

BMJ Open Descriptive, cross-country analysis of the nurse practitioner workforce in six countries: size, growth, physician substitution potential

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ABSTRACT

Objectives: Many countries are facing provider shortages and imbalances in primary care or are projecting shortfalls for the future, triggered by the rise in chronic diseases and multimorbidity. In order to assess the potential of nurse practitioners (NPs) in expanding access, we analysed the size, annual growth (2005–2015) and the extent of advanced practice of NPs in 6 Organisation for Economic Cooperation and Development (OECD) countries.

Design: Cross-country data analysis of national nursing registries, regulatory bodies, statistical offices data as well as OECD health workforce and population data, plus literature scoping review.

Setting/participants: NP and physician workforces in 6 OECD countries (Australia, Canada, Ireland, the Netherlands, New Zealand and USA).

Primary and secondary outcome measures: The main outcomes were the absolute and relative number of NPs per 100 000 population compared with the nursing and physician workforces, the compound annual growth rates, annual and median percentage changes from 2005 to 2015 and a synthesis of the literature on the extent of advanced clinical practice measured by physician substitution effect.

Results: The USA showed the highest absolute number of NPs and rate per population (40.5 per 100 000 population), followed by the Netherlands (12.6), Canada (9.8), Australia (4.4), and Ireland and New Zealand (3.1, respectively). Annual growth rates were high in all countries, ranging from annual compound rates of 6.1% in the USA to 27.8% in the Netherlands. Growth rates were between three and nine times higher compared with physicians. Finally, the empirical studies emanating from the literature scoping review suggested that NPs are able to provide 67–93% of all primary care services, yet, based on limited evidence.

Conclusions: NPs are a rapidly growing workforce with high levels of advanced practice potential in primary care. Workforce monitoring based on accurate data is critical to inform educational capacity and workforce planning.

Strengths and limitations of this study

- This study determines the total and relative size of nurse practitioners (NPs) per 100 000 population and growth rates in comparison to physicians in six Organisation for Economic Cooperation and Development (OECD) countries.
- A strength of this study is the analysis of comprehensive and largely unexplored data from authoritative sources in the six countries.
- Annual growth rates were calculated for 2005–2015 using compound annual growth rates, annual; and median percentage change to account for excessive yearly changes found.
- The study faces limitations as to accuracy of data and data variability of the activity levels of NPs and physicians, yet, for within-country comparisons, we used consistently the same activity levels for NPs and physicians.
- The few empirical studies on the substitution effect of NPs for physicians show that NPs can work at high levels of advanced practice; however, future research is necessary to validate the findings.

BACKGROUND

Health workforce shortages and geographical imbalances exist in many countries worldwide.¹ The need for primary care providers is increasing in response to the intensifying healthcare needs of their populations, triggered by the increasing rates of patients with chronic conditions and multimorbidity.^{2–3} While educating more physicians is one workforce strategy, countries are also investing increasingly in a highly qualified nursing workforce, such as nurse practitioners and other advanced practice nurses (NPs/APNs), with usually Master's level education.⁴ Expanding the roles of nurses combined with task shifting from physicians to nurses as suggested by the WHO, has received policy attention to respond to

shortages, long waiting times and high care needs of patients with chronic conditions.^{5 6}

There is a consistent body of evidence showing that nurses with advanced education can provide high-quality care that is comparable to physicians for a range of acute and chronic illnesses.^{7–10} The USA was the first country to introduce NPs in 1965 (in Colorado), followed by Canada in 1967 (in Nova Scotia).^{11 12} NP practice regulations have since been instituted and managed at the subnational level in these countries. Other countries have recently introduced NPs, including the UK, Ireland, the Netherlands, Australia and New Zealand.^{13–17}

The extent to which NPs are effective in addressing shortages and the intensifying care needs of patients with chronic conditions depends on the scale of this workforce, and its integration and implementation in healthcare.¹⁸ Scale in this context refers to two factors, sufficient numbers of NPs and their extent of advanced practice. Both elements are critical to assess the contribution of the workforce.

Existing international research on the size of the NP workforce is limited. The international literature has compared primarily NP education, governance and regulation of titles.^{19–23} In an overview of the primary care workforce in six countries, the total number of NPs was found to be low in most countries.²⁴ However, the study only provided the total number of providers, and no further information on its relative size compared with other professions or time trends. A 2010 Organisation for Economic Cooperation and Development (OECD) report found the NP workforce to be the largest in the USA in absolute and relative size compared with the total nursing workforce, followed by Canada, Australia and Ireland.²⁰ Yet, the report did not differentiate between activity levels and dates back to 2010. It did not provide data on time trends. At the individual country levels, many studies exist, particularly in the USA that aim to quantify the total number of NPs, by employment, specialty and clinical practice area.^{25–28} They found that the various data sources provide a patchy overview in the USA, particularly when focusing on the clinically active NPs and specific specialty areas.²⁵ The comparatively fewer studies analysing the size of NPs in Canada, Australia and New Zealand found that the workforce is small, but provided limited information beyond the number of providers.^{29 30}

While NPs perform a substantially expanded range of clinical services, there is limited knowledge on the detailed level of advanced practice. The 2010 OECD report provides information on the typical tasks and activities provided by NPs in Australia, Canada, Ireland, the UK and the USA suggesting that NPs provide a large range of services at the interface with the medical profession.²⁰ Conceptually, the substitution effect of physicians by NPs refers to the quantification of how many patients or services in a particular care setting can be performed by NPs that are usually provided by

physicians.^{31 32} In a systematic review, 30–70% of clinical activities of physicians were found could be taken over by NPs or other non-physician providers; however, most of the included studies were conducted in the 1970s and 1980s and included a wide range of non-physician providers, including NPs, other nursing roles and physician assistants.³¹ NPs' roles have expanded internationally, hence a review focused on NPs only, providing an update of the literature, is relevant to synthesise the evidence on the extent of advanced practice and variations across countries.

This study pursued the following three research objectives: (1) to analyse the absolute and relative size of the NP workforce in six OECD countries (Australia, Canada, Ireland, the Netherlands, New Zealand and the USA), focusing on practising NPs, their proportion of the total nursing workforce and rates per 100 000 population relative to the physician workforce; (2) to examine time trends from 2005 to 2015 in the NP compared with the physician workforces; and (3) to synthesise the evidence on the extent of advanced practice in primary care referred to as physician 'substitution effect'.

The three objectives are separate, but inter-related: all three parameters (size, growth, per cent of physician substitution) are critical for workforce planning and projections.³³ Data on the three parameters provide the numerical basis in order to forecast the current and future potential of NPs in addressing the expected growing demand and intensifying healthcare needs.

METHODS

Definitions and outcome measures

In order to assess the absolute and relative size of the NP workforce, we followed the OECD definition of activity levels of health professions: (1) practising professionals (providing direct patient care), (2) professionally active (providing direct patient care, plus working in related administration, management or research as part of the profession) and (3) registered/licensed to practice (authorised to practice, including practising, professionally active and non-practising providers).³⁴ For this study, the activity status *practising* NPs was preferred over professionally active and registered/licensed, following the OECD.³⁴ In countries with no available information on the number of practising NPs, data on professionally active or registered providers were used.

To analyse time trends, we compared the yearly growth rates of NPs to physicians from 2005 to 2015 where available. We chose the physician profession as a comparator for two reasons. First, to compare the growth rates to estimate the potential in alleviating shortages and expanding capacity and second, since OECD time series data on physicians are of better quality and comparability than those of the registered nursing profession.

To analyse the research objective on NPs levels of advanced practice, we performed a literature scoping

review,³⁵ focusing on a concept referred to as ‘substitution effect’, which estimates the potential of a new, extended professional role in taking up activities of an established profession.³¹

First phase: identification of countries and data availability—the TaskShift2Nurses Study

We identified countries with NP/APNs based on an expert survey in 39 industrialised countries (TaskShift2Nurses Study, 2015). Information on the survey itself, its sampling strategy, data collection and analysis is provided elsewhere.^{22–36} A total of 93 country experts participated (response rate 85.3%). The survey included questions on scope of practice and education, data availability, existence of nursing registries and mandatory versus voluntary registration policies, among others. Institutional Review Board (IRB) approval was obtained at the University of Pennsylvania.

The TaskShift2Nurses Study identified 11 countries with NP/APNs: Australia, Canada, Finland, Ireland, the Netherlands, England, Northern Ireland, Scotland, Wales, New Zealand and the USA.^{22–36} Definitions used were existence of NP/APNs, education at NP/APN level and advanced practice focusing on primary care, measured by seven clinical activities: authority to prescribe medications, order medical tests, decide on medical treatment, diagnose/perform advanced health assessment, referrals, responsibility for a panel of patients and first point of contact.⁴ The survey was integral to this study insofar, as it helped identify countries with data on NP/APN and the respective authoritative sources.

For the purpose of this study, in a subsequent step, we contacted country experts individually to obtain further information on data sources and holders. Finland and the four nations within the UK were excluded from this study, because no registry data or other national/federal or subnational data sources on NP/APNs were identified.

Second phase: country-specific secondary data collection

In a subsequent step, we retrieved secondary data on NPs for the remaining six countries from authorised sources as advised by country experts. All six countries had NP or similar roles working in advanced practice, of which the titles were regulated and registration was mandatory. The secondary data collection phase took place between August 2015 and January 2016. These sources included nursing boards or councils (Australia, Ireland and New Zealand), an institute on health information (Canada) and a nurse specialist registry (*Registratiecommissie Specialismen Verpleegkunde, RSV*) in the Netherlands. In the Netherlands, nurse specialists (*Verpleegkundig Specialisten*) are sometimes referred to as NPs in the English literature;¹⁴ however, we decided to keep the translation closest to its original title, since this title is regulated.

In the USA, several data sources were reviewed, including data from the Kaiser Family Foundation (KFF),³⁷

American Association of Nurse Practitioners (AANP)³⁸ and the US Bureau of Labor Statistics.^{39–41} Challenges of the US data include the coexistence of multiple sources which calculate the workforce differently. The KFF provided data on professionally active NPs based on active state NP licences; however, no data on time trends were available. The AANP data cover NPs licensed to practice; however, these data are estimated and actual numbers not available to the public. The US Bureau of Labor Statistics estimates the professionally active NP workforce, but NP-specific data are only available since 2012 and exclude self-employed NPs.^{39–41} To analyse the first research objective, we chose the data source based on the year of data availability (2015), the completeness of the data as to the total size of the workforce and the activity status (data covering ‘practising’ NPs, followed by professionally active and registered/licensed). For the second research objective, we prioritised on data sources with time series (ideally from 2005 to 2015 or the longest period covered).

Time series data were limited in four countries, the USA, the Netherlands, Ireland and Australia. Canada and New Zealand were the only two countries with continuous data on time series available since 2005, whereas the Netherlands had data since 2009, the year of introduction of the specialist registry, Ireland since 2010 and Australia since 2012.

Third phase: literature scoping review on the extent of advanced practice

In addition to the secondary data analysis, we conducted a comprehensive literature scoping review,³⁵ covering MEDLINE, CINAHL, Google Scholar and grey literature, to identify studies on substitution effect/extent of advanced practice. Literature scoping reviews have evolved over the past 20 years as a method for synthesising the evidence on a specific topic or research question.^{35–42} Compared with systematic literature reviews, research questions in scoping reviews are broader and typically defined per PCC (Population, Concept, Context) instead of PICO (Participants, Interventions, Comparisons, Outcomes) elements,³⁵ hence, suitable to a broader research question (see online supplementary material). Moreover, scoping reviews are designed to provide a synthesis of a wider and broader type of evidence beyond peer-reviewed journal articles, and include various, heterogeneous sources instead of focusing on the best evidence only.⁴³ We followed the methodology by the Joanna Briggs Institute³⁵ (see online supplementary material). Studies were included if they quantified the extent of advanced practice, also referred to as physician ‘substitution effect’. We included all evidence that measured either the percentage of typical physician-provided activities that can be performed by NPs in primary care or the percentage of all services that can be provided by NPs.^{31–33} Search terms included various combinations of the terms substitution, NP, primary care, among others (see online supplementary

material). The search was conducted in English, plus we contacted country experts for additional grey literature.

Data analysis

Regarding research objective 1, we calculated NP rates per 100 000 population using the population sizes provided by the OECD 2015 population statistics online database.⁴⁴ To compare the density of NPs with physicians, we retrieved the physician ratios per 1000 from the OECD database, which we subsequently multiplied by 100 to obtain rates per 100 000 population.⁴⁵ Data on the nursing workforce were retrieved from the same data holders from which the data on NPs were obtained, except for the Netherlands where nurse specialists are registered in a separate registry.⁴⁶

As for research objective 2 on time trends, we calculated the yearly percentage change of NPs and physicians (eg, 2005–2006, 2006–2007), covering 2005–2015 or years available, to assess the relative growth of the NP profession compared with the physician profession. Percentage change is a common arithmetic method, used in many disciplines including demographics.⁴⁷ It is based on the calculation of the absolute difference at two points in time and divided by the original group size, multiplied by 100. This method allows to quantify the increase or decrease over time periods irrespective of groups' differences in size. In addition to yearly percentage changes, we calculated the compound annual growth rate (CAGR) which is commonly used in

comparison of time trends,^{48–50} since it smoothes yearly growth rates over time. In addition, we calculated the average and median percentage change across the entire time period for each country and profession covered.³⁴

Regarding research objective 3, all studies identified from the literature scoping review were reviewed according to inclusion and exclusion criteria (see online supplementary material). Studies were included if they quantified the extent of substitution effect in primary care, provided the study was implemented in one of the six countries. We subsequently extracted the numerical results of the percentage of all services that NPs were able to provide, and information on the study design, participants, country and service delivery contexts.

RESULTS

Total and relative size of the NP workforce

The USA showed the largest number of professionally active NPs (N=174 943) compared with the other five OECD countries, which represented 5.6% of its total active US nursing workforce in 2015³⁷ (figure 1). In the Netherlands and Canada, both the total and relative sizes were lower, the percentages were 1.5% and 1.3%, respectively, based on data on registered NPs in the Netherlands and practising NPs in Canada. In Australia, New Zealand and Ireland, the relative sizes were very small, 0.5% and less.

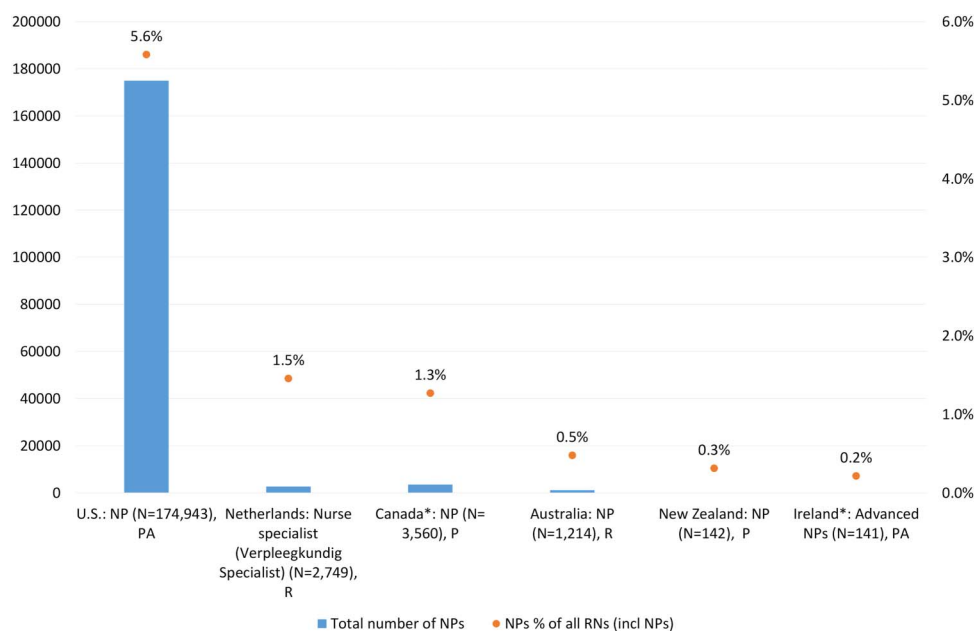


Figure 1 Total number of NPs and per cent of professional nursing workforces, 2015*. Sources: Authors' calculations, based on the TaskShift2Nurses Survey 2015 and the following data sources (Dutch Nurse Specialist Registry. Unpublished data on Nurse Specialists (*Verpleegkundig Specialisten*), 2009 to 2015, received upon request. 2015).^{37 46 51–54} Notes: *2015: except for Canada, Ireland: 2014; Data on RNs include NPs. Caveats: the Netherlands (nurse specialists): an estimated 12 test accounts are in the database (0.4%) that cannot be filtered out (personal communication, with registry advisor at Verpleegkundig Specialisten Register, 29 January 2016). N, total number; NP, nurse practitioner; P, practising; PA, professionally active; R, registered/licensed to practice; RNs, registered nurses.

Results regarding the workforce density per population showed similar patterns across the six countries (figure 2). The rate of NPs in the USA was highest, at 40.5 practising NPs per 100 000 population^{44 55} based on 2012 data to allow for comparisons with physicians. NPs were less than one-fifth of the US physician workforce.^{44 45}

In the Netherlands and Canada, the rates were considerably lower compared with the USA at 12.6 and 9.8 per 100 000 population, respectively. Compared with physicians, Australia, Ireland and New Zealand showed very low rates.

Growth of the NP workforce from 2005 to 2015

All countries showed a continuous growth of their NP workforce from 2005 to 2015 or for those years available (table 1). However, the growth rates varied considerably across countries and within countries between NPs and physicians.

In the USA, NPs licenced to practice increased from an estimated 106 000 in 2004 to 192 000 in 2014.³⁸ The rates per 100 000 population increased from 35.87 to 60.22 NPs per 100 000 population. Data on professionally active NPs showed an increase from 105 780 to 122 050 NPs, yet were only available from 2012 to 2014.^{39–41}

In the Netherlands, the numbers of nurse specialists registered increased rapidly, from 140 in 2009 to 2749 in

2015. The rate of nurse specialists per 100 000 population in the Netherlands showed the most rapid increase among all countries studied, more than 14-fold, from 0.85 nurse specialists in 2009 to 14.74 nurse specialists per 100 000 in 2014.

In Canada, the rate of NPs per 100 000 increased from 2.9 in 2005 to 10.7 in 2014, more than threefold. In Australia, the NP rate grew from 3.5 in 2012 to 5 per 100 000 population in 2014. Although a rapid increase took place in New Zealand from 0.3 in 2005 to 3.1 in 2014 and in Ireland from 0.8 in 2010 to 3.1 in 2014, the total numbers remained at low levels.

NP compared with physician growth rates

We present CAGRs and the *median* percentage changes over the 2005–2015 period to show differences in the calculation methods (table 2). In order to account for the extremely high growth rates in the first year in the Netherlands and Ireland due to the small numbers (the Netherlands 2009–2010, Ireland 2010–2011), we calculated the CAGR for the full period and the CAGR without the first year for the two countries.

Growth among NPs was high in all countries, and consistently and considerably higher than among physicians. The compound growth rate among nurse specialists in the Netherlands was 27.8% (CAGR 2010–2015), the highest among all six countries. The yearly growth was higher than that of its medical workforce at 2.9%, the

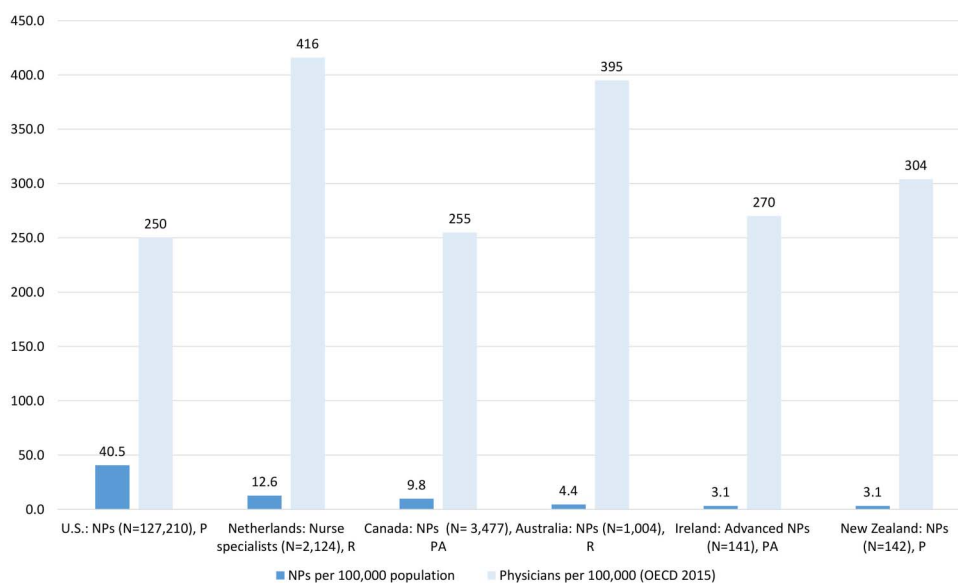


Figure 2 NP density compared with physicians per 100 000 population, 2013*. Sources: Authors' calculations, based on the following data sources (Dutch Nurse Specialist Registry. Unpublished data on Nurse Specialists (*Verpleegkundig Specialisten*), 2009 to 2015, received upon request. 2015).^{37 51–55} Data on physicians based on the OECD 2015 database,⁴⁵ drawn from the following primary data sources: USA: AMA; Canada: CIHI; the Netherlands: The BIG register, Australia: AIHW, New Zealand: Medical Council Medical Register.^{56 57} Notes: *year 2013; except for Ireland (2014), USA (2012) depending on years covered by OECD physician data. Caveats: the Netherlands (nurse specialists): an estimated 12 test accounts are in the database that cannot be filtered out (personal communication, with registry advisor at Verpleegkundig Specialisten Register, 29 January 2016). AIHW, Australian Institute of Health and Welfare; AMA, American Medical Association; CIHI, Canadian Institute for Health Information; N, total number; NPs, nurse practitioner; OECD, Organisation for Economic Cooperation and Development; P, practising; PA, professionally active; R, registered/licensed to practice.

Table 1 Total number of NPs and physicians, six countries, 2005–2015 (or years available)

Year	USA			Canada		The Netherlands		Australia		New Zealand		Ireland	
	NP	NP	MD	NP	MD	NS	MD	NP	MD	NP	MD	NP	MD
	PA	R	R	PA	PA	R	R	R	R	R	R	PA	PA
2005	–	106 000*†	902 053	943	69 619	–	55 673	–	67 890	14	11 555	–	–
2006	–	–	921 904	1129	70 870	–	57 098	–	71 740	21	11 889	–	11 617
2007	–	120 000*	941 304	1344	72 903	–	58 661	–	77 193	30	12 318	–	12 311
2008	–	–	954 224	1626	75 155	–	60 300	–	78 909	46	12 746	–	13 022
2009	–	130 000*	972 376	1990	78 623	140	62 057	–	82 895	50	13 176	–	13 663
2010	–	140 000*	985 375	2486	80 895	807	63 585	–	–	72	13 398	38	14 029
2011	–	148 000*	1 004 635	2777	84 313	1272	65 568	–	87 790	91	14 021	97	14 814
2012	105 780‡	157 000*	1 026 788	3157	87 306	1847	68 119	788	91 504	103	14 280	109	14 498
2013	113 370‡	171 000*	1 045 910	3477	90 205	2124	69 942	1004	91 467	117	14 596	123	14 054
2014	122 050‡	192 000*	–	3786	–	2480	–	1165	–	138	14 787	141	14 016
2015	–	–	–	–	–	2749	–	1214	–	157	–	–	–

Sources: authors' calculations, based on the following data sources (Dutch Nurse Specialist Registry. Unpublished data on Nurse Specialists (*Verpleegkundig Specialisten*), 2009 to 2015, received upon request. 2015),^{38–41 45 51–54 58–67} The OECD statistics on physicians are based on the following primary data sources: USA: AMA; Canada: CIHI; the Netherlands: The BIG register, Australia: AIHW, New Zealand: Medical Council Medical Register.^{56 57}

Caveats: USA: †data on professionally active NPs do not include self-employed, hence underestimate totals,³⁹ ‡year 2004 (in lieu of 2005 data availability) *data on registered NPs are estimates, exact numbers are not publicly available,³⁸ the Netherlands: data on NS (NS, R) include ~10 invalid cases per year used as test accounts (range 8–12) in the database that cannot be filtered out (estimated 8 cases yearly in 2009/2010/2011/2012 and 12 in 2013/2014/2015) (*personal communication, with registry advisor at Verpleegkundig Specialisten Register, 29 January 2016*), Canada: OECD data on MDs, based on two combined data sources, which may overstate the number of physicians, since interns and residents may be registered twice, Australia: break in OECD time series data on MDs in 2010, due to change of data holders.^{56 57} –, not available; AIHW, Australian Institute of Health and Welfare; AMA, American Medical Association; CIHI, Canadian Institute for Health Information; MD, medical doctors/physicians; NP, nurse practitioners; NS, nurse specialists; OECD, Organisation for Economic Cooperation and Development; P, practising; PA, professionally active; R, registered.

Table 2 Annual growth of the NP and physician workforces, measured by yearly percentage change, median percentage change and CAGR (%), in six countries, 2005–2015 (or years available)

Year	USA			Canada		The Netherlands		Australia		New Zealand		Ireland	
	NP	NP	MD	NP	MD	NS	MD	NP	MD	NP	MD	NP	MD
	PA (%)*	R† (%)	R (%)	PA (%)	PA (%)	R (%)	R (%)	R (%)	R (%)	R (%)	R (%)	PA (%)	PA (%)
2005–2006	–	–	2.2	19.7	1.8	–	2.6	–	5.7	50.0	2.9	–	–
2006–2007	–	–	2.1	19.0	2.9	–	2.7	–	7.6	42.9	3.6	–	6.0
2007–2008	–	–	1.4	21.0	3.1	–	2.8	–	2.2	53.3	3.5	–	5.8
2008–2009	–	–	1.9	22.4	4.6	–	2.9	–	5.1	8.7	3.4	–	4.9
2009–2010	–	7.7	1.3	24.9	2.9	476.4	2.5	–	–	44.0	1.7	–	2.7
2010–2011	–	5.7	2.0	11.7	4.2	57.6	3.1	–	–	26.4	4.6	155.3	5.6
2011–2012	–	6.1	2.2	13.7	3.5	45.2	3.9	–	4.2	13.2	1.8	12.4	–2.1
2012–2013	7.2	8.9	1.9	10.1	3.3	15.0	2.7	27.4	0	13.6	2.2	12.8	–3.1
2013–2014	7.7	12.3	–	8.9	–	16.8	–	16.0	–	17.9	1.3	14.6	–0.3
2014–2015	–	–	–	–	–	10.9	–	4.2	–	13.8	–	–	–
Median PC	7.5	7.7	2	19.0	3.2	30.1	2.8	16.0	4.6	22.2	2.9	13.7	3.8
CAGR	7.4	6.1 (1)	1.9	16.7	3.3	27.8 (2)	2.9	15.5	3.8	27.3	2.8	13.3 (3)	2.4

Sources: authors' calculations, based on the following data sources (Dutch Nurse Specialist Registry. Unpublished data on Nurse Specialists (*Verpleegkundig Specialisten*), 2009 to 2015, received upon request. 2015),^{38–41 45 51–54 58–67} The OECD statistics on physicians are based on the following primary data sources: USA: AMA; Canada: CIHI; the Netherlands: The BIG register, Australia: AIHW, New Zealand: Medical Council Medical Register.^{56 57}

Caveats: USA: *data on professionally active NPs do not include self-employed.³⁹ †Data on registered NPs are estimates, exact numbers are not publicly available,³⁸ the Netherlands: data on NS (NS, R) include ~10 invalid cases per year used as test accounts (range 8–12) in the database that cannot be filtered out (estimated 8 cases yearly in 2009/2010/2011/2012 and 12 in 2013/2014/2015) (*personal communication, with registry advisor at Verpleegkundig Specialisten Register, 29 January 2016*), Canada: OECD data on MDs, based on two combined data sources, which may overstate the number of physicians, since interns and residents may be registered twice, Australia: break in OECD time series data on MDs in 2010, due to change of data holders.^{56 57} –, not available; AIHW, Australian Institute of Health and Welfare; AMA, American Medical Association; CAGR, compound annual growth rate, (1)=CAGR (2004/2014) calculated based on 2004–2014 data (2004 data used in lieu of missing 2005 data) (2)=CAGR (2010–2015), 2009–2010 was excluded due to excessive growth rate caused by small numbers (CAGR 2009–2015: 64.3%, not shown), (3)=CAGR (2011–2014), 2010–2011 data excluded (CAGR 2010–2014: 38.8%, not shown); CIHI, Canadian Institute for Health Information; MD, medical doctors/physicians; NP, nurse practitioners; NS, nurse specialists; OECD, Organisation for Economic Cooperation and Development; P, practising; PA, professionally active; PC, percentage change; R, registered.

overall yearly growth was more than nine times higher. In New Zealand and Canada, the compound annual growth of NPs was 27.3% and 16.7%, respectively, approximately nine and five times higher than that of their medical workforces (2.8% and 3.3%). Ireland showed a comparatively lower yearly increase of its NP workforce, yet, still it was more than five times growth compared with its physician workforce. Of the six countries, the USA had the lowest annual compound growth of 6.1% or 7.4% annually depending on the data sources, yet, was still more than three times higher than that of physicians.^{38–41 44 45}

Extent of advanced clinical practice

The scoping review yielded a total of 1022 results. After removal of 31 duplicates, the titles of 991 records were screened and the full text of 46 studies analysed according to the inclusion/exclusion criteria (see online supplementary material for additional information). The review resulted in five papers, together reporting the findings from three empirical studies, quantifying the extent of clinical practice of NPs compared with physicians in primary care. These were conducted in the USA, Canada and the Netherlands (table 3). No studies conducted in the three other countries were identified. The studies found that NPs were able to provide between 67% and 93% of primary care services, emanating from one randomised controlled trial (RCT) conducted in Canada,⁶⁸ one quasi-experimental study in the Netherlands,^{69–71} and one survey of physicians and NPs in the USA²⁸ (see online supplementary material). The findings were based on small sample sizes, did not differentiate between specialty areas of NPs and covered different practice areas within primary care, such as rural areas in the USA²⁸ or out-of-hours services in the Netherlands. Moreover, the RCT in Canada was conducted more than 40 years ago.⁶⁸

DISCUSSION

The size of the NP workforce in the six countries studied is variable, but growing rapidly. The workforce shows high levels of practice in primary care, yet based on limited evidence. The USA is the only country where the NP workforce has reached a considerable density of ~40.5 practising NPs per 100 000 population, in other countries the workforce is smaller, ranging from 12.6 per 100 000 population in the Netherlands to low levels in New Zealand and Ireland. Yet, the NP workforce has rapidly and consistently grown since 2005 in all countries, at much higher rates than the physician workforce. Moreover, the few existing empirical studies show the potentially large and wide range of advanced clinical activities that NPs can provide. The studies suggest that between 67% and 93% of primary care visits and services can be safely provided by NPs. Taken together, the findings indicate that the NP workforce holds future promise in filling unmet care needs in primary care.

The study faces several limitations. First, data sources varied in the activity levels covered, for example, practising, professionally active or registered NPs and physicians across countries. This limitation is faced by all international data on health workforces, including the OECD and WHO, since countries use different registration policies and data collection methodologies. However, for within-country comparisons, we consistently compared the same activity levels of NPs and physicians. Second, we took the OECD data on physicians at face value; however, among the underlying primary data sources, differences may exist in terms of accuracy and validity. Future research could compare the accuracy of the OECD data with individual national/subnational primary data sources. Third, due to the US decentralised approach of licensing NPs, several different data sources and holders were identified. Large differences exist across data sources in terms of size, and activity levels, limiting the overall quality of data. Additionally, state-level authority over NP licensing may lead to double counting of NPs who hold licences in multiple states. Moreover, data on time trends of 10 years were based on estimates and covered the *licensed* workforce. Hence, the US data can at best be approximations of the actual number of practising NPs over the 10-year period and therefore need to be interpreted in light of the limitations.

Our results are largely in line with previous international research showing the relatively small scale of the NP workforce.^{20 24} Reasons for the differences between the scale of the NP workforce in the USA and other countries have not been empirically analysed. It is assumed they may be multifactorial. The years of existence may play a role, as the USA was the first country to implement NPs in 1965 (in the earliest adopting state); other factors may also influence their size and growth. Canada (Nova Scotia) introduced the first NPs only 2 years later, but relies on a much lower total number and density of NPs than the USA. Reasons for a small NP base in Canada have been discussed, and include limited role clarity, differences across provinces and territories in education and uptake, and challenges in creating positions for NPs.^{12 29 72} Moreover, large variations in the NP density exist across provinces and territories, rural versus urban areas and by employer, suggesting a more granular analysis of potentially influencing policies and other factors may be needed.⁵¹ The low numbers in the Netherlands, Australia, and particularly in New Zealand and Ireland are at least partly influenced by the fact that NPs were introduced much later in these countries (1990s and 2000s) than in the USA and Canada.^{13 24 60 73–75}

Time series data showed a considerable increase of NPs in all countries studied, much higher yearly growth than found in the medical workforces. This trend may partially but not entirely be related to the fact that increases in very small numbers result in large growth rates. We took account of this by excluding extreme

Table 3 Level of advanced clinical practice, measured by physician 'substitution effect' of NPs

Country	Study design (years)	Setting	Participants	Results	Reference
Canada	RCT to assess the effects of substituting NPs for physicians in primary care (1971–1972)	2 suburban Ontario family practices	Total patient N=1598 families (4325 individuals) of which 529 families (1398 individuals) were randomised to each physician; 270 families (765 individuals) were randomised to each NP	67% of all primary care patient visits can be provided by NPs. Care delivery was similar between physicians and NPs. There were no statistically significant differences between patients seen by NPs compared with patients seen by physicians in patient functional capacity, indexes of social and emotional function, mortality or satisfaction with care.	68
The Netherlands	Quasi-experimental study to compare the number of patients and caseloads between nurse specialists and GPs in out-of-hours services (2011–2012)	Out-of-hours primary care	Intervention: 1 NP and 4 GPs, control: 5 GPs working in out-of-hours services. Total patient N=12 092 from 1 GP cooperative extracted from medical records	More than 77% of patients fit the scope of practice of (<i>Verpleegkundig Specialist</i>) in out-of-hours care. On average 16.3% of all patients were treated by nurse specialists, whereas 20.9% of patients were treated by GPs. 75–83% of clinical activities in out-of-hours primary care settings (weekend shifts in GP practices) could be taken over by nurse specialists.	69–71
USA	Self-report, mailed survey to a random sample of 4000 physicians and 3000 NPs with rural addresses (all specialties)	Rural primary care in 13 states with at least 2 from each US Census Region (4 regions)	Final sample included 788 primary care physicians (response rate: 25%); and 918 primary care NPs (40%)	75–93% of weekly primary care outpatient visits can be provided by NPs.* In the outpatient setting, primary care clinical activities† were comparable between physicians and NPs in the outpatient setting.	28

Source: See directly in the table, see online supplementary material for more details.

*In an unadjusted regression model, NP average weekly number of outpatient visits was 75% of physician volume. In an adjusted model (age, sex, geographic location, and practice setting), NP average weekly number of outpatient visits was 93% of physician volume.

†On average, physicians conducted more well-child visits than NPs (12.6 vs 7.4, $p < 0.001$). Differences for prenatal visits and minor procedures were non-significant. GP, general practitioner; NP, nurse practitioners; RCT, randomised controlled trial.

values from the CAGR calculations for Ireland and the Netherlands, and calculated median percentage changes which were comparable to CAGR.

The continuous and higher growth rates point to an emerging NP workforce that may not have reached its full numerical potential, as compared with professions with a longer tradition, such as the physician workforce. Many countries in our study have removed or eased regulatory barriers to expanded NP scope of practice, such as Australia, Canada, New Zealand, the Netherlands and the USA.^{76–80} Canada and New Zealand expanded prescriptive authority for NPs in 2012 and 2014, respectively.^{77 81} In Australia, NPs got access to the Medical and Pharmaceutical Benefits Scheme in 2010, easing their practice, the Netherlands has regulated the nurse specialist profession in 2009 and expanded scope of practice in 2011, entering into effect in 2012.^{78 82} In the USA, an increasing number of states have removed regulatory barriers by revising scope of practice laws over the last decade.^{79 83} Future research is warranted to identify systemic facilitators and barriers that may cause variations in the implementation of NP roles in different country contexts.

Moreover, medical student intake or residency places are restricted by some sort of quota system or numerus clausus in all countries, to avoid an excessive medical workforce and at the same time, physician shortages.⁸⁴ These regulatory measures may explain the moderate annual increase among the medical workforce. To which extent countries' workforce planning take account of NPs or other APNs to project student intake, has received little attention in research and practice. Future research on workforce planning should include NPs in relation to physician growth and the potential for substitution, such as estimating the number of 'physician-equivalent NPs' as a strategy to ease future projected workforce shortages. In the Netherlands, for instance, nurse specialists have been added to its physician workforce projection as one scenario to account for substitution.³³ Yet, reasons for cross-country variations in health workforce supply, skill-mix changes across high-income countries and access to care is one area of research that warrant further high-quality evaluations.

The findings from our literature scoping review show that NPs could cover a range of ~67–93% of all primary care services. Findings are largely in line with a report by the American College of Physicians, suggesting that 60–90% of primary care can be provided by NPs.⁸⁵ A previous review showed a lower range of 30–70% of physician-provided activities that could be taken over by NPs, yet comparability is limited, since the review covered NPs and other non-physician providers.³¹ Yet, the number of empirical studies we identified is small, does not take into account variations in specialty areas, is based on small sample sizes and was conducted in different provider contexts. Hence, the findings require cautious interpretation of the data and call for more research in the field.

This study shows a rapid yearly increase of the NP workforce, which suggests that more attention should be paid to the monitoring of this workforce in the future to expand capacity and access to healthcare services. To date, data on the NP workforce are not covered in international health workforce databases, such as the WHO, OECD or international nursing bodies and associations. Most data are publicly available or available on request from the respective nursing regulatory bodies' websites or other data holders. In the USA with the numerically largest workforce, data availability is limited, a barrier for the monitoring of the workforce. Integrating NPs in health workforce data and intelligence systems at national and international level is therefore critical for their development, education and monitoring.

CONCLUSIONS

NPs are a rapidly growing workforce internationally, growing faster than the medical profession in the six countries studied. Data on the size and growth of NPs are available in all six countries, however, with variations in quality and completeness, particularly on time trends. Information on the extent of potential physician substitution effect is limited, yet, relevant for workforce planning. As this workforce grows, improving data availability and monitoring as part of the overall health workforce is critical to inform educational capacity, uptake in practice and workforce planning.

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