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Predictive modelling of the UK physician associate supply: 2014–2038

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ABSTRACT

Introduction: The NHS Long Term Workforce Plan aims for 10,000 physician associates (PAs, formerly physician assistants) by 2036/7. This article uses three modelling approaches to project the UK PA supply from a baseline of 2014–2021 through to 2038 to forecast the profession's growth.

Methods: The number of cClinically available PAs' (cPAs; qualified PAs either working clinically or seeking clinical employment) was estimated using raw data from the 2014–2021 Faculty of Physician Associates censuses. This provided baseline data for all models (linear regression (LRM), exponential regression (ERM) and time-series forecast (TSFM)). Attrition, using data from other healthcare professions, was also modelled.

Results: R^2 values together with authors' judgement ruled the LRM more realistic than the ERM. The LRM projected up to 8,232 cPAs by 2038, although attrition reduced this significantly. The TSFM optimistically projected an upper limit (95% confidence interval) of 13,922 cPAs by 2038.

Discussion: This article permits a wider view of potential PA numbers, with broad agreement between the LRM and the TSFM. It appears that future PA demand will be met, but factors such as attrition could impede this. Attrition itself may be mitigated through adequate resourcing, appropriate support mechanisms, and the development of a career structure. Professional regulation and legislation will further support PAs to work to their potential, subject to appropriate patient safety measures.

Introduction

Since its inception in 1948, the NHS has faced a shortage of staff[1] but, as of 2022, the level of deficit is unprecedented[2] and as of 2019 the UK had nearly 17% fewer medical doctors per head of population than the European average.[3] Shortages are seen in both primary and secondary care; in 2016 the government planned to raise general practitioner (GP) numbers by 5,000,[4] but the number of whole-time trained GPs has actually fallen by 1,700.[5] A Royal College of Physicians (RCP) survey (2020–2021) highlights that 60% of acute medicine consultants reported consultant-level vacancies in their department,[6] while for more junior roles the RCP's UK 2022 census of consultant physicians highlights significant gaps in the trainee rota,[7] impacting patient care. The reason for this decline appears multifactorial, including inadequate numbers of medical students and a tax/pension system that penalised senior clinicians,[8] leading to poor retention as a result of burnout and low morale respectively.

The long-standing staffing concerns prompted action and, in 2003, the UK government introduced physician associates (PAs, formerly physician assistants). PAs, under the medical associate professions umbrella alongside anaesthesia associates (AAs) and surgical care practitioners (SCPs),[9] are healthcare professionals who are able to provide treatment alongside doctors and surgeons.[10] They are recognised as dependent practitioners[11] and require a named supervisor (consultant or GP).

PAs receive a generalist training in healthcare, most commonly via a 2-year postgraduate programme with a preceding first degree in a life science / healthcare-related subject. However, there are other educational pathways, such as 4-year undergraduate-entry routes.[12] PAs are a potential contributor to resolving the NHS' shortfall in clinicians; due to their broad training and supervised nature, PAs have an ability to be moved where they are needed most and can work within different areas of medicine.[13] The aforementioned RCP report highlights that 28% of consultant physicians said that they worked with PAs, with the benefits including continuity of care for patients, support for medical staffing on the ward, maintenance of organisational knowledge within the team and facilitating trainee doctor attendance to more teaching.[7]

The NHS Long Term Workforce Plan also recognises the future role of PAs, aiming for 10,000 PAs by 2036/2037, alongside significant increases in the number of GP trainees and medical school places.[14] Given the importance that PAs may play and the importance of meeting workforce demand, the use of forecast modelling may provide evidence that the number of PAs required for the NHS is both realistic and achievable. Indeed, such modelling has historically been employed in a US

This article reflects the opinions of the author(s) and should not be taken to represent the policy of the Royal College of Physicians unless specifically stated.

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context.[15,16] A 2011 article from Hooker and colleagues[15] projected the US PA workforce to 2025 through linear regression, using baseline data from 2010. The model projected 127,821 PAs by 2025, with one-way sensitivity analyses producing a number range of 97,801–256,421.[15] The number of PAs in the USA is listed at 168,000 as of 2023 (per the American Academy of Physician Associates[17]) with 145,740 of these in employment as of May 2023, per the US Bureau of Labor Statistics.[18] With 2 years from this until 2025, it appears that US PA numbers will fall within the projected range and thus the use of linear regression to project workforce numbers is valid. As such, this article employs linear regression modelling alongside other methods, using modified 2014–2021 census data from the Faculty of Physician Associates (FPA),[19-26] to project the UK PA workforce to 2038. The end date of 2038 leads to a projection of 15 years from this article's inception, matching the preceding article in an American context[15] and also exceeds the NHS Long Term Workforce Plan by 1 year.

Methods

Ethical approval

This was a secondary study that relied on publicly available numerical data. As such, per the ethical guidance and initial ethics checklist from the authors' affiliated institution, this study was exempt from applying for full ethics committee review / institutional review board approval.

Data sources

The FPA is the historical 'de facto' professional regulatory body for PAs in the UK in the absence of legal regulation, though formal regulation by the General Medical Council is expected by the end of 2024.[27] The FPA has undertaken an annual census since 2014, which aims to capture, among other things, the number of PAs, where PAs work and the roles that they undertake. FPA census data from 2014–2021[19-26] were accessed on 13 March 2023 to extract the raw data required for the models. Permission to utilise these data for research purposes was sought via email and approved by the FPA on 29 June 2022. Only data pertaining to qualified PAs were included.

Baseline model data

From the 2014–2021 censuses, raw data pertaining to the estimated number of qualified PAs in the UK, the number of qualified PAs who responded to the census, and the breakdown of census respondents' roles were extracted. A multiplicative factor was calculated for each year from 2014–2021 by dividing the estimated total number of PAs by the number of respondents to the census. This multiplicative factor was then used to extrapolate the raw numbers from census respondents to an estimate for the entire PA workforce. The estimated values for the number of 'clinically available PAs' (cPAs) were calculated by summing the number of census respondents who were who were practising as a PA, practising as a PA in a training post or currently seeking work as a PA, and multiplying this value by the multiplicative factor for each year.

For the 2019–2021 censuses, raw numbers of PAs and where they worked were not provided in the census data.[19-21] Rather, percentages of survey respondents were provided for each workforce category. These percentages were used to calculate the rounded raw number by multiplying the percentages by the raw number of qualified PAs who responded to the census.

For the 2020 and 2021 censuses, there was no stated estimate of the number of PAs.[19,20] As such, to provide a reasonable estimate, the estimated number of total PAs from 2019 was divided by the number of PAs on the Managed Voluntary Register (MVR) from 2019, with both values being extracted from the 2019 census.[21] This value ('second multiplicative factor') was used in conjunction with the number of PAs on the MVR from 2020 and 2021[19,20] to calculate an estimate for the total number of PAs in each year, which was in turn used to calculate the number of cPAs as previously described. The number of cPAs and the census years formed the baseline data for the regression models, which was generated by a scatter plot and best fit line (both linear and exponential, separately). Supplementary File 1 contains all the raw data underpinning the models.

Table 1
Baseline data underpinning the projection models.

Year	Clinically available PAs
2014	184
2015	205
2016	261
2017	405
2018	575
2019	1,359
2020	1,892
2021	2,745

Model analysis and forward projection of clinically available PAs

After developing the regression models described above, the goodness-of-fit was determined by the R^2 value for both a linear regression model (LRM) and an exponential regression model (ERM). This goodness-of-fit was considered in conjunction with authors' judgement. For the LRM, Pearson's R was used to calculate a p-value of the regression model. Departure from linearity in the LRM was assessed by a runs test (also known as Wald runs test for randomness).[28] To project forwards, the regression equation was obtained and used to calculate the PA workforce from 2022 to 2038, with year as the input (X) variable. All calculations are available in Supplementary File 1.

PA attrition

While the FPA census data likely contain some unknown level of attrition, to accommodate for potential further attrition of cPAs, NHS attrition data from Nuffield Trust[29] were obtained. From this, an optimistic floor attrition rate of 4%, a ceiling of 13%, and a middle value of 8.5% were obtained to project PA attrition. The floor and ceiling values are 1% lower or higher than the lowest or highest attrition values obtained from the 'Regional variation in leaver rates for selected staff groups (in year to 30 September 2021)' chart from Nuffield Trust.[29] Underpinning calculations for the attrition data can be seen in Supplementary File 1.

Alternative time-series forecasting model with exponential smoothing

To independently forecast PA numbers using a different method, the same underlying data as for the regression models were used to undertake time-series modelling with exponential triple smoothing using Excel's FORECAST.ETS and associated functions.[30] An advantage of exponential smoothing is that the forecasts represent weighted averages of past observations, with older observations getting exponentially smaller weighting.[31] Accuracy of the time-series forecast model (TSFM) was assessed by the inclusion of a 95% confidence interval and the mean absolute scaled error (MASE) metric.[32]

Results

Baseline model data and model selection

As described in the Methods, census data from the FPA censuses 2014–2021 were accessed and processed (Supplementary File 1) to build the baseline data shown in Table 1.

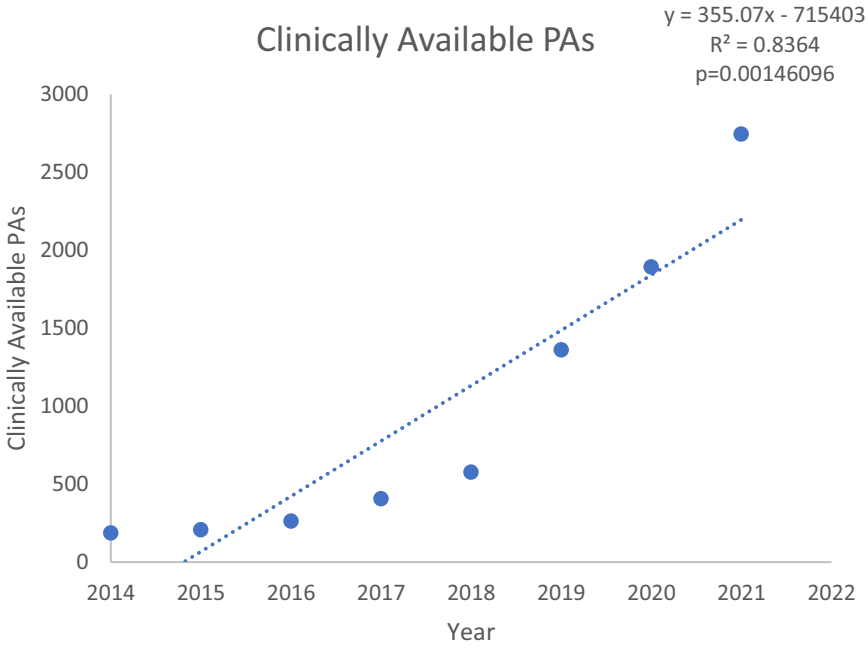

Fig. 1. LRM of cPAs.

The LRM developed from the baseline data is shown in Fig. 1.

As shown in Fig. 1, the R^2 for the LRM was 0.8364, indicating a strong goodness of fit, and the reliability of the model is emphasised by the statistically significant *p*-value of the correlation. Additionally, the runs test returned a *p*-value of 0.1143. As this is not statistically significant under conventional criteria, it indicates that there is not a significant departure from linearity; were it significant, it would indicate a poor fit of the model to the data,[28] which is not the case here. Taken together, the strength of the LRM is evident and this justifies its downstream usage.

As explained in the Methods, an ERM was also developed, which produced a better R^2 value of 0.9861 (Supplementary File 1). However, authors' judgement ruled that the future projections of the model were too high, as the ERM projected 3,316,980 cPAs by 2038, which is unreasonable given that only 145,740 physician assistants were estimated to be in employment in the USA as of May 2023[18] and that, for comparison, in the UK as of 2022, there were only 283,663 licensed medical doctors.[33] The projections from the ERM were thus discarded due to being highly unrealistic and the much more conservative LRM, with an R^2 of 0.8364, was considered more reliable overall.

Forward projection of clinically available physician associates

The LRM to project the workforce was described with the equation below:

$$y = 355.07x - 715,403$$

Where y is the number of cPAs and x is the year. This equation was used to project the PA workforce to 2038 with PA attrition scenarios, as shown in Fig. 2.

By 2038, the LRM estimates a total of 8,232 cPAs, with this number reducing to 5,523, 3,722 and 2,668 for 4%, 8.5% and 13% cumulative annual attrition. In addition to the LRM, as described in the Methods, a TSFM with exponential smoothing was also developed, shown in Fig. 3.

As shown in Fig. 3, by 2038 the TSFM projects 11,866 cPAs, with upper and lower limits (based on the 95% confidence interval) of 13,922 and 9,810 respectively. As such, the TSFM is more optimistic than the LRM (8,232 cPAs); this is likely due to greater weight being placed on later dates, with the alpha value of 0.9 reflecting this (Supplementary File 1).[31] Furthermore, the MASE value for the TSFM was 0.45; this indicates a significant level of accuracy for the forecasts, relative to a naïve model, as it is <1.[32]

It should also be noted that the TSFM shown in Fig. 3 uses the historical data starting from 2016; as shown in Supplementary File 1, inclusion of the year(s) 2014 and/or 2015 resulted in extreme values for the confidence interval (including negative numbers), which was deemed unrealistic. Therefore, to refine the model and adjust for this, the baseline historical data takes data only from 2016–2021. Finally, much like the LRM, cumulative PA attrition at 4%, 8.5% and 13% reduce the baseline forecasted PAs by 2038 in Fig. 3 to 8,090, 5,534 and 4,008 respectively.

Discussion

This study adapted data from the 2014–2021 FPA censuses[19-26] to generate baseline historical data for the number of cPAs. These data was then used to project the number of cPAs to 2038 using linear regression modelling, exponential regression modelling and time-series forecast modelling. Projected numbers vary by method, but a reasonable range – excluding attrition scenarios – appears to be between 8,232 (number projected by the LRM) and 13,922 (upper limit, based on 95% confidence interval, of the TSFM). The base forecast value from the TSFM of 11,866 cPAs represents approximately a 332% increase in PA numbers. While this might seem like a very significant increase, it is not unreasonable; per the 2021 FPA census[19] 1,184 PA students were members of the FPA on 1 October 2021. This number does not represent the entire PA student body, nor account for the growth in programmes and programme sizes. However, despite this, and assuming that all are on a standard 2-year postgraduate course (given the infancy of undergraduate entry programmes[12]), this crudely leads to 592 PA graduates per year – note that this figure also does not consider failure of the course or future attrition. Multiplied by the 2022–2038 time period (17 years), this leads to a total of 10,064 PAs; combined with the 2021 estimate of 2,745 cPAs (Supplementary File 1), this provides 12,809 PAs, well within the range of PA numbers projected between the LRM and the TSFM.

One factor that could, of course, influence PA numbers is PA attrition. The models generated in this article suggest that numbers are, generally, on track to meet the NHS Long Term Workforce Plan of 10,000 PAs by 2036/7.[14] However, PA attrition could hamper these efforts. Clinician attrition is an issue pervasive in medicine and healthcare,[29]

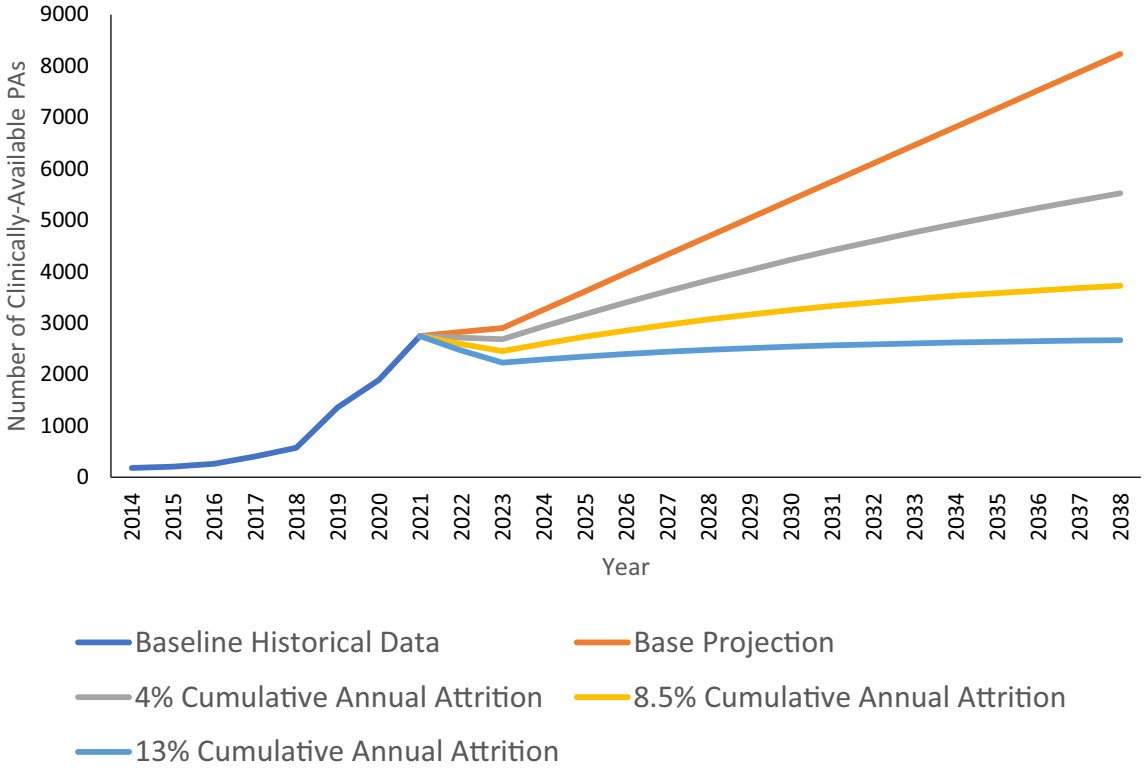

Fig. 2. Projection of cPAs in the UK (2014–2038, linear regression). Baseline historical data are shown in dark blue on the far left of the x-axis, with the base projection shown in orange. 4%, 8.5% and 13% cumulative annual attrition are shown in grey, yellow and light blue respectively. Note that the 2022 value for cPAs was imputed for the baseline and subsequent attrition models. The regression model predicted a value of 2,551 for this year, which was lower than the previous year (from actual data), which had a value of 2,745. Therefore the average (2,826) of the actual value for 2021 (2,745) and the predicted value for 2023 (2,906) was used as the value for 2022.

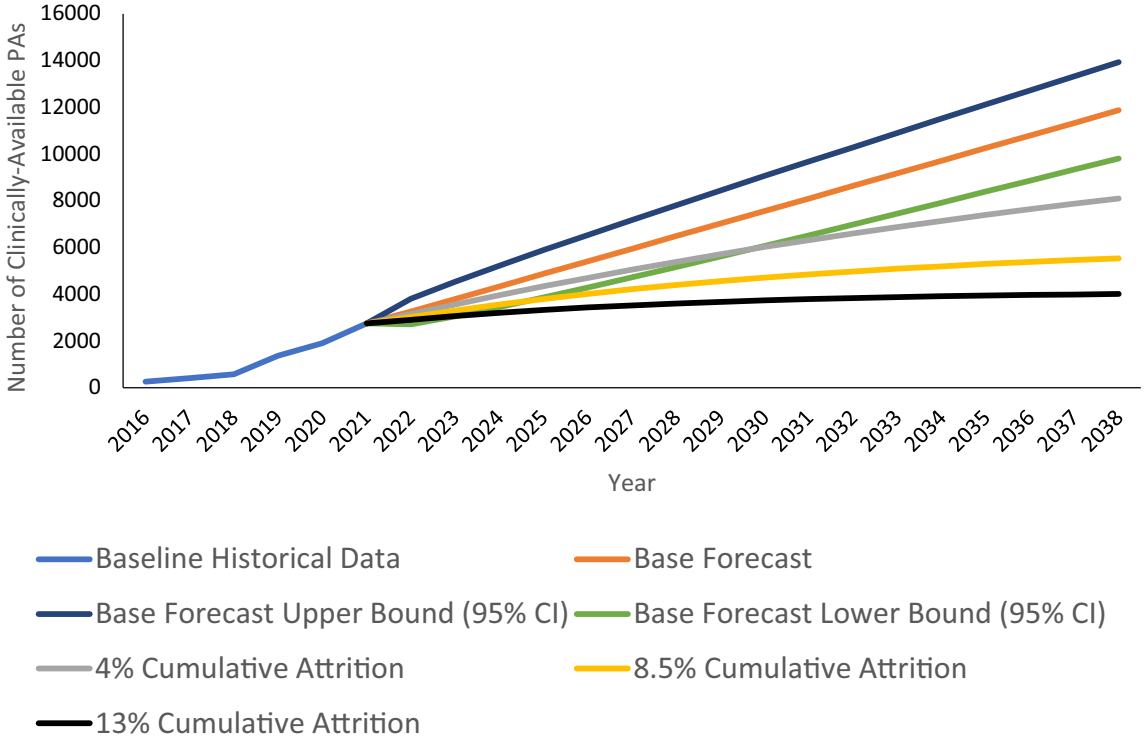

Fig. 3. Projection of cPAs in the UK (2016–2038, time-series forecast). Baseline historical data are shown in light blue on the far left of the x-axis, while the base forecast is shown in orange. Upper and lower limits, based on the 95% confidence interval, are shown in dark blue and green respectively. 4%, 8.5% and 13% cumulative annual attrition against the baseline are shown in grey, yellow and black respectively.

and it is clear from Figs. 2 and 3 that this could significantly impact PAs as well. On the extreme scenario of 13% cumulative annual attrition, regardless of the model used, PA numbers by 2038 would barely increase from baseline values. Given the potential for PAs to help address health workforce shortages,[34] policy makers and managers should consider factors that may influence a PA to leave clinical practice and thus develop strategies to mitigate this. Due to the infancy of the profession, attrition figures and reasons are not available or widely explored within the UK context. The FPA censuses have highlighted that PAs may leave clinical practice for a number of reasons, including to become a PA educator, to undertake care, to go into research, or to become a medical doctor.[19,21] Further potential attrition reasons include gender stereotypes and societal expectations of women,[35] such as a greater expectation to contribute to childcare, alongside a lack of societal support systems to ameliorate these differences and redress gender stereotyping.[36] This failing is particularly pertinent for PAs, as FPA census data highlight that the majority of PAs are women (77% of the 2021 census respondents were women).[19] An additional potential attrition factor is the current lack of PA regulation, with commonly expressed frustrations including the inability of PAs to prescribe and, at times, a lack of understanding of the role from a number of sources including fellow healthcare workers[37] and patients.[38]

Taken together, to mitigate attrition, promote career satisfaction and support regard of PAs by those who work with them[39] and are treated by them,[38] there are several pertinent recommendations. Professional regulation and legislation, with appropriate patient safety measures, will support PAs. PAs would also benefit from an established career structure and there has been recent consultation on this through the Medical Associate Professions (MAPs) Career Development Framework.[40] It is, however, recognised that PA career progression in the UK has historically focussed on horizontal progression rather than the traditional vertical progression seen in medicine.[37] This horizontal progression permits a unique flexibility to PAs, allowing them to contribute to a variety of multidisciplinary teams. Concurrent with this is facilitating wider recognition of the role, as patients in past studies have had misconceptions regarding what a PA is, which could impact trust[41] as transparency is key. Finally, although this is a comment that impacts across medicine and healthcare, it is important to reduce burnout and overworking. The census data highlight that half of PAs already feel that they work under excessive pressure.[19] Formal regulation may increase this pressure further, even if it provides increased satisfaction and direct accountability, so it is sensible to consider implementing measures to mitigate burnout. The importance of this is further evident in light of a 2022 study which found, following a survey conducted in early 2020, that 11.8% of PAs selected 'work–life balance' as a reason for them leaving a job.[42]

Strengths and limitations

Although the LRM and TSFM developed for this article produce reasonable projections, there are nonetheless several limitations to this study and the methods used. Firstly, the base underlying data for cPAs were not raw exact figures, but rather were calculated based on adjusting values from survey respondents. This could result in inaccurate underlying data if proportionality is different between survey respondents and non-respondents, which would influence the projections of the models. There were also some inconsistencies between the censuses' data. For example, the 2020 and 2021 censuses did not provide estimates for the total number of PAs[19,20] and, as such, this number had to be calculated to arrive at a reasonable estimate. The data are also limited in that the baseline data from 2014 to 2021 will naturally include some level of PA attrition, yet exact amounts cannot be determined from it. As such, the attrition simulations shown in Figs. 2 and 3 may be skewed and thereby overestimate the effect it could have.

Despite the above, it is the authors' opinions that the numbers projected are nonetheless reasonable and worth considering, due to the strengths of several aspects in the study. Firstly, the use of multiple modelling techniques permitted a wide view of potential PA numbers, though the models were not automatically accepted, as shown by the discard of the ERM. The baseline projections between the LRM and the TSFM were fairly similar, though the latter was notably more optimistic. To the authors' knowledge, this is the first study of its kind on UK PAs and therefore this paper fills an underserved niche. Other strengths of the study include the statistical validation of the various models, ranging from the R^2 value and significant p-value for the LRM, to the MASE value for the TSFM. Additionally, despite the noted issues above with the underlying data from the censuses, the FPA is a reliable source of information for PAs in the UK, given their status as the initial 'de facto' regulatory body for PAs.

Conclusions

This study implemented a novel approach to the analysis of FPA census data and used this to generate baseline information of 'clinically available PAs' (cPAs) from 2014 to 2021. These numbers were projected to 2038 using three modelling approaches: linear regression, exponential regression and time-series forecast. The linear regression and time-series forecast models were the most reasonable, with an upper limit of 13,922 PAs. The actual number of PAs by 2038 is contingent on several factors, including programme growth, PA attrition and development of the UK PA career structure. Policy makers and workforce planners should consider factors influencing PA satisfaction, alongside the unique composition of PAs as a valuable addition to the workforce.

Declaration of competing interest

Emyr Yosef Bakker reports a relationship with University of Central Lancashire that includes: employment. Peter Anthony Dixon reports a relationship with University of Central Lancashire that includes: employment. Tim Smith reports a relationship with University of Central Lancashire that includes: employment. Jane Frances Rutt-Howard reports a relationship with University of Central Lancashire that includes: employment. All authors on this article are involved in physician associate education and assessment at the Module Tutor, Module Leader, and/or Course Leader level at their affiliated institution, as well as involvement nationally through external roles at other HEIs, membership of multi-institution organisations or involvement in the Physician Associate National Exam (PANE).

CRediT authorship contribution statement

Emyr Yosef Bakker: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Peter Anthony Dixon:** Writing – review & editing, Writing – original draft, Visualization, Resources, Investigation, Formal analysis, Data curation. **Tim Smith:** Writing – review & editing, Writing – original draft, Visualization, Resources, Investigation, Formal analysis, Data curation. **Jane Frances Rutt-Howard:** Writing – review & editing, Writing – original draft, Visualization, Resources, Investigation, Formal analysis, Data curation.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.fhj.2024.100176.

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