

Effects of a regional–rural immersion program in Northland, New Zealand, on returning to work in that region

Charlotte J. W. Connell PhD¹  | Warwick Bagg MD¹ | Emmanuel Jo BSc^{1,2} | Philippa Poole MD¹

¹Department of Medicine, School of Medicine, The University of Auckland, Auckland, New Zealand

²Analytics and Intelligence Section, Health Workforce, Ministry of Health, Wellington, New Zealand

Correspondence

Charlotte J. W. Connell, Medical & Health Sciences Building, Building 507, Level 2, 28 Park Avenue, Grafton, Auckland 1023, New Zealand.
Email: c.connell@auckland.ac.nz

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Abstract

Introduction: It is well established that rural workforce outcomes are more likely among medical graduates who spend time training in non-urban areas; however, fewer studies have assessed whether graduates are more likely to return to the specific area where they undertook rural training.

Objective: This study aimed to determine whether graduates who had undertaken a regional–rural immersion program in Northland, NZ, were more likely to have returned to work in Northland as of mid-2021, relative to peers who did not participate.

Design: This prospective cohort study used longitudinal tracking survey responses, medical school administrative data and workforce outcome information. A multinomial model, accounting for other covariates, was built to determine the association between graduates practising in Northland (population < 100 000), which encompasses both rural (population < 25 000) and regional (25 000 < population < 100 000) areas, and having participated in a Northland-based immersion program during medical school. The study population was University of Auckland domestic medical students graduating between 2009 and 2018, inclusive. Immersion program participants who responded to longitudinal career tracking surveys were included in the study sample.

Findings: The final sample size was 1320 students (80% of population of interest). Graduates who undertook the Northland immersion program ($n = 169$) were more likely than non-participants ($n = 1151$) to be working in Northland as of 2020–2021 (relative risk: 3.2).

Discussion and Conclusion: Regional–rural immersion programs might preferentially build workforces in that specific region; however, further research is required to understand whether these findings are generalizable, and the main reasons for this effect.

KEYWORDS

career choice, curriculum, health workforce, medical education, rural health

1 | INTRODUCTION

As in other countries, Aotearoa New Zealand (NZ) faces an ongoing geographic maldistribution of its medical workforce and a shortage of medical professionals outside its main urban centres.^{1,2} The effect of workforce maldistribution on health care access is yet to be quantified³; however, international data suggest workforce shortages are a key factor exacerbating the health disadvantage associated with ethnicity and socioeconomic deprivation.⁴

NZ has two medical programs: one at the University of Otago, and the other at the University of Auckland. Nationally, the number of students accepted into medical training has increased over the last decade to approximately 530 domestic students per year. Both programs have implemented evidence-based selection and educational initiatives to ensure more doctors are predisposed to work in rural areas. For example, preferential rural entry pathways into each NZ medical school were established on the association between doctors originating from non-urban areas and a rural work intention⁵ or a rural work outcome.⁶⁻⁹

Medical schools often institute curriculum-based strategies in addition to selection-based initiatives to foster rural workforce outcomes in medical graduates. Rural exposure during medical training might be for the entirety of the program in rurally based schools,¹⁰ or through rural immersion of varying duration and structure (3 weeks to a year or more) in urban-based programs (immersion programs).¹¹⁻¹⁴ The latter positively impacts rural work intentions¹¹ and the likelihood of rural practice, independent of rural origin.^{15,16}

Research that has assessed the impact of immersion programs on the workforce outcomes of medical students has often focused on whether graduates return to areas broadly similar to the rural immersion context in terms of population size or degree of remoteness. Studies that have explored this while controlling for other independent factors, such as rural background and rural work interest, have found that graduates are more likely to return to work in areas with a similar level of rurality to where they had a rural immersion experience during medical school than those without that experience.^{8,15,17} However, until recently, the propensity for graduates to return to the specific region of rural immersion to work has not been explored in depth.

The question of whether rural immersion in a specific region leads to a greater likelihood of graduates returning

What is already known on this subject:

- Non-urban work outcomes are higher among medical students with a non-urban background and those who spend time training in non-urban, rural settings, usually via immersion programs at medical school

What this paper adds:

- This is the first controlled study in NZ to show that participation in a regional-rural immersion program might enrich the medical workforce in that location specifically, as well as other regions. Further, it follows outcomes for up to 12 years post-graduation

that region to practise is an important one. This is the premise on which such programs might be based in the first place. Early findings from Australia suggest this might be the case: graduates exposed to a rural region during medical training, either for at least 12 months,¹⁸ or the entire duration of their medical training¹⁹ appear to be returning to those specific regions to practise, at least early on in their careers. Similarly, in the NZ context, the University of Auckland's Northland-based regional-rural immersion program (Pūkawakawa) had a positive impact on recruiting doctors back to the area to practise.¹³ Sixty-two percent of Pūkawakawa graduates between 1 and 3 years into their careers ($n = 45$) were working in a regional or rural hospital,¹³ and the majority of those working in Northland (93%) reported that their decision to work there was influenced by Pūkawakawa.¹³ However, this study was limited by a small sample size, and the lack of comparison group of graduates who did not complete Pūkawakawa. Furthermore, the sample included only graduates in the early stages of their career (3 years or less). Thus, the propensity of Pūkawakawa participants to return to Northland (the region of immersion), while also accounting for other influencing factors that affect work location, is yet to be explored in the NZ context.

Pūkawakawa has been running long enough for its first participants to be over 12 years into their careers. Thus, we are well-placed to investigate the impact of Pūkawakawa on work outcomes using a much larger sample than in earlier research, in addition to the ability to account for other factors known to affect rural work outcomes.¹³

The purpose of this paper was to assess the effect of Pūkawakawa participation on the recruitment of graduates back to the Northland region, and to other regional-rural areas, relative to their non-participant peers. In addition, we aim to identify predictors of working outside an urban setting.

2 | METHODS

2.1 | Study population

The study population of interest was domestic University of Auckland medical students who graduated between 2009 and 2018, inclusive. Thus, graduates could be between 3 and 12 years post-graduation at the time that we collected their mid-2021 workplace location. This study utilised data collected as a part of a national longitudinal career tracking study of medical students (Medical Schools Outcomes Database and Longitudinal Tracking Study; MSOD) merged with medical practising certificate registration and work location data from the Medical Council of New Zealand (MCNZ) and Ministry of Health. Since 2012, students and graduates at the University of Auckland have been invited to complete MSOD career surveys at medical school entry, exit (graduation) and at postgraduate follow-up points in years one, three, five and eight. Before 2012, the University of Auckland (UA) tracking project collected student career intentions at medical school only, with these data now integrated into MSOD. International students were excluded from the study.

2.2 | Pūkawakawa (regional-rural immersion) program context

For the period of the study, the Auckland medical program had its main clinical campus in Auckland City (Figure 1, panel a), with additional clinical training hubs in Auckland (North Shore; Waitakere; Middlemore; Auckland City), Hamilton, Tauranga, New Plymouth, Rotorua, Whakatane and Whangarei (Figure 1, panel a). From 2008, students could apply for one of 24 places on the Northland-based regional-rural immersion program (Pūkawakawa) in Year 5, which is the penultimate year of their medical program. In this time period, Pūkawakawa was the only regional-rural immersion program offered to University of Auckland students. Pūkawakawa was developed in partnership with local health services and iwi (Māori groups) and consists of a year-long integrated curriculum including cultural and community cohort activities. Pūkawakawa students completed clinical placements at Whangarei hospital, and a seven-week

General Practice/Integrated Care placement in one of four rural towns, including a rural hospital experience (Figure 1, Panel a).²⁰ The main hub for Pūkawakawa students is Whangarei, a regional centre with a population of ~95 000, located a 2.5-h drive north of Auckland. The four rural sites in Northland that Pūkawakawa students also spend time in are all approximately 2-h drive away from Whangarei, with populations ranging from 500 to 5000 people. In these smaller towns, the health needs of the community are served by GPs, community health care workers, Māori health providers and small rural hospitals. More students applied than places available, with preference given to those who entered medical school via the Regional-Rural Admission Scheme (RRAS), the Māori and Pacific Admissions Scheme (MAPAS), or students connected to Northland. Students who did not participate in Pūkawakawa were required to complete at least one of their clinical training years outside of Auckland, based at one of the clinical hubs listed earlier and illustrated in Figure 1 (Hamilton; Tauranga; New Plymouth; Rotorua or Whangarei). However, their training at these sites consisted of more traditional clerkships. General Practice is a compulsory placement for all students in Years 4, 5 and 6 with at least one of these in a rural setting.

2.3 | Data sources

Socio-demographic information from MSOD career survey data served as the main source for ascertaining student background. If this was not available, background was assigned using administrative data sources.

MSOD data were merged with University of Auckland administrative data, which provided information on secondary school, Pūkawakawa participation, medical school entry pathway, year of graduation and other socio-demographic features (date of birth, ethnicity, citizenship and gender). Finally, Medical Council of New Zealand (MCNZ) data on medical practice registration and location in mid-2021 were linked to the dataset.

2.4 | Data processing and analysis

2.4.1 | Designing the geographical base—Rural/Regional/Urban/Northland

The terms 'rural' and 'urban' are broadly used to refer to areas with similar population sizes, population concentrations and/or remoteness. The cut-offs for population size, population concentration and remoteness that separate 'rural' and 'urban' categories are dependent on the context and the research question. The optimal definition of

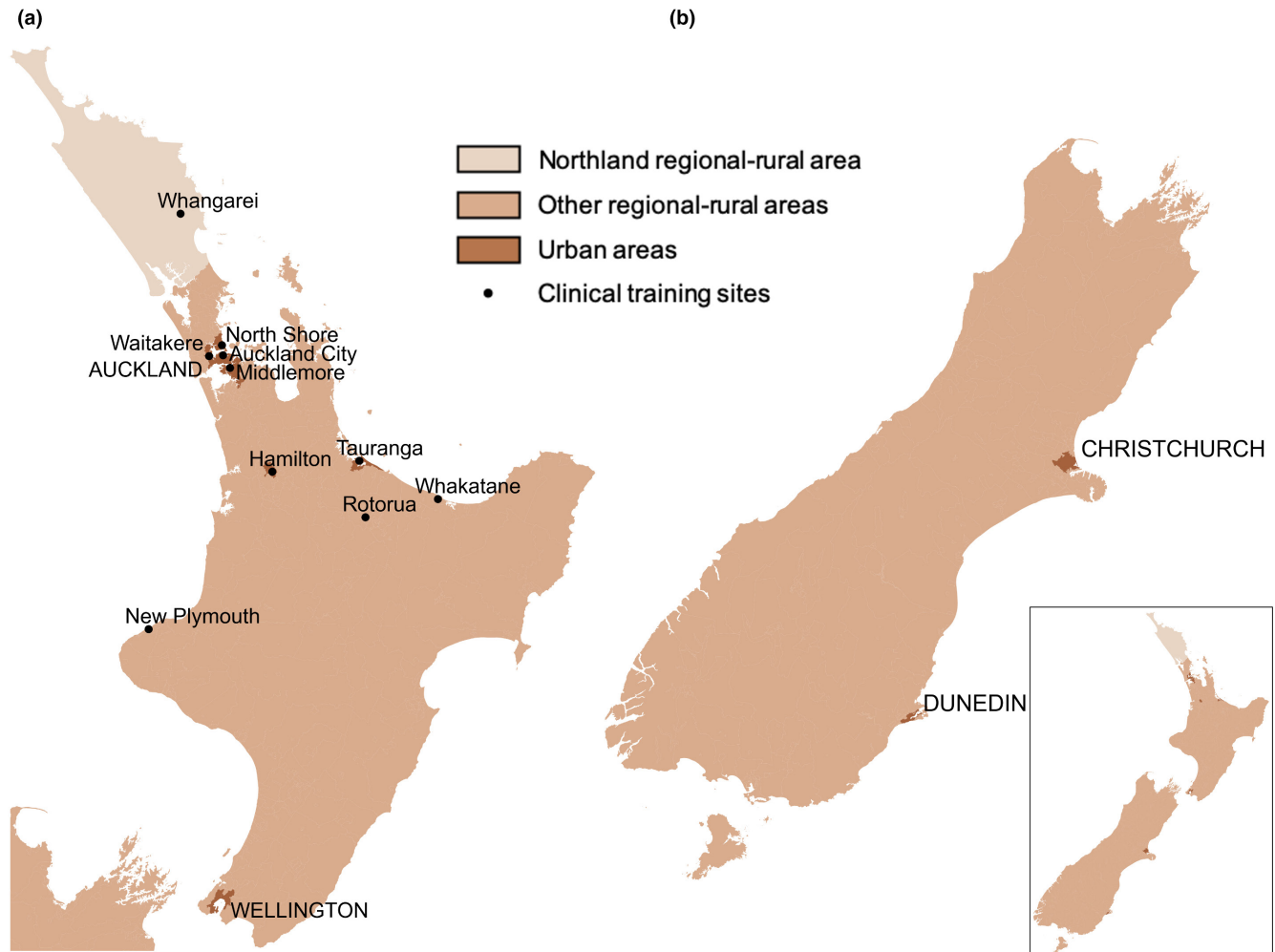


FIGURE 1 Map of NZ highlighting the Northland regional–rural area, other regional–rural areas of NZ, urban areas and University of Auckland main clinical training hubs (•). Panel (a) Map of the North Island of New Zealand showing: the Northland regional–rural area where Pūkawakawa was based; other areas of the North Island considered to be ‘other regional–rural’ (population < 100 000) and the major ‘urban’ areas. Panel (b) Map of the South Island of New Zealand showing areas considered to be ‘other regional–rural’ areas or ‘urban’ areas (named in capitals). This map does not show all the general practice placement sites

‘rural’ and ‘urban’ to use in health workforce terms for NZ has been debated for several years.³ There is an emerging consensus that a three-category framework based on population size is preferable, namely urban (population over 100 000); regional (population 25 000–100 000) and rural (population less than 25 000).²¹ These categories are broadly comparable to categories M1/M2, R1 and R2/R3/Rem1/Rem2, respectively, in the Australian Rural, Remote and Metropolitan Areas remoteness classification.²² We created custom geographic boundaries to designate background locations into the three-category framework described above and another boundary file to group post-graduate work locations into the categories: Northland (area serviced by the Northland District Health Board [DHB] where Pūkawakawa is based); other regional–rural (areas outside of Northland with a population less than 100 000) and urban (population over 100 000).

The smallest areas from the 2013 NZ census (Meshblocks, MB) and their associated populations were used as the building blocks for customised geographical boundaries.²³ While MBs are the smallest statistical unit, they were not suitable for application of our three-category criteria. Instead, larger geographical areas defined by the 2019 urban–rural boundaries²⁴ were used. These urban–rural boundaries define areas similar in population, population concentration, remoteness and infrastructure.²⁵ Population counts of MBs within areas of the 2019 urban–rural boundaries were aggregated and then categorised as ‘urban’ (population > 100 000), ‘regional’ (population 25 000–100 000) or ‘Rural’ (> 25 000). Cities with counts at the upper threshold of the ‘regional’ category, namely Dunedin, Lower Hutt and Tauranga (population count 96 405, 94 044 and 91 740, respectively) were changed to ‘urban’. From a health delivery perspective, these areas

more closely resemble 'urban' areas than 'regional' areas. Another customised boundary file with categories, 'Northland', 'other regional-rural' and 'urban', was created by adding the Northland DHB boundary²⁶ and combining 'rural' and 'regional' areas in the first customised boundary file into one category ('other regional-rural'). There were no urban areas within the Northland DHB: all were either 'rural' or 'regional'. An illustration of the areas that comprise each category across NZ is provided in [Figure 1](#).

2.4.2 | Outcome variable

The primary outcome variable was postgraduate location in mid-2021. The most recent work location from MCNZ or MSOD data sources served as the best approximation of a graduate's work location.

Location coordinates were coded using the GeoPy Python library and the MapBox application programming interface to place them into Northland, other regional-rural or urban categories ([Figure 1](#)). If a work address from both registration and MSOD were available for the same year, the registration location took preference.

2.4.3 | Explanatory variables

Variables associated with rural work intentions in the NZ context⁵ and rural work outcomes in international contexts^{8,27,28} were retained for analysis. These included gender, age at graduation, student background, ethnicity and undergraduate regional-rural immersion experience (in this study, Pūkawakawa participation).

Student backgrounds were sorted into rural, regional and urban categories. If students indicated in a survey a background of longest residence with a population size <25 000, they were considered Rural. They were considered regional if they indicated a hometown location with a population size between 25 000 and 100 000 and urban if they indicated their hometown location had a population >100 000. If they did not indicate the population size of their background location but perceived themselves as coming from a Rural background, they were categorised as Rural. Where survey responses were unavailable, high school location was used to categorise backgrounds (See [Section 2.4.1](#) for detail).

Prioritisation criteria were applied to select only one ethnicity where a student responded with more than one. The criteria, from highest to lowest priority, were Māori, Pacific Island, Other and New Zealand European. These criteria make no assumptions of the ethnicity with which the respondent identified most strongly but are consistent with that applied by the NZ Ministry of Health.²⁹

2.5 | Analysis and model selection

Bivariate statistical significance was assessed with χ^2 (chi-square) tests for categorical data and one-way ANOVA or Mann-Whitney *U* tests for continuous variables.

A multinomial logistic regression with outcome variable Postgraduate Location (Northland/Other Rural-Regional/Urban) was built in SPSS (IBM SPSS Statistics, Version 25). Explanatory variables included Pūkawakawa (Yes/No), Background (Rural/Regional/Urban), Gender (Male/Female), Ethnicity (Māori or Pacific/Other/NZ European) and Age at Graduation (>30 years/≤30 years). The reference category for the outcome variable was 'urban'. Non-significant factors ($p > 0.2$) were removed via backward elimination to arrive at the final model. Multicollinearity among explanatory variables was assessed by factorising categorical variables and calculating variance inflation factors (VIF). Statistical significance was set at α (alpha) = 0.05.

Data processing, variable selection and descriptive analyses were performed in Python 3.7 using Pandas,³⁰ Scipy³¹ and Matplotlib³² packages.

3 | RESULTS

A total of 1666 University of Auckland graduates from the population of interest (University of Auckland Graduates: 2009–2018) responded to longitudinal tracking study surveys. Of those respondents, 139 international graduates were excluded from the study sample, 212 were not registered with MCNZ in mid-2021, and 115 were registered but a work location could not be identified for them. Furthermore, 26 graduates were missing demographic information and were excluded. This left an effective sample size of 1313 graduates, or 80% of the domestic graduate population from the University of Auckland graduating between 2009 and 2018. There were 169 graduates in the final sample who had participated in Pūkawakawa. [Figure 2](#) provides a flowchart of the effective sample size for the study.

Bivariate comparisons of Pūkawakawa participants versus non-participants are provided in [Table 1](#). The groups differed significantly by gender ($p < 0.05$), ethnicity ($p < 0.001$), background ($p < 0.001$) and postgraduate location ($p < 0.001$). Compared to non-participants, the Pūkawakawa group had a higher proportion of women, a larger proportion of Māori, Pacific and NZ European graduates, and more students from a regional or rural background. Lastly, there was a higher proportion of graduates in the Pūkawakawa group working in Northland or other regional/rural locations compared to those in the non-participant group. The groups did not differ on the

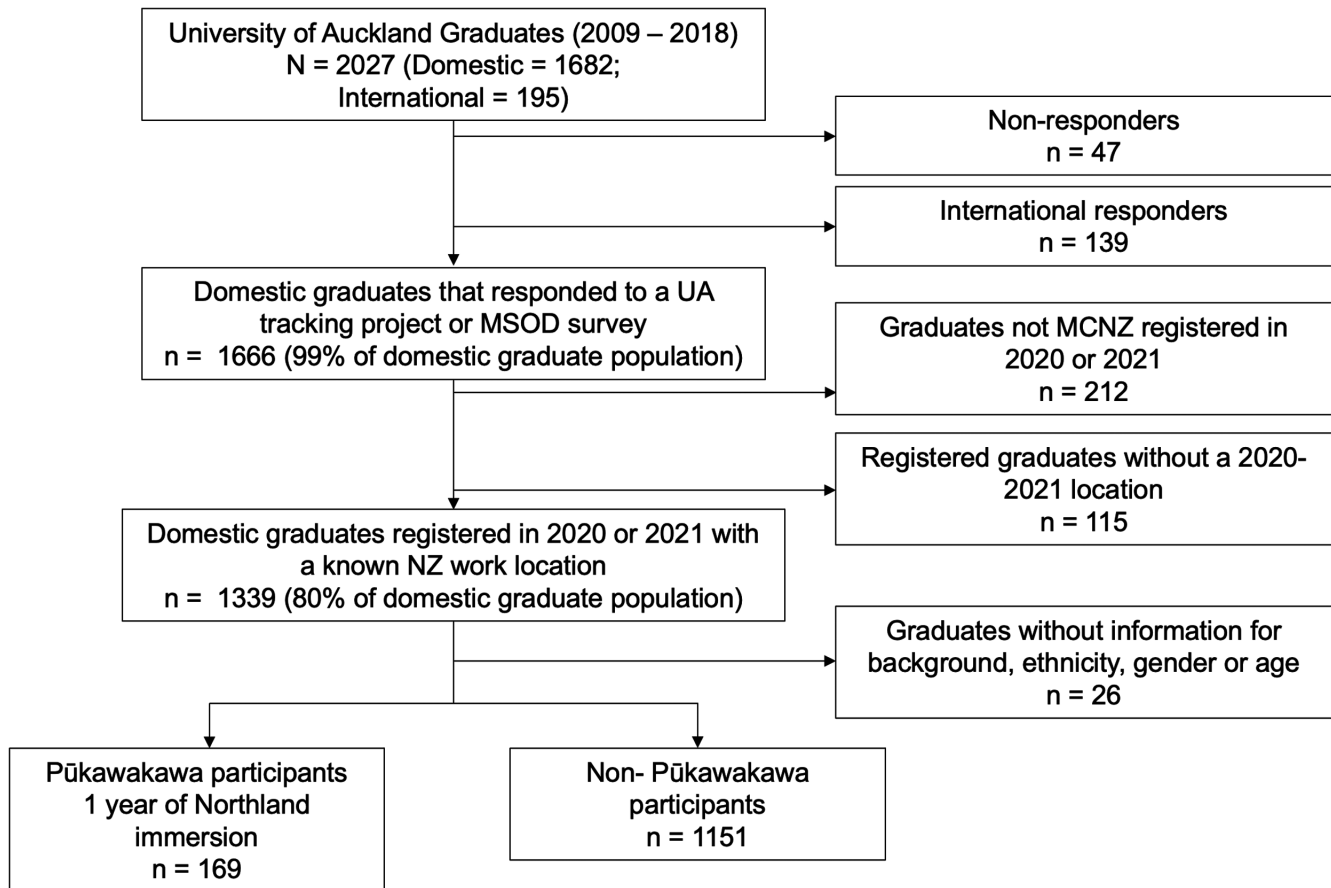


FIGURE 2 Flow diagram of study sample

proportion of graduates over or under 30 years of age at the time of graduation, nor did the groups differ on the proportion of graduates from each graduation year. Overall, the sample had greater representation of those who graduated from 2012 onwards due to increasing class sizes and more comprehensive data being available in recent years, but response rates did not differ between the Pūkawakawa group and non-participants (Table 1).

The explanatory variables Pūkawakawa, Background, Ethnicity, Gender and Age at Graduation were entered into the multinomial model. In the final model, Background ($p < 0.001$), Ethnicity ($p < 0.001$) and Pūkawakawa ($p < 0.001$) were statistically significant. Gender and age at graduation were dropped from the model in the backward stepwise regression procedure. The findings from this analysis, including relative risk ratios (RR), are presented in Table 2. Participation in Pūkawakawa was associated with a 3.4 ($p < 0.001$) times greater likelihood of working in Northland than in an urban location than for non-participants. Compared to those with an urban location, Northland-located graduates were more likely to have a regional background (RR 2.9, $p < 0.01$) and less likely to have other ethnicity (RR 0.3, $p < 0.01$) compared to an NZ European ethnicity.

Compared to graduates in an urban location, graduates in an other regional/rural location were more likely to have a regional or rural background (RR 3.2, $p < 0.001$ and RR 1.9, $p < 0.01$, respectively) and less likely to have other ethnicity, compared to having an NZ European ethnicity (RR 0.5, $p < 0.001$).

4 | DISCUSSION

This was a large longitudinal follow-up study of 1313 NZ medical graduates from the University of Auckland medical program of whom 13% percent had undertaken the Northland-based regional–rural immersion program during medical school (Pūkawakawa). The main finding was that Pūkawakawa participants were over three times more likely than non-participants to be working in Northland at the time of collection of their work location up to 12 years after their immersion. The study also confirmed the positive association of non-urban background with working outside urban areas across NZ.

The major insight from this study is the importance of regional–rural immersion on medical workforce development for the specific region in which immersion

	Pūkawakawa (n = 169)	Non-Pūkawakawa (n = 1144)	Sig.
Postgraduate location			
Northland	23 (14%)	40 (4%)	0.000**
Other Regional/Rural	41 (24%)	165 (14%)	
Urban	105 (62%)	939 (82%)	
Gender			
Female	103 (61%)	586 (51%)	0.018*
Male	66 (39%)	558 (49%)	
Ethnicity			
Māori	46 (27%)	125 (11%)	0.000**
Pacific	16 (10%)	85 (7%)	
Other	14 (8%)	469 (41%)	
NZ European	93 (55%)	465 (41%)	
Background			
Rural	57 (34%)	128 (11%)	0.000**
Regional	31 (18%)	97 (9%)	
Urban	81 (48%)	919 (80%)	
Age at graduation			
>30 years	7 (4%)	83 (7%)	0.135
<30 years	162 (96%)	1061 (93%)	
Graduation year			
2009	10 (6%)	37 (3%)	0.651
2010	7 (4%)	49 (4%)	
2011	7 (4%)	49 (4%)	
2012	16 (9%)	89 (8%)	
2013	22 (13%)	121 (11%)	
2014	18 (11%)	136 (12%)	
2015	23 (14%)	140 (12%)	
2016	17 (10%)	161 (14%)	
2017	24 (14%)	170 (15%)	
2018	25 (15%)	192 (17%)	

Note: Significance values are derived from chi-squared tests of independence.

*<0.05, **<0.001.

takes place. These results support and extend the early evaluations of Pūkawakawa that gave an early indication of its positive impact on workforce distribution, promoting a return of graduates who were very early in their postgraduate careers to Northland.¹³ The inclusion of a non-participant comparison group in this study permitted quantification of students' propensity to return to Northland. The high return-to-region rate observed in Pūkawakawa graduates (RR 3.2) likely relates to positive experiences that graduates have reported previously¹³ acting as 'pull' factors. Among the main themes that emerged from earlier interviews of Pūkawakawa graduates were that the program gave them a sense of community belonging and a positive experience working in a regional-rural

TABLE 1 Demographic data for Pūkawakawa and non-Pūkawakawa University of Auckland medical graduates between 2009 and 2018 with known mid-2021 NZ work location

setting.¹³ As a result, Pūkawakawa graduates are likely to have gained an understanding of the Northland context and have developed inter-personal connections in the area, perhaps encouraging return. Additionally, immersion programs might add capacity such as infrastructure, teaching and research opportunities, thereby attracting future workforce.^{20,33}

Pūkawakawa involved ~20 weeks of clinical attachments in a regional hospital and a 7-week integrated care and GP attachment in a satellite rural area, in addition to a 2-week lecture block and 5-week elective term. This is concordant with the findings of O'Sullivan et al.^{14,15} who propose that the immersion programs need to provide students with training across both rural and regional settings

TABLE 2 Multivariate multinomial logistic regression model

Explanatory variable	Postgraduate location						
	Northland			Other Regional/Rural			Urban
	<i>n</i>	RR [95% CI]	Sig.	<i>n</i>	RR [95% CI]	Sig.	<i>n</i>
Pūkawakawa participation							
No	40	—	—	165	—	—	939
Yes	23	3.4 [1.9–6.2]	<0.001*	41	1.4 [0.9–2.2]	0.094	105
Background							
Urban	37	—	—	120	—	—	843
Regional	14	2.9 [1.5–5.9]	0.002*	40	3.2 [2.1–5.0]	<0.001*	74
Rural	12	1.2 [0.6–2.5]	0.629	46	1.9 [1.3–2.9]	0.002*	127
Ethnicity							
NZ European	35	—	—	112	—	—	411
Other	9	0.3 [0.2–0.8]	0.008*	44	0.5 [0.3–0.7]	<0.001*	430
Māori or Pacific	19	1.0 [0.6–1.9]	0.887	50	1.0 [0.7–1.4]	0.795	203

Note: The 'Urban' category was the reference category for the response variable, postgraduate location ($n = 1313$, domestic students only). Model coefficients were exponentiated to yield relative risk ratios (RR) for explanatory variables and are presented in with 95% Confidence intervals (CI) in square brackets.

* <0.05 , ** <0.001 .

to achieve improved rural workforce outcomes. Although we cannot discern the extent to which Pūkawakawa participants had a pre-existing regional or rural work intention before participation in this study, Pūkawakawa participants in a previous study have reported that participation did confirm or consolidate their desire to work in a rural or regional setting or even change their view to a positive consideration of future regional or rural work.¹³ Training in rural hospitals and practices might build a graduates' confidence and self-efficacy for practising in similar contexts to those they experienced during regional-rural immersion.¹⁸ It is also possible that the smaller hospital and rural practices on the program provide an environment where students feel more in control of their learning and embedded as part of a team. Together, these factors might lead to a greater sense of self-determination and encourage students to want to return to the region.³⁴ Overall, the 'Pūkawakawa effect' that we observed here, namely the impact of a regional-rural immersion program in Northland promoting a return-to-Northland to work provides justification for the continuation of this program as a part of the medical curriculum at the University of Auckland. As the Pūkawakawa intake is constrained by the clinical resources of the area including supervisors, the capacity to scale the program further is limited. To overcome this, the University of Auckland has established three further regional-rural immersion programs to Year 5 medical students, based in Tauranga, New Plymouth and Hamilton. A total of 84 students now undertake a regional-rural program in Year 5, which is about third of the domestic students.

It is well established that students from a rural background enter rural work locations at significantly higher rates than students from an urban background.^{7,35} The results of this study are concordant with the international literature in this respect, as we saw that regional and rural backgrounds were related to higher rates of practising in a regional-rural area of NZ, and that a regional background was associated with a greater likelihood of a Northland work location, compared with an urban location. This was independent of participation in a regional-rural immersion program during medical school. The lack of effect of a rural background on eventual practice in Northland might be an artefact of smaller numbers or the relative effect of the immersion program.

Our sample included graduates a minimum of 3 years, and up to 12 years into their postgraduate pathway, confirming that the positive impact of Pūkawakawa in promoting a return to Northland to work persists beyond the very early postgraduate years (PGY1-PGY2).¹³ However, even beyond the very early stages of a doctor's career limitations on work location are likely to influence workforce distribution. McGrail et al.¹⁸ highlight that a graduate's materialisation of their intention to return to a specific region might be restricted by the number of pre-vocational jobs in those areas or opportunities for vocational training being limited to urban outposts—this factor is likely to play a role in the NZ context and we were unable to examine it in this study; however, we hope to be able to look at it in future work. The datasets include perception of influencing factors in career choice, as well as the actual specialty choice. Adding these into the modelling

might well be illustrative. As mentioned, the University of Auckland has three additional regional–rural sites in the North Island, which will enable us to examine whether the ‘Pūkawakawa effect’ that we have observed here applies to other areas.

This study is the largest, and the first controlled study from NZ to isolate the impact of regional–rural immersion on a specific work location outcome from other factors that influence graduate career choices. Assessing the independent effect of a rural immersion program on workforce outcome requires a study design with sufficient sample size, control group and statistical analysis that adjusts for potential confounders. The linking of longitudinal survey data with workforce data has made this possible, allowing for 80% of the total population of interest (2009–2018) to be included in this study. As graduates advance through their careers and more data are collected, our ability to control for the influence of different factors on workforce outcomes and better understand the work location distribution of graduates will only improve.

The present study has limitations. Students were not randomly allocated to rural immersion. Those entering medical school via regional–rural or Māori and Pacific entry pathways, or with a connection to Northland, were preferentially selected for Pūkawakawa, thereby introducing the possibility of selection bias. Additionally, we were unable to account for student career intentions in the analysis and it is plausible that most students who applied for Pūkawakawa were interested in Northland as a place to live or the types of medical practice available. Although we did achieve a high representation of students from the study population of interest in the effective sample (80% of University of Auckland Domestic graduates 2009–2018), there was lower representation of graduates from cohorts graduating between 2009 and 2012, and we cannot ignore the possibility that this might introduce an unobserved bias. Lastly, we did observe small sample size numbers for certain ethnic groups, particularly in the Pūkawakawa participants group.

In conclusion, these findings are relevant to policy decision-making at the local medical school level. They might inform the selection criteria and design of programs to increase medical workforce supply to specific regions and produce graduates with the desire and skillset^{13,20} to work outside of urban areas. These findings are an encouraging sign that initiatives by NZ communities, local health providers and universities to build workforces in specific areas might pay off in the longer term.

AUTHOR CONTRIBUTIONS

CJWC: conceptualization; data curation; formal analysis; investigation; methodology; software; validation; visualization; writing – original draft; writing – review

and editing. WB: conceptualization; funding acquisition; investigation; project administration; supervision; validation; writing – review and editing. EJ: conceptualization; data curation; funding acquisition; project administration; supervision; validation; writing – review and editing. PP: conceptualization; funding acquisition; investigation; project administration; supervision; validation; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST

The authors have no competing financial interests to declare.

ETHICS STATEMENT

For the MSOD and UA tracking project surveys, participants provided written informed consent. The MSOD project and UA tracking project have been approved by the University of Auckland Human Participants Ethics Committee (#022388; #018456) and the University of Otago Ethics Committee (#07–155). These ethics approvals permit linking with administrative and MCNZ data. Linkage to registration data was performed using secure protocols at the Ministry of Health.

ORCID

Charlotte J. W. Connell  <https://orcid.org/0000-0002-2068-4097>

REFERENCES

1. Lawrenson R, Reid J, Nixon G, Laursen A. The New Zealand rural hospital doctors workforce survey 2015. *N Z Med J*. 2016;129(1434):9–16.
2. Wong DL, Nixon G. The rural medical generalist workforce: the Royal New Zealand College of General Practitioners' 2014 workforce survey results. *J Prim Health Care*. 2016;8(3):196–203.
3. Fearnley D, Lawrenson R, Nixon G. “Poorly defined”: unknown unknowns in New Zealand Rural Health. *N Z Med J*. 2016;129(1439):77–81.
4. Smith KB, Humphreys JS, MGA W. Addressing the health disadvantage of rural populations: how does epidemiological evidence inform rural health policies and research? *Aust J Rural Health*. 2008;16(2):56–66.

5. Kent M, Verstappen AC, Wilkinson T, Poole P. Keeping them interested: a national study of factors that change medical student interest in working rurally. *Rural Remote Health*. 2018;18(4):4872.
6. Easterbrook M, Godwin M, Wilson R, Hodgetts G, Brown G, Pong R, et al. Rural background and clinical rural rotations during medical training: effect on practice location. *Can Med Assoc J*. 1999;160:1159–63.
7. Laven G, Wilkinson D. Rural doctors and rural backgrounds: how strong is the evidence? A systematic review. *Aust J Rural Health*. 2003;11(6):277–84.
8. Playford D, Ngo H, Gupta S, Puddey IB. Opting for rural practice: the influence of medical student origin, intention and immersion. *Med J Aust*. 2017;207(4):154–8.
9. Rabinowitz HK, Diamond JJ, Markham FW, Santana AJ. The relationship between entering medical students' backgrounds and career plans and their rural practice outcomes three decades later. *Acad Med*. 2012;87(4):493–7.
10. Sen Gupta T, Murray R, Hays R, Woolley T. James Cook University MBBS graduate intentions and intern destinations: a comparative study with other Queensland and Australian medical schools. *Rural Remote Health*. 2013;13(2):2313.
11. Abid Y, Connell CJW, Sijnja B, Verstappen AC, Poole P. National study of the impact of rural immersion programs on intended location of medical practice in New Zealand. *Rural Remote Health*. 2020;20(4):5785.
12. Campbell DG, McGrail MR, O'Sullivan BG, Russell DJ. Outcomes of a 1-year longitudinal integrated medical clerkship in small rural Victorian communities. *Rural Remote Health*. 2019;19(2):4987.
13. Matthews C, Bagg W, Yelder J, Mogol V, Poole P. Does Pūkawakawa (the regional-rural programme at the University of Auckland) influence workforce choice? *N Z Med J*. 2015;128(1409):35–43.
14. O'Sullivan BG, McGrail MR, Russell D, Chambers H, Major L. A review of characteristics and outcomes of Australia's undergraduate medical education rural immersion programs. *Hum Resour Health*. 2018;16(1):8.
15. O'Sullivan BG, McGrail M, Russell D, Walker J, Chambers H, Major L, et al. Duration and setting of rural immersion during the medical degree relates to rural work outcomes. *Med Educ*. 2018;52(8):803–15.
16. Playford DE, Evans SF, Atkinson DN, Auret KA, Riley GJ. Impact of the Rural Clinical School of Western Australia on work location of medical graduates. *Med J Aust*. 2014;200(2):104–7.
17. O'Sullivan BG, McGrail MR. Effective dimensions of rural undergraduate training and the value of training policies for encouraging rural work. *Med Educ*. 2020;54(4):364–74.
18. McGrail MR, O'Sullivan BG, Russell DJ. Rural training pathways: the return rate of doctors to work in the same region as their basic medical training. *Hum Resour Health*. 2018;16(1):56.
19. Woolley T, Ray RA. Effectiveness of regional medical schools in attracting and retaining students for early-career practice in the local area: the James Cook University experience. *Aust J Rural Health*. 2019;27(2):125–31.
20. Poole P, Bagg W, O'Connor B, Dare A, Mckimm J, Meredith K, et al. The Northland Regional-Rural program (Pukawakawa): broadening medical undergraduate learning in New Zealand. *Rural Remote Health*. 2010;10(1):1254.
21. Poole P, Van Lier D, Verstappen A, Bagg W, Connell CJW, Nixon G, et al. How rural is rural? The relationship between rural background of medical students and their career location intentions. *Aust J Rural Health*. 2021;29:363–72.
22. Australian Institute of Health Welfare. Rural, regional and remote health: a guide to remoteness classifications [Internet]. Canberra: AIHW; 2004 [cited 2021 May 6]. Available from: <https://www.aihw.gov.au/reports/rural-remote-australians/guide-to-remoteness-classifications>
23. Stats NZ, editor. Population by meshblock (2013 Census). 4th ed. Wellington: Stats NZ; 2015.
24. Stats NZ, editor. Geographic Areas File 2019. 6th ed. Stats NZ: Wellington; 2019.
25. Stats NZ. ANZLIC metadata for urban rural, 2019 [Internet]. Wellington: Stats NZ; 2019 [cited 2021 Mar 17]. Available from: <http://www.stats.govt.nz>
26. Stats NZ, editor. District Health Board 2015 [Internet]. datafinder.stats.govt.nz; 2017 [cited 2021 Mar 17]. Available from: <https://datafinder.stats.govt.nz/layer/87883-district-health-board-2015/>
27. Puddey IB, Mercer A, Playford DE, Riley GJ. Medical student selection criteria and socio-demographic factors as predictors of ultimately working rurally after graduation. *BMC Med Educ*. 2015;15:74.
28. Rabinowitz HK, Diamond JJ, Markham FW, Hazelwood CE. A program to increase the number of family physicians in rural and underserved areas: impact after 22 years. *JAMA*. 1999;281(3):255–60.
29. Health Information Standards Organisation. In: Ministry of Health, editor. Ethnicity data protocols [Internet]. Wellington: Ministry of Health; 2017 [cited 2020 Nov 26]. Available from: <https://www.health.govt.nz/system/files/documents/publications/hiso-10001-2017-ethnicity-data-protocols-v2.pdf>
30. McKinney W. Data structures for statistical computing in python. In: Proceedings of the 9th Python in Science Conference. Austin, TX; 2010. p. 51–6.
31. Jones E, Oliphant T, Peterson P. SciPy: open source scientific tools for Python [Internet]. 2014 [cited 2020 Feb 18]. Available from: <http://www.scipy.org/>
32. Hunter JD. Matplotlib: a 2D graphics environment. *Comput Sci Eng*. 2007;9(3):90–5.
33. Nixon GH, Kerse NM, Bagg W, Skinner MA, Larmer PJ, Crampton P. Proposal for a National Interprofessional School of Rural Health. *N Z Med J*. 2018;131:1485.
34. Hirsh DA, Ogur B, Thibault GE, Cox M. "Continuity" as an organizing principle for clinical education reform. *N Engl J Med*. 2007;356(8):858–66.
35. Wilson N, Couper I, De Vries E, Reid S, Fish T, Marais B. A critical review of interventions to redress the inequitable distribution of healthcare professionals to rural and remote areas. *Rural Remote Health*. 2009;9:1060.

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