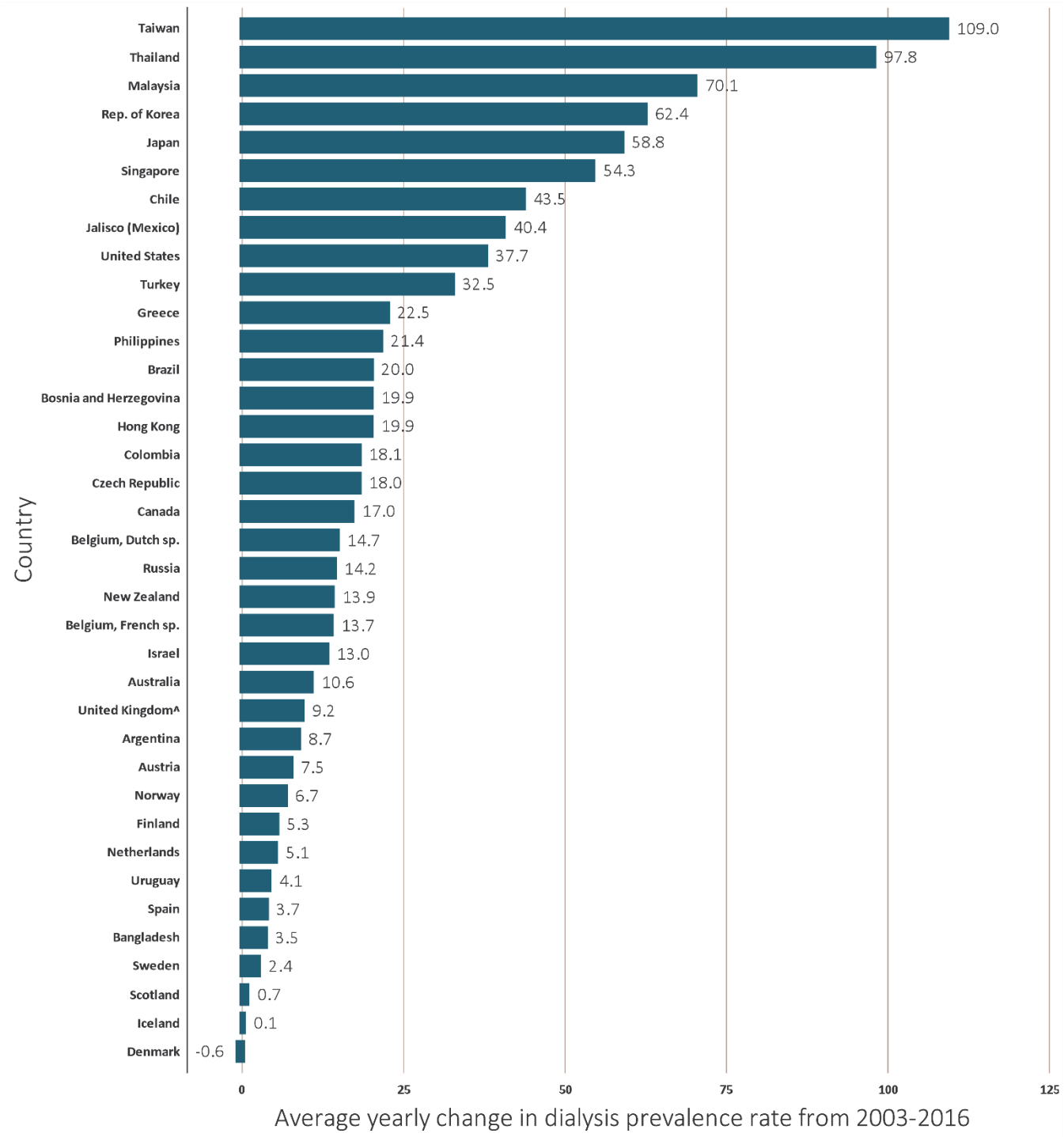


Figure 11.14 continued on next page.

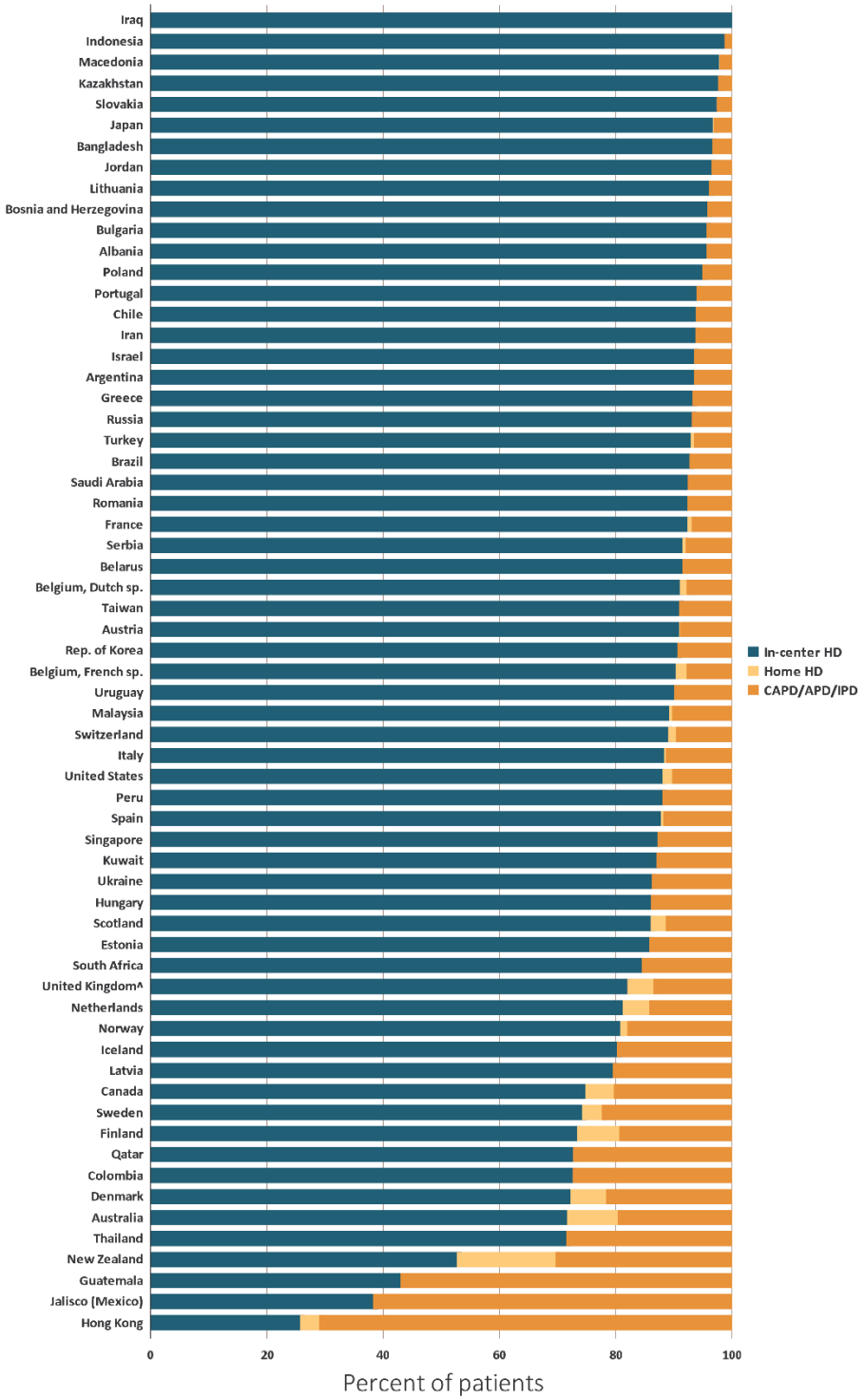
vol 2 Figure 11.14 Trends in the prevalence of dialysis per million population, by country, 2003-2016 (continued)

(b) Average yearly change in dialysis prevalence rate from 2003-2016



Data source: Special analyses, USRDS ESRD Database. (a) Ten countries having the highest percentage rise in dialysis prevalence: 2015/16 versus that in 2003/04, plus the United States. The prevalence is unadjusted and reflects prevalence of dialysis at the end of each year. (b) Estimates derived from linear regression. Abbreviation: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.15 Distribution of the percentage of prevalent dialysis patients using in-center HD, home HD, or peritoneal dialysis (CAPD/APD/IPD), 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Denominator was calculated as the sum of patients receiving HD, PD, Home HD; does not include patients with other/unknown modality. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Guatemala exclude pediatric ESRD patients and patients receiving non-institutional RRT. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Data from Latvia representative of 80% of ESRD patient population. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: APD, automated peritoneal dialysis; CAPD, continuous ambulatory peritoneal dialysis; ESRD, end-stage renal disease; HD, hemodialysis; IPD, intermittent peritoneal dialysis; PD, peritoneal dialysis; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

Kidney Transplantation

International kidney transplantation rates vary greatly, which may reflect not only geographic variations in ESRD incidence and prevalence but also differences in national health care systems, infrastructure for transplantation services, organ availability, degree of genetic homogeneity or heterogeneity within a country's population, and cultural beliefs. Kidney transplantation rates when expressed PMP serve to standardize rates according to the size of a country's population and thus, to some extent, account for the potential kidney donor pool size (Figure 11.16.a).

However, it is also of interest to understand transplantation rates in relationship to the size of the population in need. Towards this purpose, we also display kidney transplantation rates per 1,000 dialysis patients in a country (Figure 11.16.b). Such a comparison indicates that the relative rates differ considerably between the two metrics. For example, the United States ranks third in the world in terms of transplants PMP, yet ranks 39th of 61 reporting countries in transplants per 1,000 dialysis patients. This may be due, in part, to the high numbers of dialysis patients in the United States.

Kidney transplant rates varied more than 80-fold across countries, from less than 1 to 79 PMP, in 2016 (Figure 11.16.a). The highest kidney transplant rate was reported for the Jalisco region of Mexico (79 PMP), followed by Spain (64 PMP) and the United States (62 PMP). Kidney transplant rates have now been provided for the first time for all of Mexico in this international chapter. Transplants in the Jalisco region (79 PMP) make up approximately one-fifth of all transplants in Mexico, which has an overall transplant rate of 25 PMP. Kidney transplant rates ranged from 30-60 kidney transplants PMP for 44% of countries, 11-29 transplants PMP for 27% of countries, and 1–10 PMP for the remaining 25%. Countries reporting the lowest rates of kidney transplantation, at 1-5 PMP, included Bangladesh, Malaysia, Ukraine, Macedonia, South Africa, the Philippines, Peru, and Bulgaria.

Kidney transplant rates when expressed per 1,000 dialysis patients also varied greatly across countries, from 2 to 171 in 2016 (Figure 11.16.b). The highest rates per 1,000 dialysis patients occurred in Kazakhstan (171), Belarus (167), Norway (162), the Netherlands (152), Finland (136), Scotland (119), Spain (110), and Latvia (110). Transplant rates of 90 to 108 per 1,000 dialysis patients were reported in Iran, Austria, Kuwait, the Jalisco region of Mexico, Denmark, Sweden, Estonia, and the United Kingdom Twenty-one percent of reporting countries reported rates of 53 to 86 per 1,000 dialysis patients, 21% had rates of 30-48, and the remaining 30% of countries reported rates of less than 30 transplants per 1,000 dialysis patients in 2016. During 2016 in the United States, 39 kidney transplants were performed per 1,000 dialysis patients.

Since 2003, some countries have shown a substantial increase in kidney transplant rates PMP (Figure 11.17.a). When comparing transplant rates in 2015/16 to 2003/04, Turkey, Russia, Iceland, Colombia, the Republic of Korea, Bangladesh, Thailand, Scotland, Brazil, and the Jalisco region of Mexico demonstrated the largest increases, from 46% to 394% (*Reference Table N.8*). Additionally, during the same period, kidney transplantation rates PMP were 22-45% higher in the Netherlands, Hong Kong, Australia, Canada, Denmark, the United Kingdom, Finland, Singapore, New Zealand, and the Dutch-speaking region of Belgium.

Overall absolute yearly change in kidney transplant rates PMP was calculated over the time period from 2003 to 2016 (Figure 11.17.b), and ranged from an average yearly decrease of 0.9 kidney transplants PMP per year in Greece to an average yearly increase of 3.2 kidney transplants PMP per year in Turkey (median country had an average yearly increase of 0.4 kidney transplants PMP per year). Other countries with high average yearly increases (range: 1.0 to 2.1) in the number of kidney transplants PMP per year from 2003-2016 were: the Republic of Korea, Scotland, the Netherlands, the United Kingdom, the Jalisco region of Mexico, Colombia, Denmark, Australia, Iceland, Canada, and Brazil.

vol 2 Figure 11.16 Kidney transplantation rate, by country, 2016

(a) Per million population

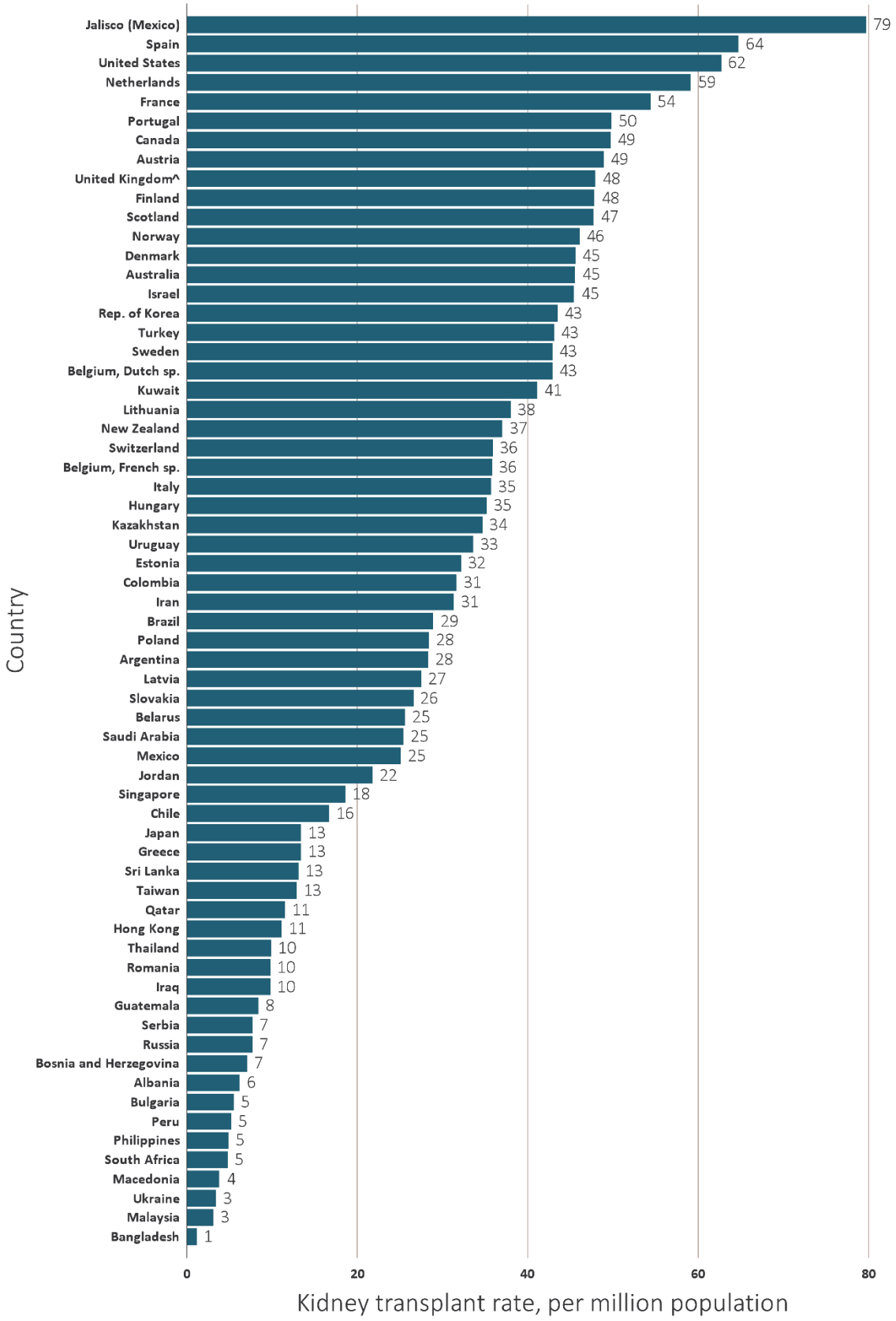
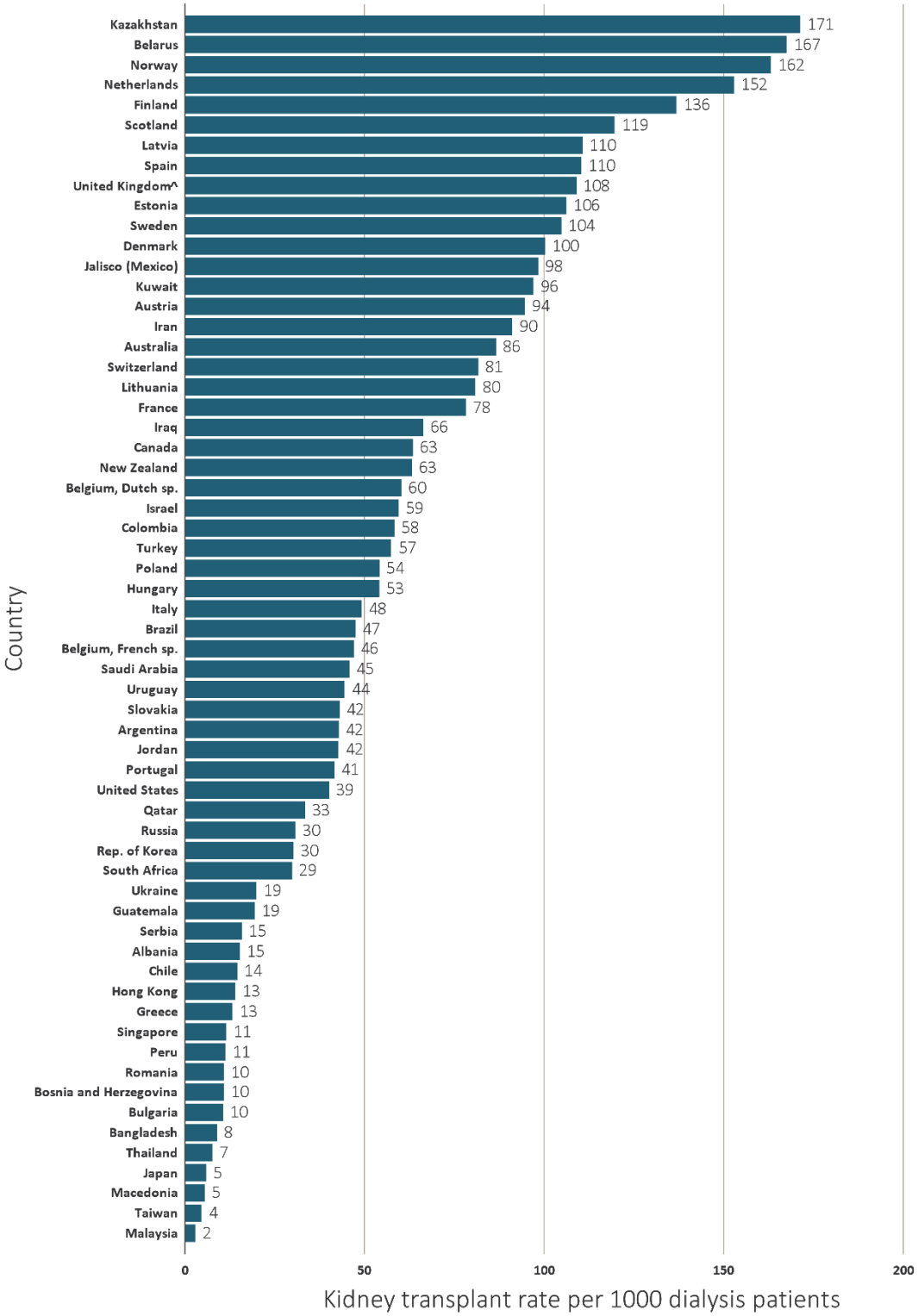


Figure 11.16 continued on next page

vol 2 Figure 11.16 Kidney transplantation rate, by country, 2016 (continued)

(b) Per 1,000 dialysis patients



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. All rates are unadjusted. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Guatemala exclude pediatric ESRD patients and patients receiving non-institutional RRT. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Overall transplantation rate for Mexico presented in addition to the rate for the Jalisco region of Mexico only. Data for Sri Lanka is from seven government hospitals. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviation: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.17 Trends in kidney transplantation rates (per million population), by country, 2016

(a) Ten countries having the highest percentage rise in kidney transplantation rate in 2003/04 versus that in 2015/16, plus the United States

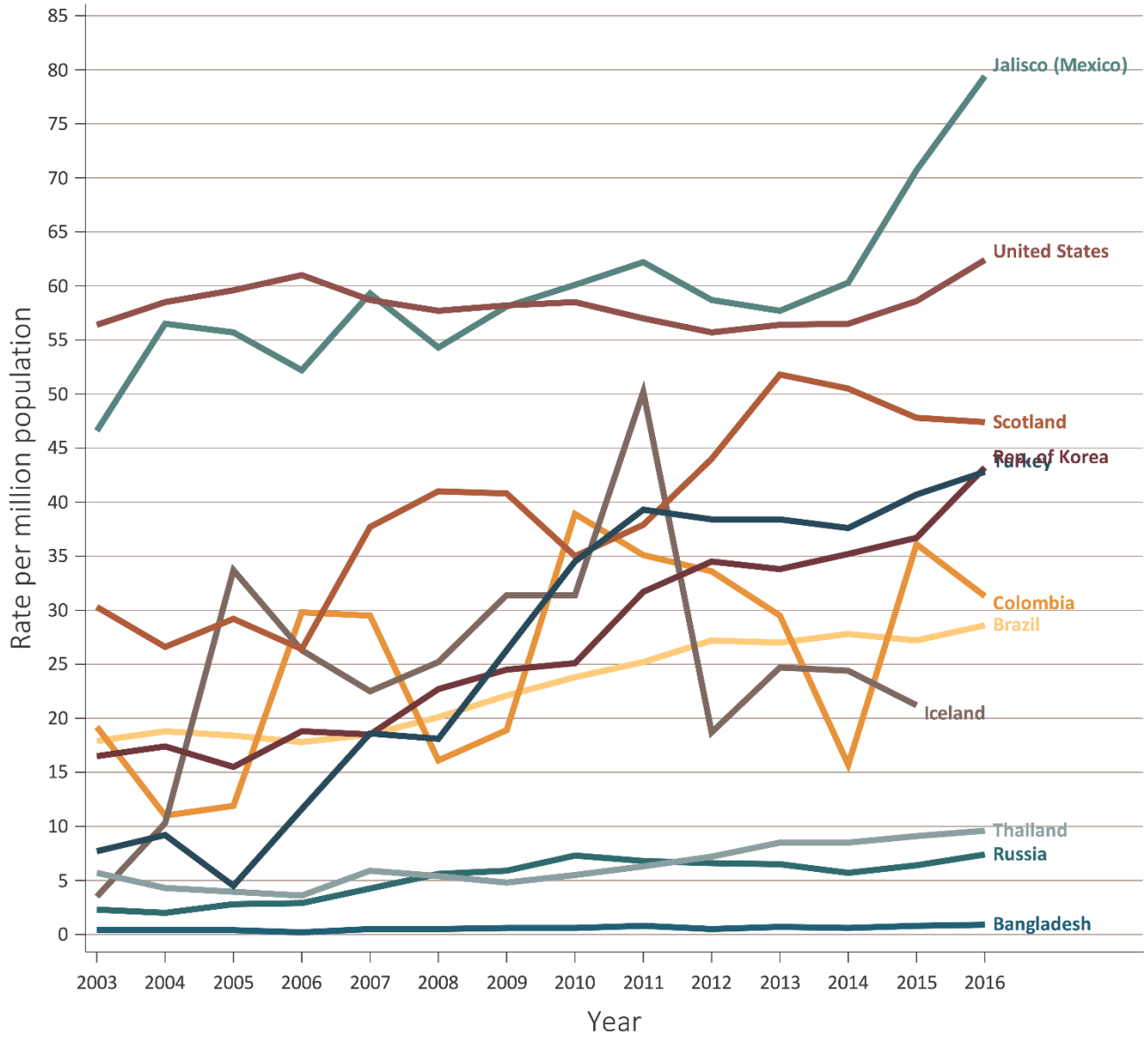
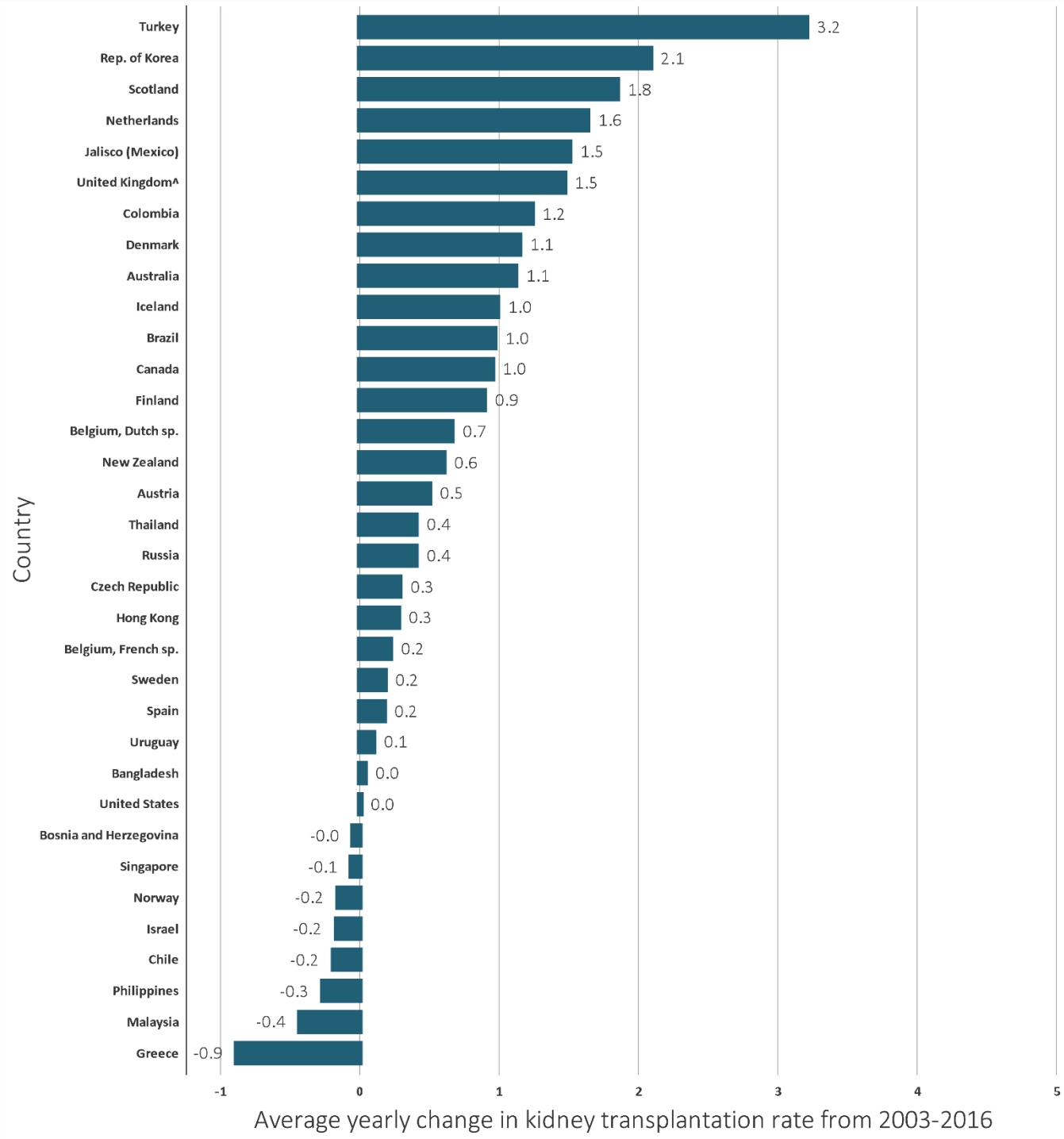


Figure 11.17 continued on next page.

vol 2 Figure 11.17 Trends in kidney transplantation rates per million population, by country, 2016 (continued)

(b) Average yearly change in kidney transplantation rate from 2003-2016



Data source: Special analyses, USRDS ESRD Database. (a) Ten countries having the highest percentage rise in kidney transplantation rate: 2015-2016 versus that in 2003-2004, plus the United States. All rates are unadjusted. (b) Estimates derived from linear regression. Abbreviations: ESRD, end-stage renal disease; Rep., Republic; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

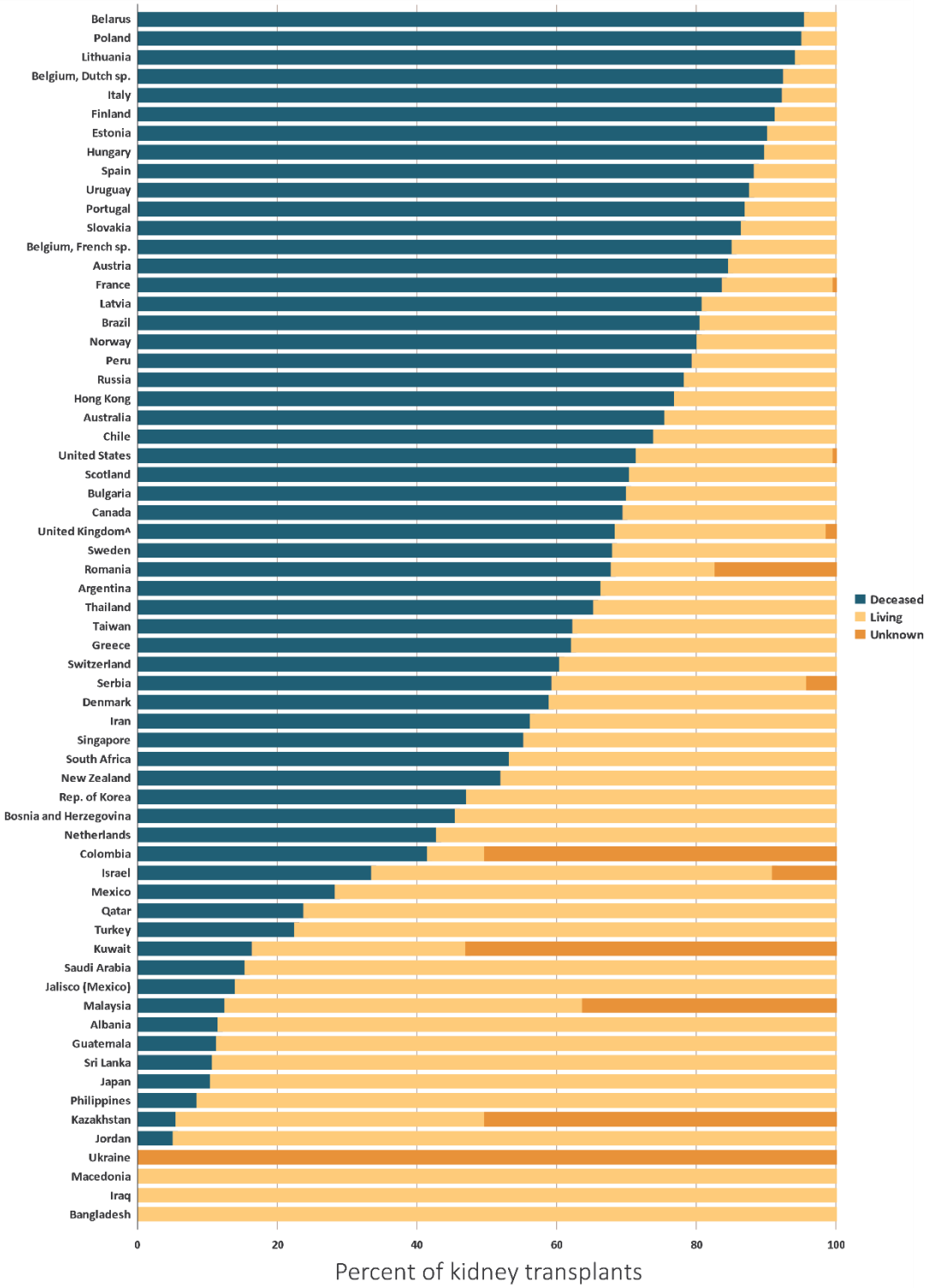
Large international differences were also seen in the types of kidney donors. Rates of living-donor transplantation ranged from 80%-100% in Saudi Arabia, the Jalisco region of Mexico, Albania, Guatemala, Sri Lanka, Japan, the Philippines, Jordan, Bangladesh, Iraq, and Macedonia to 10% or lower in Hungary, Estonia, Finland, Colombia, Italy, the Dutch-speaking region of Belgium, Lithuania, Poland, and Belarus (Figure 11.18). In nearly 67% of countries, donation from deceased individuals was the predominant form of kidney donation during 2016.

In 2016, Spain, the Netherlands, the United States, Norway, and Portugal reported the highest prevalence of ESRD patients living with a kidney transplant PMP, at 646 to 693 PMP (Figure 11.19). Twenty-five percent of countries indicated 457 to 634 prevalent ESRD patients PMP living with a kidney transplant, while the remaining 66% of countries were nearly evenly divided between having less than 202, or 208-432 PMP. However, as noted earlier in this chapter, countries having a high prevalence of ESRD patients living with a kidney transplant PMP may not necessarily have a high fraction of ESRD patients living with a kidney transplant.

The average yearly change in the prevalence of ESRD patients living with a kidney transplant PMP from 2003 to 2016 was calculated for countries with available data (Figure 11.20). Results ranged from an average yearly decrease of 0.3 ESRD patients living with a kidney transplant PMP per year in Malaysia to an average yearly increase of 21 ESRD patients living with a kidney transplant PMP per year in the United Kingdom and the Netherlands (Sweden, the median country, had an average yearly increase of 12.2 ESRD patients living with a kidney transplant PMP per year). Other countries with higher average yearly increases (range: 16.4 to 19.4) in the number of ESRD patients living with a kidney transplant PMP per year from 2003-2016 were: Denmark, the United States, Spain, Iceland, and Uruguay.

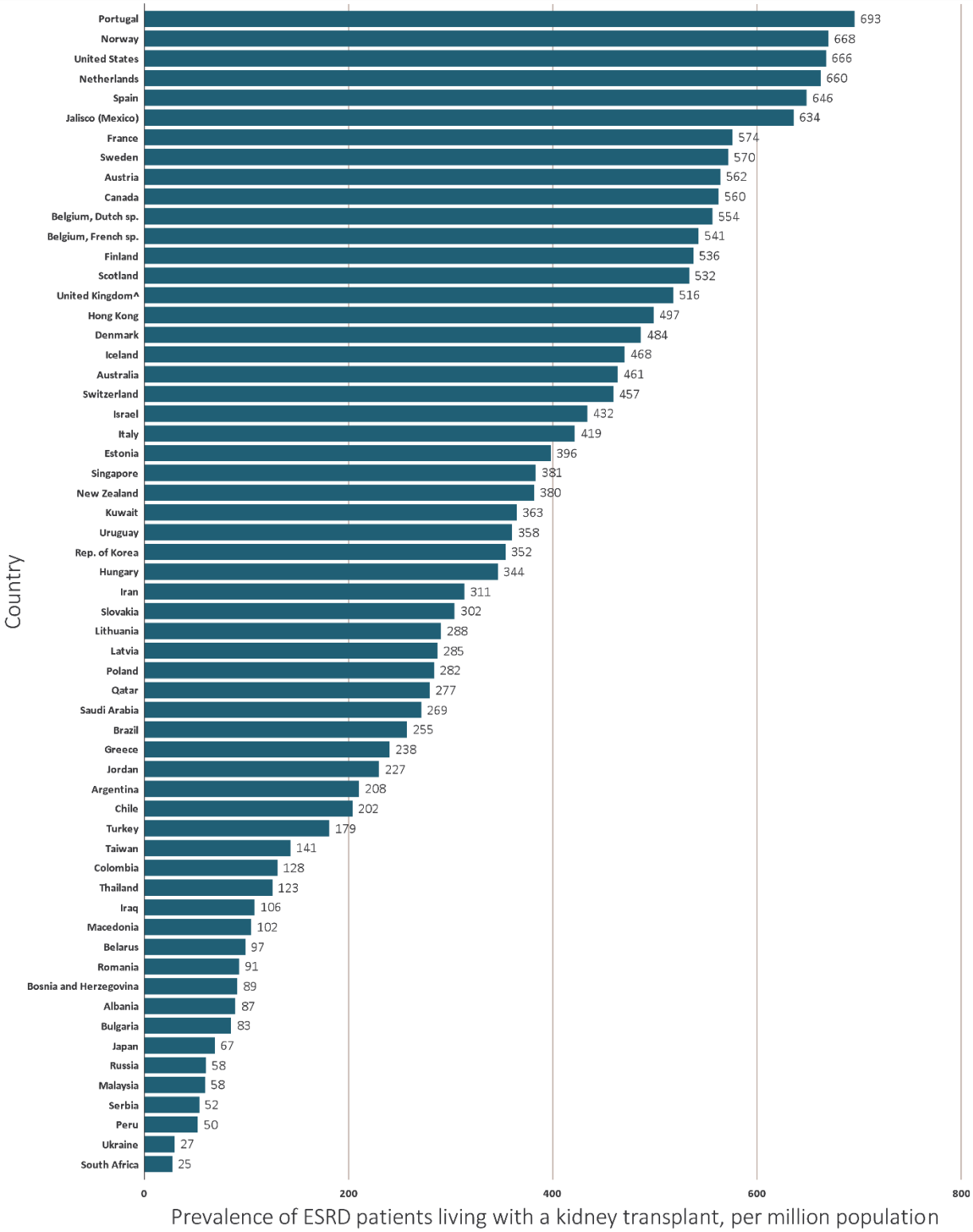
Earlier, in Figure 11.12, large variability was noted across countries in the percentage of ESRD patients living with a kidney transplant. From 2003-2016 the percentage of all ESRD patients living with a kidney transplant remained relatively constant within most countries (*Reference Table N.9.c*). However, some nations have demonstrated a continuing increase in the percentage of all ESRD patients living with a kidney transplant, particularly in: Australia, Bosnia and Herzegovina, Canada, Denmark, Iceland, the Netherlands, Scotland, Spain, Sweden, Turkey, the United Kingdom, and Uruguay. In contrast, the percentage of ESRD patients living with a kidney transplant declined substantially in Chile, France, Malaysia, the Philippines, Russia, Singapore, and Thailand from 2003-2016.

vol 2 Figure 11.18 Distribution of the percentage of kidney transplantations by kidney donor type and country, 2016



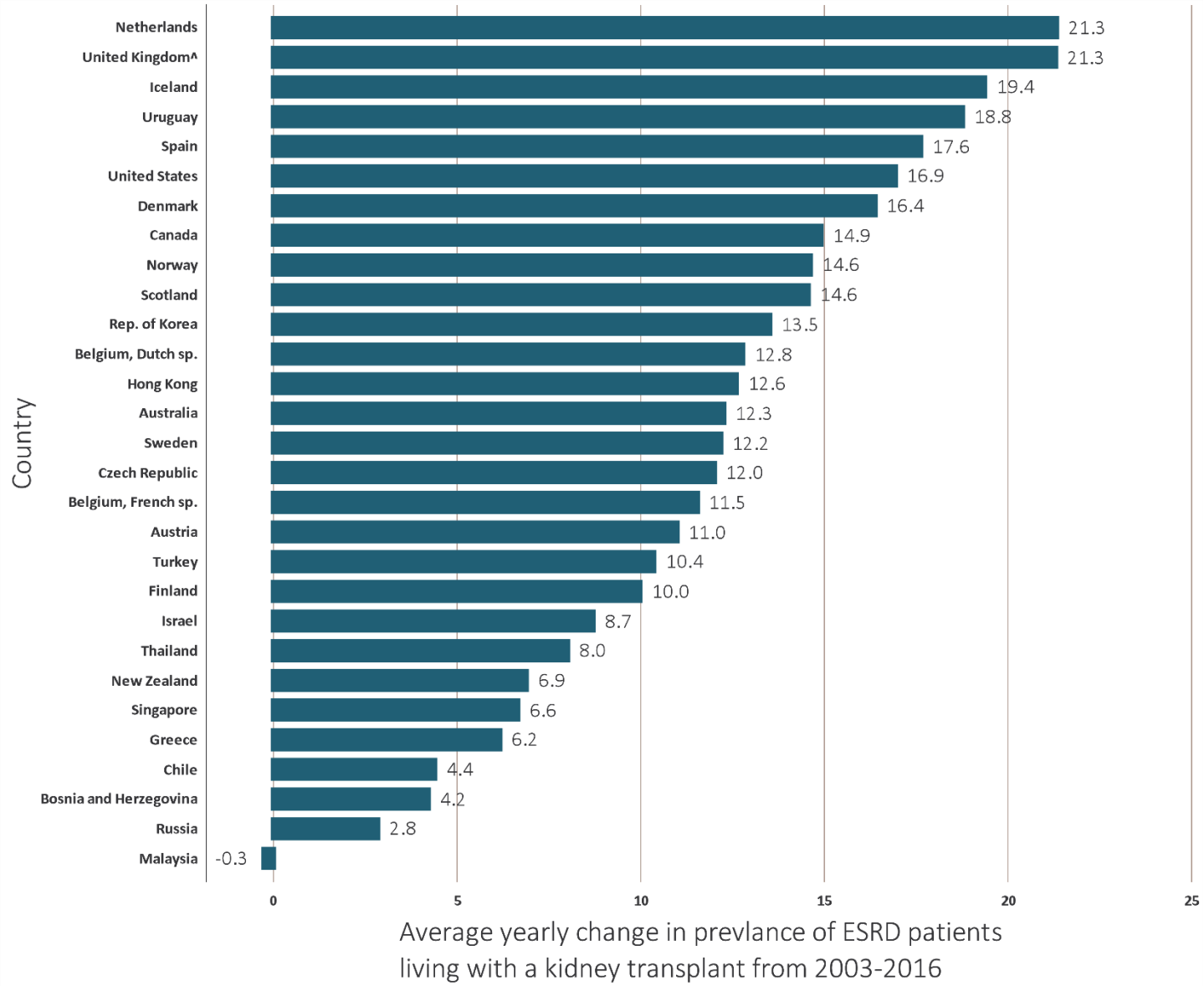
Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. Denominator is calculated as the sum of deceased, living-donor, and unknown transplants. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Guatemala exclude pediatric ESRD patients and patients receiving non-institutional RRT. *Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Overall transplantation rate for Mexico presented in addition to the rate for the Jalisco region of Mexico only. Data for Sri Lanka is from seven government hospitals. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviation: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.*

vol 2 Figure 11.19 Prevalence of treated ESRD patients with a functioning kidney transplant, per million population, by country, 2016



Data source: Special analyses, USRDS ESRD Database. Data presented only for countries from which relevant information was available. The prevalence is unadjusted. Data for Belarus from 43 of 51 RRT centers. Data for Canada exclude Quebec. Data for France exclude Martinique. Data for Indonesia represent the West Java region. Data for Italy representative of 35% (7 out of 19 regions) of ESRD patient population. Prevalent functioning graft data for Slovakia only available for prevalent transplant patients. United Kingdom^: England, Wales, Northern Ireland (Scotland data reported separately). Abbreviations: ESRD, end-stage renal disease; Rep., Republic; RRT, renal replacement therapy; sp., speaking. NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

vol 2 Figure 11.20 Trends in the prevalence of treated ESRD patients with a functioning kidney transplant, by country, 2003-2016



Data source: Special analyses, USRDS ESRD Database. Estimates derived from linear regression. Abbreviations: ESRD, end-stage renal disease; Rep., Republic; sp., speaking . NOTE: Data collection methods vary across countries, suggesting caution in making direct comparisons.

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South Africa	MR Davids, N Marais , JC Jacobs. South African Renal Registry Annual Report 2015. South African Renal Society, Cape Town, 2017
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Notes