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Longitudinal impact of preregistration interprofessional education on the attitudes and skills of health professionals during their early careers: a non-randomised trial with 4-year outcomes

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ABSTRACT

Objective To assess whether a preregistration interprofessional education (IPE) programme changed attitudes towards teamwork and team skills during health professionals' final year of training and first 3 years of professional practice.

Design Prospective, longitudinal, non-randomised trial.

Setting Final year health professional training at three academic institutions in New Zealand.

Participants Students from eight disciplines eligible to attend the IPE programme were recruited (617/730) prior to their final year of training. 130 participants attended the IPE programme; 115 intervention and 372 control participants were included in outcome analysis.

Intervention The 5-week Tairāwhiti IPE (TIPE) immersion programme during which students experience clinical placements in interdisciplinary teams, complete collaborative tasks and live together in shared accommodation.

Main outcome measures Data were collected via five surveys at 12-month intervals, containing Attitudes Towards Healthcare Teams Scale (ATHCTS), Team Skills Scale (TSS) and free-text items. Mixed-model analysis of covariance, adjusting for baseline characteristics, compared scores between groups at each time point. Template analysis identified themes in free-text data.

Results Mean ATHCTS scores for TIPE participants were 1.4 (95% CI 0.6 to 2.3) points higher than non-TIPE participants (p=0.002); scores were 1.9 (95% CI 0.8 to 3.0) points higher at graduation and 1.1 (95% CI −0.1 to 2.4) points higher 3 years postgraduation. Mean TSS scores for TIPE participants were 1.7 (95% CI 0.0 to 3.3) points higher than non-TIPE participants (p=0.045); scores were 3.5 points (95% CI 1.5 to 5.5) higher at graduation and 1.3 (95%CI −0.8 to 3.5) points higher 3 years postgraduation. TIPE participants made substantially more free-text comments about benefits of interprofessional collaboration and perceived the TIPE programme had a meaningful influence on their readiness to work in teams and the way in which they performed their healthcare roles.

Conclusions TIPE programme participation significantly improved attitudes towards healthcare teams and these changes were maintained over 4 years.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is a prospective, longitudinal, non-randomised trial of an immersive interprofessional education intervention, delivered to final year health students from eight disciplines.
⇒ Data were collected through validated scales and free-text comments over participants' final year of training and first 3 years of professional practice.
⇒ Group allocation was non-randomised and students who were more interested in interprofessional education may have chosen to attend the interprofessional programme.
⇒ The degree of Attitudes to Health Care Teams Scale or Teams Skills Scale change needed to indicate a meaningful change in clinical practice is unknown.
⇒ This study assessed learner attitudes and self-perceived teamwork skills but did not objectively measure teamwork skills, impacts on patient care or patient outcomes.

INTRODUCTION

Interprofessional practice enables different and complementary skill sets to contribute to collaborative, safe and high-quality healthcare.[1–3] Most health regulators require that graduates are competent to work within collaborative healthcare teams. This has prompted universities and training providers to offer interprofessional education (IPE) to preregistration healthcare students.[4]

IPE is integral to creating a collaborative practice-ready health workforce.[5] IPE occurs when health professionals or students from two or more disciplines intentionally learn with, from and about each other.[6] Evaluations of preregistration IPE have found improvements in students' collaborative knowledge, skills and attitudes.[7] Short-term evaluations have found increases in knowledge and skills required for collaborative practice, improved

student attitudes towards collaboration and improved clinical behaviour and patient care,[1 3 7 8] however, very few studies have assessed the longer term impact of preregistration IPE on subsequent professional practice, including whether immediate postgraduation changes are maintained over time and how interprofessional competencies and professional behaviour change during the early years of a health professional's career.[9–12] There is also a paucity of data to indicate how interprofessional attitudes and teamwork abilities change over time irrespective of exposure to IPE.[7] Worldwide, health professional training programmes have been urged to provide IPE despite a lack of evidence to demonstrate long-term changes in learners' attitudes, skills or clinical practice. Experimental longitudinal studies are needed that compare the interprofessional attitudes and skills of practising health professionals who did and did not participate in IPE programmes when they were students during their preregistration training.[13]

The Longitudinal Interprofessional Study was designed to examine the long-term impacts of attending a 5-week immersion programme delivered during health professional students' final year of preregistration training.[14] The principal aim of the study was to assess whether participation in the IPE programme influenced attitudes to interprofessional teams and teamwork abilities observed at graduation and over the first 3 years of professional practice in the disciplines of dentistry, dietetics, nursing, medicine, occupational therapy, oral health, pharmacy and physiotherapy.

METHODS

Study design

This was a 5-year quasiexperimental study with non-randomised, non-equivalent groups (those who attended the Tairāwhiti IPE (TIPE) programme and those who did not) and annual data collection points. This survey study was underpinned by a pragmatic postpositive paradigm[15] containing free-text items to give further meaning and context to quantitative items. The study was conducted in accordance with the published protocol[16] and findings are reported in accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement (online supplemental material 1).[17]

Participants

Senior students from health professional degree programmes eligible to take part in the TIPE programme were invited to participate in the study prior to commencing their final year of preregistration training. This included all students from a single-year cohort from the disciplines of: dentistry, dietetics, oral health, pharmacy, physiotherapy (University of Otago); medicine (University of Otago Wellington, a secondary campus of Otago University); nursing (Eastern Institute of Technology) and occupational therapy (Otago Polytechnic). These disciplinary cohorts represented all students who were eligible to attend the TIPE programme. There were no exclusion criteria, but participants were withdrawn if they did not successfully complete their final year of training and, therefore were ineligible for professional registration.

Participants were recruited in two cohorts. Cohort 1, recruited in October 2014 (all disciplines except oral health and pharmacy) or February 2015 (pharmacy), represented all students who were eligible to attend the TIPE programme in 2015, a subset of whom participated in the programme. Cohort 2, recruited in February 2016 (all disciplines), represented students who were expected to attend the 2016 TIPE programme.[16] Cohort 1 participants were recruited in class lectures, whereas cohort 2 participants were recruited via email invitation. Institutional administrative data were used to assess response rates to baseline surveys for each discipline involved.

Intervention

The TIPE programme caters for 70–75 final year preregistration students each year, drawn from a mix of health disciplines. Interprofessional collaborative practice,[18 19] indigenous Māori health (hauora Māori),[20 21] rural health and long-term condition management[22] are the pillars of the 5-week immersion programme. The programme is underpinned by adult learning theories, with a focus on building social relationships and creating non-threatening learning environments.[19] The programme is run in a region that has a high Māori (indigenous) and remote rural population and low levels of income and employment. Interprofessional learning outcomes are based on six core competency domains: communication; role clarification and appreciation; reflective practice; leadership and followership; shared decision-making and teamwork. Students experience supervised clinical placements in their own discipline (c.50%) and interdisciplinary teams (c.30%) and also complete collaborative tasks (c.20%). Students live and socialise together in shared accommodation for the duration of the programme. Teaching and learning are provided across diverse town and rural settings by an interprofessional teaching team employed by the University of Otago.[14 23] Participants are required to successfully complete all aspects of the programme in order to graduate.

Control group students did not attend the TIPE programme (but were eligible to) and attended supervised clinical placements in their own discipline. Some of these students may have been opportunistically exposed to informal and/or less intensive (fewer hours and not involving living together) IPE opportunities.

Assignment

Enrolment of individual students into the TIPE programme was not random and varied depending on each discipline's requirements, as detailed in the protocol.[16] Many students (but not all) deliberately choose to attend the programme; this may be due to interest in interprofessional practice, rural health and/or

hauora Māori. Only a portion of those who wish to attend are able to do so. No blinding was possible.

Outcomes

Participants' attitudes towards healthcare teams were assessed with the Attitudes Towards Health Care Teams Scale (ATHCTS),[24] as modified by Curran *et al*.[25] The ATHCTS contains 14 items on a five-point Likert scale; scores range from 14 to 70, with higher scores representing more positive attitudes towards teamwork. Participants' self-assessed ability to function within interprofessional teams was assessed with the Team Skills Scale (TSS).[26] The TSS contains 17 items on a five-point Likert scale; scores range from 17 to 85, with higher scores representing higher self-reported skills to function within an interprofessional team. The modified ATHCTS[27 28] and the TSS[29 30] were selected due to their high internal consistency when completed by student and graduate health professionals.

Free-text items elicited further information about scale responses and other comments about interprofessional care or the survey itself. For those who took part in the TIPE programme, surveys 3–5 (postgraduate) contained four additional items: two items on experiences of working in interprofessional teams; one item exploring the preregistration preparation to work in interprofessional teams and one item exploring the influence of TIPE on career choices. These items were placed at the end of the survey (and in this order) to minimise influence on other responses.

Data collection and survey instruments

Data were collected via surveys at baseline and 12-month follow-up intervals, capturing the end of the final year of training (survey 2) and first 3 years of professional practice (surveys 3–5). Baseline data for cohort 1 were collected by paper-based survey and inputted into an Access database (Microsoft, Redmond, Washington). Baseline data for cohort 2 and follow-up data for both cohorts were collected by a web-based survey (IBM Data Collection; IBM, Armonk, New York) administered by an independent research company. Follow-up surveys were administered each September to November (in 2015–2018 for cohort 1 and 2016–2019 for Cohort 2). Surveys contained sociodemographic items, the two standardised interprofessional outcome scales and free-text items online supplemental material 2. Surveys 2 and 3 data collection instruments and methods were piloted with a group of nurses to enable refinements of item wording and data collection processes; pilot nurses were recruited at the same time as cohort 1, but graduated 6 months ahead of cohort 1 participants.

Participant retention was maximised by collecting and regularly updating a range of contact details, regular communication with study participants, offering a certificate for completing each survey (that could count towards professional development requirements) and offering prizes for completion of each survey as well as a larger prize for completing all surveys. Non-responders were followed-up with reminder phone calls and emails or texts (according to participant preference).

Cohort 1 participants who did not graduate as expected (eg, those studying part time, deferring studies or failing to meet course requirements) but who met registration requirements before July 2016 were included with their original cohort. Cohort 1 TIPE participants who met registration requirements between July 2016 and June 2017 were moved to cohort 2 for survey 3–5 data collection. Non-TIPE participants who met registration requirements after July 2016 and TIPE participants who met registration requirements after July 2017 were withdrawn from the study. TIPE participants who did not complete the programme were withdrawn from study.

Study size

Study size was determined by the number of students eligible to attend the TIPE programme from a single-year cohort. Cohort 2 was recruited from students who attended the TIPE programme in 2016 to increase power to detect differences between TIPE and non-TIPE groups (it was not feasible to recruit an additional complete year group). There were no major changes in curriculum influencing the comparability of cohort 1 TIPE participants to those from Cohort 2.

Statistical methods

Data analyses at individual student level were conducted using SAS V.9.4 software (SAS Institute, Cary, North Carolina). Baseline demographic, ATHCTS and TSS characteristics were compared for the TIPE and non-TIPE groups and for TIPE cohorts 1 and 2. Demographic items were compared with Wilcoxon rank-sum tests/Kruskal-Wallis tests or χ^2 tests. Baseline ATHCTS and TSS were compared with t tests. Mixed-model analysis of covariance compared scores, adjusted for discipline, baseline demographics, ATHCTS and TSS, with terms for whether graduates participated in the TIPE programme, time of survey, the interaction of TIPE programme and time and random terms for individual students. The impact of loss-to-follow-up and missing data was investigated with multiple imputation that included all the variables in the analysis model.

Qualitative analysis methods

Free-text data in surveys 3–5 were extracted from Excel documents into Word documents and managed in NVivo V.12 (QSR International). The qualitative analysis method has been described in depth elsewhere.[31] In brief, template analysis was used to provide a systematic way of analysing the large data set while allowing in-depth thematic analysis.[32 33] Unlike other forms of qualitative analysis that typically have only one or two levels of coding, it is common to use four or more levels to capture the most detailed aspects of the data.[34]

Free-text analyses were undertaken by a team of qualitative researchers experienced in reflexive thematic analysis

(MB, BD, SP and EM). The initial template was based on the survey questions, with new versions of the template repeatedly updated as à priori themes changed and new codes were identified (online supplemental material 3). Initial coding was undertaken independently by one researcher (MB) on a line-by-line basis; items were analysed per survey, per cohort and per item, with each item coded separately; for example, responses to the item 'For what reason/s have you chosen to work or train in (clinical setting)' were coded under a separate grandparent node to responses to the item 'For what reason/s have you chosen to work or train in (location)'. The analysis explored variations and similarities across surveys and within context of the related quantitative findings (ie, survey year, cohort, study ID, demographics and related quantitative responses). Codes and categories were developed iteratively across surveys and crosschecked by a second researcher (BD), with all differences resolved through regular discussions. Themes and subthemes were further examined to find and interpret patterns and outliers, as is typical in reflexive forms of thematic analysis. Thus far, codes had been applied survey-by-survey (ie, all data from one survey were analysed before moving to the next survey); MB and BD then crosschecked the coding by applying the template item-by-item (ie, each item was checked across all surveys before proceeding to the next item). Theme documentation was checked and discussed with other authors regularly throughout the analyses, from initial template development and template modifications until final themes and subthemes were agreed on by all researchers to ensure themes represented the data. In addition, the research team compared themes and data extracts with the quantitative survey results to find and interpret commonalities and differences—that is to say, instances where the free-text responses supported or expanded on the closed-question answers, and instances where contradictions existed. The relative frequency of themes within and across the longitudinal surveys is

Table 1 Baseline characteristics of TIPE and non-TIPE participants

Characteristic	TIPE cohort 1 (n=59)	TIPE cohort 2 (n=71*)	P	TIPE (n=130*)	Non-TIPE (n=443*)	P	Total
Female	66.1% (39/59)	75.4% (49/65)	0.26	71.0% (88/124)	69.9% (309/442)	0.82	70.1% (397/566)
Age	22 (22–23) n=59	23 (21–24) n=65	0.58	23 (21–24) n=124	22 (21–23) n=442	0.003	22 (21–24) n=566
Ethnicity†							
NZ European	59.3% (35/59)	60.9% (39/64)	0.85	60.2% (74/123)	55.0% (243/442)	0.31	56.1% (317/565)
Maori	10.2% (6/59)	14.1% (9/64)	0.51	12.2% (15/123)	5.9% (26/442)	0.017	7.3% (41/565)
Pacific	0.0% (0/59)	1.6% (1/64)	1.00	0.8% (1/123)	1.4% (6/442)	1.00	1.2% (7/565)
Chinese	16.9% (10/59)	10.9% (7/64)	0.33	13.8% (17/123)	17.4% (77/442)	0.34	16.6% (94/565)
Indian	8.5% (5/59)	6.3% (4/64)	0.64	7.3% (9/123)	4.3% (19/442)	0.17	5.0% (28/565)
Other	13.6% (8/59)	17.2% (11/64)	0.58	15.4% (19/123)	22.6% (100/442)	0.084	21.1% (119/565)
Discipline			0.40			<0.0001	
Dentistry	15.3% (9)	12.7% (9)		13.8% (18)	15.3% (68)		15.0% (86)
Dietetics	13.6% (8)	14.1% (10)		13.8% (18)	4.7% (21)		6.8% (39)
Medicine	20.3% (12)	12.7% (9)		16.2% (21)	15.1% (67)		15.4% (88)
Nursing	16.9% (10)	14.1% (10)		15.4% (20)	9.0% (40)		10.5% (60)
Occupational therapy	3.4% (2)	5.6% (4)		4.6% (6)	12.2% (54)		10.5% (60)
Oral health	0.0% (0)	8.5% (6)		4.6% (6)	0.0% (0)		1.0% (6)
Pharmacy	20.3% (12)	18.3% (13)		19.2% (25)	27.1% (120)		25.3% (145)
Physiotherapy	10.2% (6)	14.1% (10)		12.3% (16)	16.5% (73)		15.5% (89)
Previous location			0.020			0.95	
Major urban city	59.3% (35/59)	32.3% (21/65)		45.2% (56/124)	45.0% (197/438)		45.0% (253/562)
Regional city	23.7% (14/59)	32.3% (21/65)		28.2% (35/124)	28.5% (125/438)		28.5% (160/562)
Small town	8.5% (5/59)	20.0% (13/65)		14.5% (18/124)	16.0% (70/438)		15.7% (88/562)
Very small town/ remote	8.5% (5/59)	15.4% (10/65)		12.1% (15/124)	10.5% (46/438)		10.9% (61/562)
ATHCTS	55.1 (5.3) n=57	55.5 (4.8) n=65	0.63	55.3 (5.1) n=122	53.3 (5.4) n=436	0.0003	53.8 (5.3) n=558
TSS	55.1 (13.9) n=57	52.6 (11.6) n=63	0.27	53.8 (12.8) n=120	54.8 (11.3) n=426	0.39	54.6 (11.7) n=546

*Six TIPE participants and one non-TIPE participant did not provide any Survey 1 (baseline) data.
†Participants could identify with more than one ethnicity.
ATHCTS, Attitudes Towards Health Care Teams Scale; TIPE, Tairāwhiti Interprofessional Education Programme; TSS, Team Skills Scale.

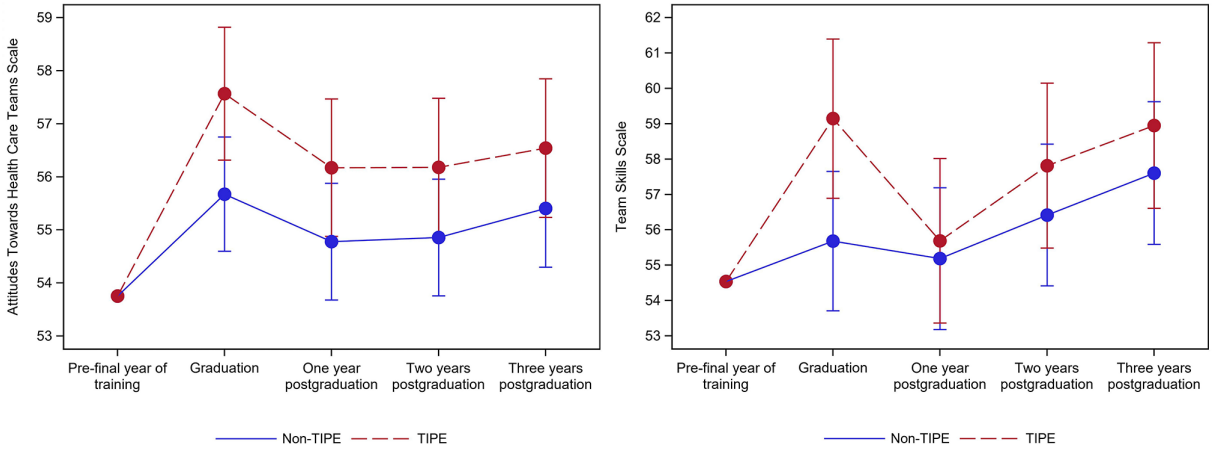

Figure 1 Changes in Attitudes Towards Health Care Teams Scale (left) and Teams Skills Scale (right) for those who did and did not participate in the Tairāwhiti Interprofessional Education Programme (TIPE). TIPE, Tairāwhiti Interprofessional Education Programme.

reported; using frequency and numerical data within a contextually based interpretation such as template analysis provides a broad sense for how different factors vary in importance to the participants and how these change over time (without mechanically linking isolated variables out of context).[35]

Role of the funding source

The funder had no role in the study design, collection, analysis and interpretation of the data; writing of the protocol, or in the decision to submit the paper for publication.

Patient and public involvement

Students and early career health professionals were not involved in the design or conduct of this study. Regular study updates were sent to participants during the study. Results will be shared directly with study participants using existing distribution lists and shared with broader health professional and education communities through publication, presentation at scientific meetings, and through social media platforms.

RESULTS

Participants

Participant flow for both cohorts (including participant numbers at each follow-up and reasons for non-participation) is seen in online supplemental material 4. In total, 730 students were invited to participate (cohort 1 n=651, cohort 2 n=79), of which 611 completed the baseline survey (non-TIPE n=481, TIPE cohort 1 n=61, TIPE cohort 2 n=69). Following baseline data collection, 6 participants joined TIPE cohort 2, 40 participants were withdrawn as they did not complete their final year of training and 4 participants were withdrawn because they did not complete their TIPE placement. Baseline age, gender and ethnicity were broadly comparable between groups (despite a statistical difference for age) (table 1). Mean ATHCTS scores at baseline were higher in the TIPE group than the non-TIPE group (mean (95% CI) 55.3 (54.4 to 56.2) vs 53.3 (52.8 to 53.8)).

Response rates ranged from 88% of invited participants completing survey 2 (see online supplemental material 4) to 73% of invited participants completing survey 5 (TIPE=87%; non-TIPE=69%). TIPE participants were significantly more likely to complete their fifth survey than non-TIPE participants (p<0.0001). There was no significant difference in survey 5 response rates between TIPE cohort 1 and cohort 2 (p=0.71). Dietetic, female and NZ European participants were less likely to be lost to follow-up. Those of other ethnicities and those with lower baseline ATHCTS scores were more likely to be lost to follow-up.

Outcome scales

The differences in adjusted ATHCTS scores between TIPE and non-TIPE students were not significantly different between the surveys (interaction of exposure and time p=0.70). Mean scores for TIPE participants were significantly higher than non-TIPE participants (p=0.002). Mean TIPE participant scores were 1.9 (95% CI 0.8 to 3.0) points higher at graduation and 1.1 (95% CI −0.1 to 2.4) points higher 3years postgraduation (figure 1).

The differences in adjusted TSS scores between TIPE and non-TIPE students were significantly different between surveys (interaction of exposure and time; p=0.040). Mean TSS scores for TIPE participants were significantly higher than non-TIPE participants (p=0.045). Mean-adjusted scores for TIPE participants were 3.5 (95% CI 1.5 to 5.5) points higher at graduation than and 1.3 (95% CI −0.8 to 3.5) points higher 3 years postgraduation (figure 1).

The estimates from multiple imputation, that included all the variables in the analysis model, were similar to those from the complete data analysis (see online supplemental material 4).

Table 2 Frequency of themes from free-text comments made after completing Attitude Towards Health Care Teams and Teams Skills Scales

Interprofessional teamwork—attitudes and experiences	Number of comments*					
	One year post-graduation		Two years post-graduation		Three years post-graduation	
	TIPE (n=117)	Non-TIPE (n=320)	TIPE (n=115)	Non-TIPE (n=305)	TIPE (n=113)	Non-TIPE (n=298)
Benefits of interprofessional teams or collaboration	103	16	98	8	78	17
► Enjoyable or positive	39	5	34	3	29	7
► Others' expert perspectives, support, learning	37	5	32	0	28	2
► Patient care, experiences and outcomes	27	6	32	5	21	8
Challenges of interprofessional teams or collaboration	41	34	56	27	35	29
► Not on the same page, role/input not understood or valued	18	20	27	16	26	14
► Inefficient, inconvenient for example, time pressures, paperwork	16	9	20	8	3	11
► Hard to communicate for example, availability, staffing issues, incompatible software	7	5	9	3	6	4
Interprofessional interaction outside of formal team	32	19	29	28	29	17

*Participants could make more than one free-text comment within an item response.
TIPE, Tairāwhiti Interprofessional Education Programme.

Qualitative findings

Participants made 696 free-text comments in surveys 3–5 relating to interprofessional attitudes and skills (tables 2 and 3). Most participants in the TIPE group, and a few participants in the non-TIPE group, used this opportunity to expand on their quantitative scale responses. Three themes were identified: 'benefits of interprofessional teams or collaboration'; 'challenges of interprofessional

Table 3 Examples of free-text comments made after completing Attitude Towards Health Care Teams and Teams Skills Scales

Interprofessional teamwork—attitudes and experiences	Examples of comments (TIPE and non-TIPE)
Benefits of interprofessional teams or collaboration ► Enjoyable or positive ► Others' expert perspectives, support, learning ► Patient care, experiences and outcomes	– At times can be daunting when you are new to the team or it is a complex case. However I always find I learn more from others working this way.—Survey 5, TIPE, Dietetics, #1768 – I really enjoy having others to explore reasons behind patients' challenges and come up with creative solutions to manage these that I may not have come up with in my own. The IDT is a great source of support when working with difficult cases.—Survey 5, TIPE, Physiotherapy, #0317
Challenges of interprofessional teams or collaboration ► Not on the same page, role/input not understood or valued ► Inefficient, inconvenient, for example, time pressures, paperwork ► Hard to communicate for example, availability, staffing issues, incompatible software	– At times it can be very difficult when other members of the team don't value your opinion.—Survey 3, TIPE, Nursing, #0258 – Sometimes meetings take too long… you do not need a Registered house officer and a consultant at the meeting. We have real work to do and while MDTs are important you don't need all the doctors there if one knows all the patients.—Survey 3, non-TIPE, Medicine, #8376
Interprofessional interaction outside of formal team	– Some collaboration with local GPs/pharmacists on the telephone to discuss patients' needs.—Survey 3, TIPE, Dentistry, #9045 – My current role [in community pharmacy] does not involve many interactions as much as I'd like, but when I do I ensure to approach each situation from an interdisciplinary approach.—Survey 5, TIPE, Pharmacy, #4640

GP, general practitioner; IDT, interdisciplinary team; IPE, interprofessional education; MDT, multidisciplinary team.

Table 4 Frequency of themes from free-text comments made by Tairāwhiti Interprofessional Education programme graduates about influence of pre-registration training on their professional practice

Influence of pre-registration training on preparation for workforce and TIPE on career	Number of comments*		
	One year post-graduation (n=117)	Two years post-graduation (n=115)	Three years post-graduation (n=113)
Participated in an IPE course	102	90	93
► TIPE helpful	34	21	32
The way I do my job	102	87	83
► Understand others' roles/perspectives	17	16	6
► Connecting with other health professionals	48	30	43
► Collaborating to prioritise patient well-being	15	10	7
► Thriving in interprofessional teams	15	15	16
► Hit the ground running	4	5	5
► Interprofessional champions	0	2	1
No perceived influence	22	14	24

*Participants could make more than one free-text comment within an item response.
IPE, interprofessional education; TIPE, Tairāwhiti Interprofessional Education Programme.

teams or collaboration'; 'interprofessional interaction outside of formal teams'. Additional examples of verbatim extracts for each theme are given in online supplemental material 5.

Comments about interprofessional benefits were split across three main areas: (1) a positive and enjoyable experience (2) support and learning received from other health practitioners and (3) enabling better patient care, experiences and outcomes. Almost all of the comments regarding benefits (across all surveys) were from TIPE participants.

Comments about interprofessional challenges particularly related to not feeling valued or understood. Other subthemes were related to inefficient processes or communication difficulties. Fewer comments were made about interprofessional challenges than benefits by TIPE participants, while more comments were made about challenges than benefits by non-TIPE participants. Comments about interprofessional interactions outside of formal teams (or lack thereof) were often made by clinicians working in primary care.

Three themes were identified from TIPE participants' comments related to how preregistration training (of any type) prepared them for working in teams or the influence of TIPE on their careers (table 4). The two most common areas of comment were that the TIPE prepared them to work in interprofessional teams and influenced the way in which they performed their job. A smaller number of comments indicated that TIPE participation had not influenced their career. Examples of verbatim extracts for each theme are given in online supplemental material 6.

DISCUSSION

Students who attended the TIPE programme became more positive about teamwork and their teamwork skills over the course of their final year of preregistration training than students who did not attend. TIPE participants' attitudes to healthcare teams remained higher during their first 3 years of clinical practice than those of their peers who did not attend TIPE. Despite representing just 5 weeks out of 3–6 years of each student's training, the TIPE programme had a measurable impact on learner attitudes that was statistically significant and sustained longterm.

The quantitative changes in attitudes measured were supported by longitudinal free-text analysis,[36] with the qualitative findings indicating a greater impact of the IPE programme than the degree of score change on the quantitative scales. These early career health professionals described key benefits that they perceived arose from interprofessional teamwork, along with the challenges that they faced when working in teams. Graduates who attended the TIPE programme made substantially more (unprompted) comments about the benefits of interprofessional collaboration across the full 3 years of graduate follow-up than those who did not attend. Many TIPE graduates perceived that the programme had a meaningful influence on their readiness to work in teams and the way in which they performed their healthcare roles.

Strengths and limitations

This study recruited a high proportion of the eligible population and had excellent retention rates over prolonged follow-up, reducing the risk that findings were influenced by non-response bias. Results from multiple imputation and complete case analyses were similar. Although students were aware of the nature of the research, most had little investment in the quantitative outcomes, reducing potential for scores to be affected by social desirability bias.

To our knowledge, this is the first study to explore the impact of preregistration IPE on early career

health professional attitudes and skills using a quasi-experimental design. This study also has the longest post-IPE programme follow-up, covering not only the final year of preregistration training but also the first 3 years of professional practice. Pollard and Miers found that after 9–12 months of qualified practice, graduates exposed to an interprofessional curriculum had higher Interprofessional Relationships Scale scores than those who experienced a uniprofessional curriculum. However, these two cohorts were from different year groups, had different disciplinary composition and represented only one-third of eligible participants rather than an entire year cohort.[37]

Despite the ATHCTS and TSS having high internal consistency, the degree of change necessary to indicate a meaningful change in clinical practice has not been established; it is possible that the outcome scale changes shown in this study are not observable in clinical practice; however, the related qualitative findings indicate that there was a meaningful impact on practice. A key limitation of this study is that although it captures learner attitudes to healthcare teams and self-perceived teamwork abilities, it was not able to independently measure teamwork skills nor impact on patient care or outcomes. Objective assessment tools of interprofessional competencies are available,[38] but conducting these assessments with such a large number of participants working in very diverse practice settings over time was not feasible.

Exposure to the TIPE programme was the key difference between graduates in both arms of our study, with all other elements of their education being broadly comparable. Allocation to the TIPE programme was not random and many students (but not all) deliberately chose to attend; this choice may have been related to their interest in interprofessional practice. TIPE students had more positive attitudes to healthcare teams at baseline, but these were controlled for in analytic models. Consistent with other TIPE evaluations, those who attended the TIPE programme reported valuing the experience highly; this may have made them more positive about the impact of the experience on their subsequent careers.[23 39]

Longitudinal analysis of free-text comments allowed exploration of changes through time[36] and integration of free text and quantitative findings.[40] Variations in theme frequencies across the longitudinal surveys were crucial to understanding the context (rather than generalisability) of how participants perceived the importance of different factors over time. However, we used inferential statistics from the quantitative data to compare those who participated in TIPE and those who did not because it was not appropriate to use frequency counts of qualitative data to make such comparisons.

There is a paucity of studies exploring the effects of pregraduation IPE learning activities during health professionals' early careers. Postgraduate recollections of preregistration IPE experiences and perceived impacts of IPE on teamwork abilities have been reported previously.[39 41 42] Hylin *et al* found that graduates, who had spent 2 weeks in an interprofessional training ward, had lasting positive and negative impressions of this course and they considered that they promoted teamwork in the workplace 18 months postgraduation.[42] Graybill *et al* found that the former students recalled IPE experiences after they had completed their training and they were in the workplace.[41] Our study extends these findings through longer duration follow-up, the inclusion of a non-IPE exposed control group, the ability to quantify the relative proportions of graduates who did and did not perceive a lasting impact from IPE participation, and the contextually based integration of free-text findings to aid interpretation of the quantitative results.

Meaning and implications

This study indicates that immersive IPE programmes for senior preregistration students improve teamwork skills and attitudes to collaborative practice, which are sustained over time. The 5-week TIPE programme is resource intensive and involves a relatively small number of students at one time. The magnitude of the quantitative changes observed may cause some to question whether this is a useful investment. This study should increase the confidence that short-term changes in interprofessional competence previously observed are maintained over time. The TIPE programme is specific to the setting in which it is delivered; however, it is likely that these findings could be generalised to similarly intense preregistration IPE programmes elsewhere, provided these provide a similar mix of learning experiences and learning outcomes.

CONCLUSIONS

An explicit interprofessional training experience improved attitudes towards healthcare teams and these changes were maintained over 4 years. Perceptions of teamwork skills improved at graduation. Participation in the TIPE programme appeared to influence how early career clinicians from a range of disciplines viewed their skills and performed their roles.

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Contributors BD, LG, EM and SP contributed to the conception and design of the study and obtained funding. BD, GP and SP developed the analysis plan. BD is the guarantor and drafted the initial protocol. GP analysed quantitative data and MB and BD analysed free-text data with support from EM and SP. BD and MB wrote the first draft. BD, MB, LG, EM, GP and SP revised manuscripts for important intellectual content and read and approved the final version of the manuscript to be published.

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Competing interests All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by University of Otago Ethics Committee (D13/019). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. De-identified participant quantitative data (including data dictionaries) will be available 6 months after publication by request to corresponding author by researchers whose proposed use of data has been approved by an independent review committee. Proposals should be directed to ben.darlow@otago.ac.nz. To gain access, data requestors will need to sign a data access agreement. Qualitative participant data cannot be made available due to the risk of identifying participants.

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Supplementary 1: TREND checklist for reporting of non-randomized evaluations of behavioral and public health interventions

Darlow, B., Brown, M., McKinlay, E., Gray, L. Purdie, G., Pullon, S. (2022). Longitudinal impact of pre-registration interprofessional education on the attitudes and skills of health professionals during their early careers: a non-randomised trial with 4-year outcomes. BMJ Open

Paper Section/Topic	Item No.	Descriptor	Reported? ✓	Reported? Pg #
TITLE and ABSTRACT				
Title, Abstract	1	• Information on how units were allocated to interventions	✓	2
		• Structured abstract recommended	✓	2
		• Information on target population or study sample	✓	2
INTRODUCTION				
Background	2	• Scientific background and explanation of rationale	✓	4
		• Theories used in designing behavioral interventions	N/A	
METHODS				
Participants	3	• Eligibility criteria for participants, including criteria at different levels in recruitment/sampling plan (e.g., cities, clinics, subjects)	✓	4
		• Method of recruitment (e.g., referral, self-selection), including the sampling method if a systematic sampling plan was implemented	✓	4
		• Recruitment setting	✓	4
		• Settings and locations where the data were collected	✓	6
Interventions	4	• Details of the interventions intended for each study condition and how and when they were actually administered, specifically including:	✓	5
		○ Content: what was given?	✓	5
		○ Delivery method: how was the content given?	✓	5
		○ Unit of delivery: how were subjects grouped during delivery?	✓	5
		○ Deliverer: who delivered the intervention?	✓	5
		○ Setting: where was the intervention delivered?	✓	5
		○ Exposure quantity and duration: how many sessions or episodes or events were intended to be delivered? How long were they intended to last?	✓	5
		○ Time span: how long was it intended to take to deliver the intervention to each unit?	✓	5
		○ Activities to increase compliance or adherence (e.g., incentives)	N/A	
Objectives	5	• Specific objectives and hypotheses	✓	4
Outcomes	6	• Clearly defined primary and secondary outcome measures	✓	5
		• Methods used to collect data and any methods used to enhance the quality of measurements	✓	6
		• Information on validated instruments such as psychometric and biometric properties	✓	6
Sample size	7	• How sample size was determined and, when applicable, explanation of any interim analyses and stopping rules	✓	6
Assignment method	8	• Unit of assignment (the unit being assigned to study condition, e.g., individual, group, community)	✓	5
		• Method used to assign units to study conditions, including details of any restriction (e.g., blocking, stratification, minimization)	✓	4,5
		• Inclusion of aspects employed to help minimize potential bias induced due to non-randomization (e.g., matching)	NA	
Blinding (masking)	9	• Whether or not participants, those administering the interventions, and those assessing the outcomes were blinded to study condition assignment; if so, statement regarding how the blinding was accomplished and how it was assessed	✓	4
Unit of Analysis	10	• Description of the smallest unit that is being analysed to assess intervention effects (e.g., individual, group, or community)	✓	6
		• If the unit of analysis differs from the unit of assignment, the analytical method used to account for this (e.g., adjusting the standard error estimates by the design effect or using multilevel analysis)	N/A	

Statistical methods	11	• Statistical methods used to compare study groups for primary methods outcome(s), including complex methods for correlated data	✓	6
		• Statistical methods used for additional analyses, such as subgroup analyses and adjusted analysis	✓	6
		• Methods for imputing missing data, if used	✓	6
		• Statistical software or programs used	✓	6
RESULTS				
Participant flow	12	• Flow of participants through each stage of the study: enrollment, assignment, allocation and intervention exposure, follow-up, analysis (a diagram is strongly recommended)	✓	7, S3
		○ Enrollment: the numbers of participants screened for eligibility, found to be eligible or not eligible, declined to be enrolled, and enrolled in the study	✓	7, S3
		○ Assignment: the numbers of participants assigned to a study condition	✓	7,8, S3
		○ Allocation and intervention exposure: the number of participants assigned to each study condition and the number of participants who received each intervention	✓	7,8, S3
		○ Follow-up: the number of participants who completed the follow-up or did not complete the follow-up (i.e., lost to follow-up), by study condition	✓	9, S3
		○ Analysis: the number of participants included in or excluded from the main analysis, by study condition	✓	9, S3
		• Description of protocol deviations from study as planned, along with reasons	N/A	
Recruitment	13	• Dates defining the periods of recruitment and follow-up	✓	4,6
Baseline data	14	• Baseline demographic and clinical characteristics of participants in each study condition	✓	7,8
		• Baseline characteristics for each study condition relevant to specific disease prevention research	✓	7,8
		• Baseline comparisons of those lost to follow-up and those retained, overall and by study condition	✓	7,8
		• Comparison between study population at baseline and target population of interest	✓	7,8
Baseline equivalence	15	• Data on study group equivalence at baseline and statistical methods used to control for baseline differences	✓	7-9
Numbers analyzed	16	• Number of participants (denominator) included in each analysis for each study condition, particularly when the denominators change for different outcomes; statement of the results in absolute numbers when feasible	✓	S3
		✓ Indication of whether the analysis strategy was “intention to treat” or, if not, description of how non-compliers were treated in the analyses	✓	7,9
Outcomes and estimation	17	• For each primary and secondary outcome, a summary of results for each estimation study condition, and the estimated effect size and a confidence interval to indicate the precision	✓	9
		• Inclusion of null and negative findings	✓	9
		• Inclusion of results from testing pre-specified causal pathways through which the intervention was intended to operate, if any	N/A	
Ancillary analyses	18	• Summary of other analyses performed, including subgroup or restricted analyses, indicating which are pre-specified or exploratory	N/A	
Adverse events	19	• Summary of all important adverse events or unintended effects in each study condition (including summary measures, effect size estimates, and confidence intervals)	N/A	
DISCUSSION				
Interpretation	20	• Interpretation of the results, taking into account study hypotheses, sources of potential bias, imprecision of measures, multiplicative analyses, and other limitations or weaknesses of the study	✓	12, 13
		• Discussion of results taking into account the mechanism by which the intervention was intended to work (causal pathways) or alternative mechanisms or explanations	✓	12, 13
		• Discussion of the success of and barriers to implementing the intervention, fidelity of implementation	N/A	
		• Discussion of research, programmatic, or policy implications	✓	12, 13
Generalizability	21	• Generalizability (external validity) of the trial findings, taking into account the study population, the characteristics of the intervention, length of follow-up, incentives, compliance rates, specific sites/settings involved in the study, and other contextual issues	✓	12, 13
Overall evidence	22	• General interpretation of the results in the context of current evidence and current theory	✓	12, 13

From: http://www.cdc.gov/trendstatement/ *Also see:* https://www.equator-network.org/reporting-guidelines/improving-the-reporting-quality-of-nonrandomized-evaluations-of-behavioral-and-public-health-interventions-the-trend-statement/

Supplementary 2: Longitudinal Interprofessional Study survey items

Darlow, B., Brown, M., McKinlay, E., Gray, L. Purdie, G., Pullon, S. (2022). Longitudinal impact of pre-registration interprofessional education on the attitudes and skills of health professionals during their early careers: a non-randomised trial with 4-year outcomes. BMJ Open

Survey	Components	Stage
Survey 1	ATHCTS TSS Demographic items	Pre- the final year of training (and prior to TIPE or control exposure)
Survey 2	ATHCTS TSS Clinical practice intention (quantitative and free text items)	Post- the final year of training (and after TIPE or control exposure)
Survey 3	ATHCTS TSS Clinical practice characteristics (quantitative and free text items) Satisfaction (quantitative and free text items) Interprofessional practice (quantitative and free text items)*	One year post-graduation (and end of first year of professional practice)
Survey 4	ATHCTS TSS Clinical practice characteristics (quantitative and free text items) Satisfaction (quantitative and free text items) Interprofessional practice (quantitative and free text items)*	Two years post-graduation (and end of second year of professional practice)
Survey 5	ATHCTS TSS Clinical practice characteristics (quantitative and free text items) Satisfaction (quantitative and free text items) Interprofessional practice (quantitative and free text items)*	Three years post-graduation (and end of third year of professional practice)

ATHCTS, Attitudes Towards Health Care Teams Scale; TSS, Team Skills Scale; TIPE, Tairāwhiti interprofessional education programme

* Free-text questions #3 *interprofessional practice* completed only by participants who attended the Tairāwhiti interprofessional education programme.

Supplementary 3: Development of thematic template

Darlow, B., Brown, M., McKinlay, E., Gray, L. Purdie, G., Pullon, S. (2022). Longitudinal impact of pre-registration interprofessional education on the attitudes and skills of health professionals during their early careers: a non-randomised trial with 4-year outcomes. BMJ Open

Table S1. A Priori Template for Testing a Subset of Longitudinal Interprofessional Study Data

Free-text survey items	1. Explanation of response *'not working or training'* 2. Explanation of response *'Other health profession'* 3. Comments on responses to the '*Attitudes Towards Health Care Teams Scale'* 4. Comments on responses to the *'Team Skills Scale'* 5. Explanation of response *'Other practice setting/professional area'* 6. Explanation of response *'Other practice setting/professional area -- most of time spent'* 7. Explanation of response *'working or training in practice setting / professional area'* 8. Explanation of response *'Other location type'* 9. Explanation of response *'Other location type -- most of time spent'* 10. Explanation of response *'choosing to work in location type'* 11. Comments on response *'job and career satisfaction'* 12. [TIPE participants only] Comments on response *'function and purpose of this interprofessional team'* 13. [TIPE participants only] Explanation of response *'Other types of interprofessional team disciplines'* 14. [TIPE participants only] Description of response *'how this interprofessional team works and your role'* 15. [TIPE participants only] Comments on response *'experience of working or collaborating with different disciplines or health profession'* 16. [TIPE participants only] Comments on response *'aspects of interprofessional education that prepared you for working in interprofessional team'* 17. [TIPE participants only] Comments on response *'influence of TIPE on career choices'* 18. Other comments
A priori themes and sub-themes	**All participants** 1. Current work • General Details • Reason for choosing clinical setting (Items 1, 2, 5 - 7) • Reason for choosing location (Items 8 - 10) • Job satisfaction (item 11) • Interprofessional team in current job ○ Function and Purpose (Item 12, 13) ○ How it works (Item 14)
	Participants who attended TIPE 2. Attitudes or experience regarding interprofessional teams or skills • Attitudes toward collaborating (Item 3) • Ability or experience collaborating (Items 4, 15) 3. Beliefs regarding the influence of interprofessional education • Pre-registration training preparation for interprofessional teams (Item 16) • Impact of TIPE on career (Item 17)

TIPE, Tairāwhiti Interprofessional Education program

Table S2. Initial Template (V1) for Coding the Longitudinal Interprofessional Study Full Dataset (all levels of codes)

Initial themes and sub-themes	**All participants** 1. To be coded (free node) 2. Doing for work • Reason for choosing Clinical Setting • Job Reasons • Personal Reasons • Reason for choosing Location • Job Reasons • Personal Reasons • Job Satisfaction • Satisfied • Dissatisfied
	Participants who attended TIPE 3. Attitudes or experience regarding interprofessional teams or skills • Ability or experience collaborating • Attitudes toward collaborating 4. Beliefs regarding the influence of interprofessional education • Pre-registration training preparation for interprofessional teams • TIPE influence on career
Free-text items not coded (descriptive-only answers)	1. Interprofessional team in current job (Items 12 - 14) • Function and Purpose • How it works

TIPE, Tairāwhiti Interprofessional Education program

Table S3. Final Themes and Sub-themes in the Longitudinal Interprofessional Study (higher-level codes only)

Themes (Level 1)	Sub-themes (including higher-level codes only)*

Theme 1: Current Work	**1. Reason for choosing clinical setting**
	• *Job Reasons*
	  ○ Requirement for career path
	  ○ Availability of job or opportunities
	  ○ Nature of the job
	• *Personal Reasons*
	  ○ Family
	  ○ Partner
	  ○ Friends
	2. Reason for choosing location
	• *Job Reasons*
	  ○ Requirement for career path
	  ○ Availability of job or opportunities
	  ○ Nature of the job
	• *'Nature of the Location' Reasons*
	• *Personal Reasons*
	  ○ Home, where I live
	  ○ Family
	  ○ Partner
	  ○ Friends
	3. Job satisfaction
	• [Coded, but results not reported due to low response rates]

Theme 2: Attitudes/experiences related to interprofessional teams or skills	• *Benefits of working in interprofessional teams or collaboration* • *Varies: challenges of working in interprofessional teams or collaboration* • *Health practitioner interaction but not part of team*
Theme 3: Influence of interprofessional education	**1. Pre-registration preparation for working in interprofessional teams** • *Participated in interprofessional education* • *Choice of clinical setting* • *Collaboration and teamwork* • *Hit the ground running* **2. Influence of TIPE on career** • *Choice of clinical setting* • *Choice of location* • *The way I do my job* • *No influence*

Note. Detailed lower-level codes (≥ level 5) are reported elsewhere (manuscript of results in review).
TIPE, Tairāwhiti Interprofessional Education program

Supplementary 4: Participant flowchart and additional analyses

Darlow, B., Brown, M., McKinlay, E., Gray, L. Purdie, G., Pullon, S. (2022). Longitudinal impact of pre-registration interprofessional education on the attitudes and skills of health professionals during their early careers: a non-randomised trial with 4-year outcomes. BMJ Open

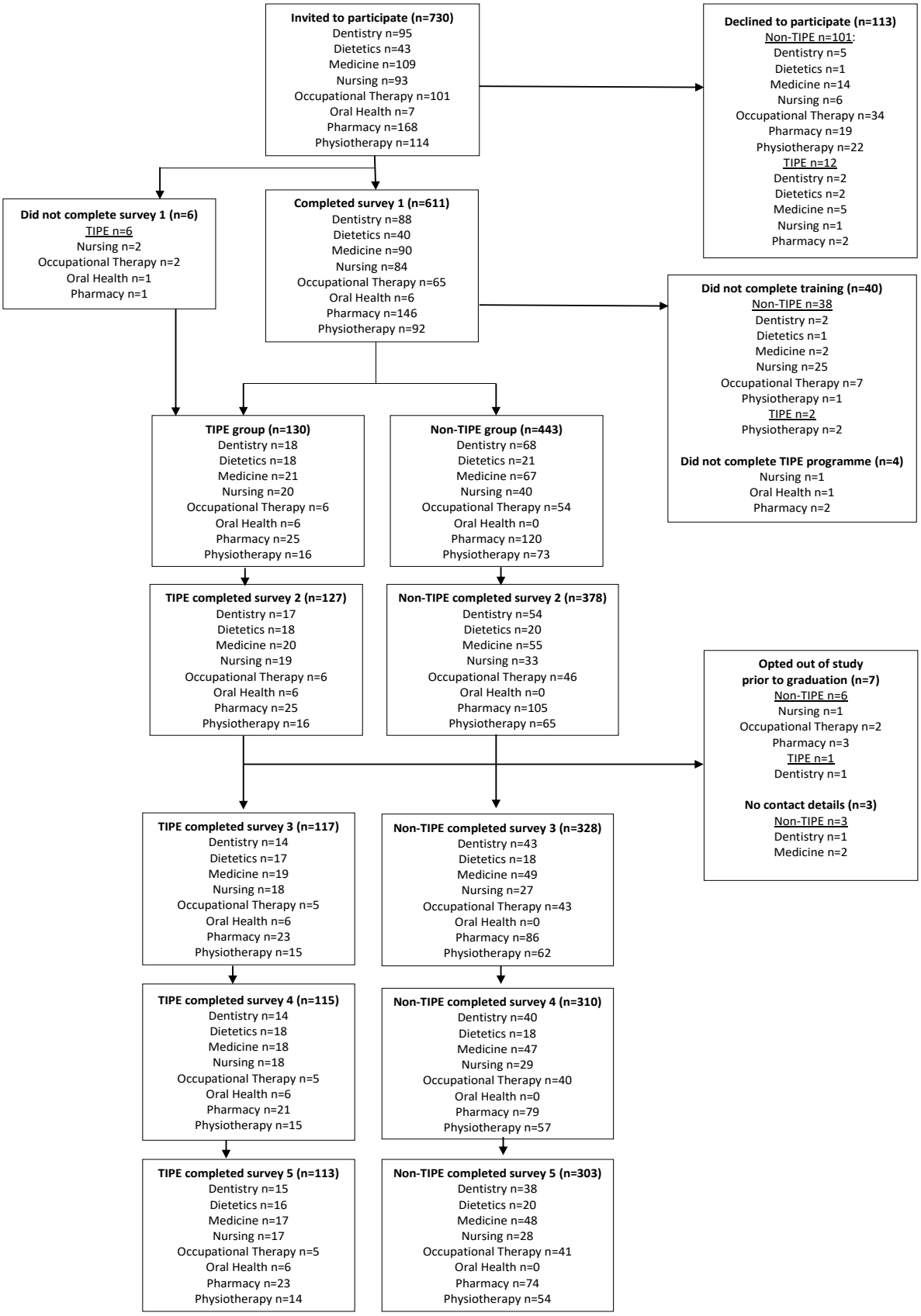

Figure S1. Participant flow. TIPE = Tairāwhiti Interprofessional Education programme

Response rates and loss to follow-up

Table S1. Survey 1 (baseline) response rates

Cohort and discipline	Invited	Completed survey	Response rate %
Non-TIPE			
Dentistry	75	70	93%
Dietetics	23	22	96%
Medicine	83	69	83%
Nursing	71	65	92%
Occupational Therapy	95	61	64%
Oral Health	0	0	-
Pharmacy	139	120	86%
Physiotherapy	96	74	77%
Total	582	481	83%
TIPE Cohort 1			
Dentistry	10	9	90%
Dietetics	10	8	80%
Medicine	15	12	80%
Nursing	10	10	100%
Occupational Therapy	2	2	100%
Oral Health	0	0	
Pharmacy	14	12	86%
Physiotherapy	6	6	100%
Total	67	59	88%
TIPE Cohort 2			
Dentistry	10	9	90%
Dietetics	10	10	100%
Medicine	11	9	82%
Nursing	9	8	89%
Occupational Therapy	2	2	100%
Oral Health	5	5	100%
Pharmacy	12	12	100%
Physiotherapy	10	10	100%
Total	69	65	94%

TIPE = Tairāwhiti Interprofessional Education programme

Table S2. Survey 2 (graduation) response rates

Cohort and discipline	Invited	Completed survey	Response rate %
Non-TIPE			
Dentistry	68	54	79%
Dietetics	21	20	95%
Medicine	67	55	82%
Nursing	40	33	83%
Occupational Therapy	54	46	85%
Oral Health	0	0	
Pharmacy	120	105	88%
Physiotherapy	73	65	89%
Total	443	378	85%
TIPE Cohort 1			
Dentistry	9	8	89%
Dietetics	8	8	100%
Medicine	12	11	92%
Nursing	10	10	100%
Occupational Therapy	2	2	100%
Oral Health	0	0	
Pharmacy	12	12	100%
Physiotherapy	6	6	100%
Total	59	57	97%
TIPE Cohort 2			
Dentistry	9	9	100%
Dietetics	10	10	100%
Medicine	9	9	100%
Nursing	10	9	90%
Occupational Therapy	4	4	100%
Oral Health	6	6	100%
Pharmacy	13	13	100%
Physiotherapy	10	10	100%
Total	71	70	99%

TIPE = Tairāwhiti Interprofessional Education programme

Table S3. Survey 3 (end of first year of clinical practice) response rates

Cohort and discipline	Invited	Completed survey	Response rate %
Non-TIPE			
Dentistry	66	42	64%
Dietetics	21	18	86%
Medicine	66	48	73%
Nursing	40	27	68%
Occupational Therapy	54	43	80%
Oral Health	0	0	
Pharmacy	117	84	72%
Physiotherapy	69	58	84%
Total	433	320	74%
TIPE Cohort 1			
Dentistry	9	6	67%
Dietetics	8	7	88%
Medicine	12	10	83%
Nursing	10	9	90%
Occupational Therapy	2	2	100%
Oral Health	0	0	
Pharmacy	12	11	92%
Physiotherapy	6	6	100%
Total	59	51	86%
TIPE Cohort 2			
Dentistry	9	8	89%
Dietetics	10	10	100%
Medicine	9	9	100%
Nursing	10	9	90%
Occupational Therapy	4	3	75%
Oral Health	6	6	100%
Pharmacy	13	12	92%
Physiotherapy	10	9	90%
Total	71	66	93%

TIPE = Tairāwhiti Interprofessional Education programme

Table S4. Survey 4 (end of second year of clinical practice) response rates

Cohort and discipline	Invited	Completed survey	Response rate %
Non-TIPE			
Dentistry	66	40	61%
Dietetics	21	18	86%
Medicine	66	46	70%
Nursing	40	29	73%
Occupational Therapy	54	40	74%
Oral Health	0	0	
Pharmacy	117	78	67%
Physiotherapy	69	54	78%
Total	433	305	70%
TIPE Cohort 1			
Dentistry	9	7	78%
Dietetics	8	8	100%
Medicine	12	10	83%
Nursing	10	9	90%
Occupational Therapy	2	2	100%
Oral Health	0	0	
Pharmacy	12	10	83%
Physiotherapy	6	6	100%
Total	59	52	88%
TIPE Cohort 2			
Dentistry	9	7	78%
Dietetics	10	10	100%
Medicine	9	8	89%
Nursing	10	9	90%
Occupational Therapy	4	3	75%
Oral Health	6	6	100%
Pharmacy	13	11	85%
Physiotherapy	10	9	90%
Total	71	63	89%

TIPE = Tairāwhiti Interprofessional Education programme

Table S5. Survey 5 (end of third year of clinical practice) response rates

Cohort and discipline	Invited	Completed survey	Response rate %
Non-TIPE			
Dentistry	66	38	58%
Dietetics	21	20	95%
Medicine	66	47	71%
Nursing	40	28	70%
Occupational Therapy	54	41	76%
Oral Health	0	0	
Pharmacy	117	73	62%
Physiotherapy	69	51	74%
Total	433	298	69%
TIPE Cohort 1			
Dentistry	9	7	78%
Dietetics	8	7	88%
Medicine	12	10	83%
Nursing	10	9	90%
Occupational Therapy	2	2	100%
Oral Health	0	0	
Pharmacy	12	11	92%
Physiotherapy	6	6	100%
Total	59	52	88%
TIPE Cohort 2			
Dentistry	9	8	89%
Dietetics	10	9	90%
Medicine	9	7	78%
Nursing	10	8	80%
Occupational Therapy	4	3	75%
Oral Health	6	6	100%
Pharmacy	13	12	92%
Physiotherapy	10	8	80%
Total	71	61	86%

TIPE = Tairāwhiti Interprofessional Education programme

Table S6. Baseline characteristics of participants who completed survey 5 and those did not complete survey 5 (lost to follow-up)

	Lost to follow-up (n=157)	Non lost to follow-up (n=416)	Total (n=573)	p
Discipline				0.009*
Dentistry	21.0% (33)	12.7% (53)	15.0% (86)	
Dietetics	1.9% (3)	8.7% (36)	6.8% (39)	
Nursing	9.6% (15)	10.8% (45)	10.5% (60)	
Medicine	14.6% (23)	15.6% (65)	15.4% (88)	
Pharmacy	30.6% (48)	23.3% (97)	25.3% (145)	
Physiotherapy	13.4% (21)	16.3% (68)	15.5% (89)	
Occupational Therapy	8.9% (14)	11.1% (46)	10.5% (60)	
Oral Health	0.0% (0)	1.4% (6)	1.0% (6)	
Female	61.1% (96/157)	73.6% (301/409)	70.1% (397/566)	0.004*
Age	22 (21–24) N=156	22 (21–24) N=410	22 (21–24) N=566	0.69†
NZ European	38.5% (60/156)	62.8% (257/409)	56.1% (317/565)	<0.0001*
Maori	3.8% (6/156)	8.6% (35/409)	7.3% (41/565)	0.054*
Pacific	1.3% (2/156)	1.2% (5/409)	1.2% (7/565)	1.00*
Chinese	19.9% (31/156)	15.4% (63/409)	16.6% (94/565)	0.20*
Indian	5.8% (9/156)	4.6% (19/409)	5.0% (28/565)	0.58*
Other	32.7% (51/156)	16.6% (68/409)	21.1% (119/565)	<0.0001*
Previous location				0.51*
Major urban city	43.9% (68/155)	45.5% (185/407)	45.0% (253/562)	
Regional city	26.5% (41/155)	29.2% (119/407)	28.5% (160/562)	
Small town	19.4% (30/155)	14.3% (58/407)	15.7% (88/562)	
Very small town/remote	10.3% (16/155)	11.1% (45/407)	10.9% (61/562)	
ATHCTS	52.4 (5.3) N=154	54.3 (5.3) N=404	53.8 (5.3) N=558	0.0002‡
TSS	55.8 (11.7) N=150	54.1 (11.6) N=396	54.6 (11.7) N=546	0.13‡
TIPE	10.8% (17)	27.2% (113)	22.7% (130)	<0.0001*

* Chi-squared test

† Wilcoxon rank sum test

‡ T-test

Table S7. ATHCTS and TSS scores compared between Surveys 1 and 2 for TIPE and non-TIPE students

Score	Difference		n	Baseline mean (SE)	Survey 2 mean (SE)	Difference (95%CI)	p
ATHCTS	ATHCTS - ATHCTS baseline	Non-TIPE	364	53.7 (0.3)	55.3 (0.3)	1.6 (1.0 to 2.2)	<0.0001
ATHCTS	ATHCTS - ATHCTS baseline	TIPE	118	55.4 (0.5)	58.2 (0.5)	2.8 (1.8 to 3.8)	<0.0001
TSS	TSS - TSS baseline	Non-TIPE	361	54.7 (0.6)	56.2 (0.6)	1.4 (0.3 to 2.5)	0.010
TSS	TSS - TSS baseline	TIPE	117	53.6 (1.2)	59.5 (1.0)	6.0 (3.7 to 8.3)	<0.0001

ATHCTS, Attitudes Towards Health Care Teams Scale. TSS, Team Skills Scale. TIPE, Tairāwhiti Interprofessional Education Programme.

Table S8. Attitudes to Health Care Teams Scale scores at each time point for cohort 1, cohort 2 and combined TIPE, non-TIPE students and each disciplinary group

Cohort	ATHCTS Survey 1 n	ATHCTS Survey 1 mean (95% CI)	ATHCTS Survey 2 n	ATHCTS Survey 2 mean (95% CI)	ATHCTS Survey 3 n	ATHCTS Survey 3 mean (95% CI)	ATHCTS Survey 4 n	ATHCTS Survey 4 mean (95% CI)	ATHCTS Survey 5 n	ATHCTS Survey 5 mean (95% CI)
TIPE Cohort 1	57	55.1 (53.7, 56.5)	56	57.3 (55.7, 59.0)	47	56.4 (54.6, 58.2)	51	56.5 (55.0, 58.1)	48	57.6 (56.0, 59.1)
TIPE Cohort 2	65	55.5 (54.3, 56.7)	70	59.0 (57.6, 60.3)	65	57.3 (55.8, 58.7)	59	57.4 (55.9, 58.9)	57	56.9 (55.4, 58.3)
TIPE	122	55.3 (54.4, 56.2)	126	58.2 (57.2, 59.3)	112	56.9 (55.8, 58.0)	110	57.0 (55.9, 58.0)	105	57.2 (56.1, 58.2)
Non-TIPE	436	53.3 (52.8, 53.8)	370	55.4 (54.8, 55.9)	308	54.6 (53.9, 55.3)	301	54.7 (54.1, 55.4)	283	55.4 (54.7, 56.2)
Dentistry	85	50.9 (49.8, 52.0)	69	52.8 (51.4, 54.1)	57	51.6 (50.1, 53.1)	54	51.8 (50.4, 53.2)	53	52.2 (50.3, 54.1)
Dietetics	39	54.9 (53.4, 56.4)	37	58.5 (56.7, 60.2)	31	57.8 (55.9, 59.8)	32	57.3 (55.1, 59.5)	33	57.3 (55.3, 59.3)
Medicine	86	54.0 (52.7, 55.3)	74	56.3 (55.1, 57.5)	68	56.3 (55.0, 57.6)	64	56.8 (55.2, 58.3)	58	57.8 (56.1, 59.5)
Nursing	57	56.4 (54.9, 57.8)	51	57.6 (56.1, 59.1)	43	56.6 (55.2, 58.0)	46	56.3 (54.8, 57.9)	44	56.9 (55.4, 58.4)
Occupational Therapy	58	54.1 (52.9, 55.3)	50	55.0 (52.8, 57.1)	41	57.0 (55.2, 58.8)	40	56.8 (55.1, 58.4)	40	56.3 (54.5, 58.1)
Oral Health	5	52.6 (46.5, 58.7)	6	56.8 (54.1, 59.5)	6	54.3 (48.1, 60.5)	6	54.0 (50.6, 57.4)	6	54.7 (51.9, 57.5)
Pharmacy	142	53.7 (52.9, 54.6)	128	56.0 (55.1, 56.9)	98	54.6 (53.3, 55.9)	98	54.2 (53.2, 55.2)	90	55.5 (54.2, 56.7)
Physiotherapy	86	54.1 (53.0, 55.2)	81	57.6 (56.3, 58.8)	76	55.1 (53.6, 56.5)	71	56.1 (54.6, 57.6)	64	56.4 (54.7, 58.1)

ATHCTS, Attitudes Towards Health Care Teams Scale; TIPE, Tairāwhiti Interprofessional Education programme

Table S9. Team Skills Scale scores at each time point for cohort 1, cohort 2 and combined TIPE, non-TIPE students and each disciplinary group

Cohort	TSS Survey 1 n	TSS Survey 1 mean (95% CI)	TSS Survey 2 n	TSS Survey 2 mean (95% CI)	TSS Survey 3 n	TSS Survey 3 mean (95% CI)	TSS Survey 4 n	TSS Survey 4 mean (95% CI)	TSS Survey 5 n	TSS Survey 5 mean (95% CI)
TIPE Cohort 1	57	55.1 (51.4, 58.8)	57	59.2 (56.2, 62.1)	47	55.2 (52.6, 57.9)	51	57.5 (55.0, 59.9)	48	60.1 (57.1, 63.0)
TIPE Cohort 2	63	52.6 (49.6, 55.5)	70	60.3 (57.7, 62.8)	64	57.8 (55.3, 60.4)	56	59.9 (57.1, 62.7)	56	59.2 (56.5, 61.9)
TIPE	120	53.8 (51.5, 56.1)	127	59.8 (57.9, 61.7)	111	56.7 (54.9, 58.6)	107	58.7 (56.9, 60.6)	104	59.6 (57.6, 61.5)
Non-TIPE	426	54.8 (53.8, 55.9)	372	56.4 (55.3, 57.5)	305	55.6 (54.4, 56.7)	299	57.2 (56.0, 58.4)	283	58.3 (57.1, 59.4)
Dentistry	86	57.0 (54.7, 59.2)	70	55.9 (53.7, 58.0)	57	53.1 (50.8, 55.4)	52	53.9 (51.6, 56.2)	53	56.2 (53.1, 59.2)
Dietetics	37	47.5 (44.0, 51.0)	38	57.5 (54.6, 60.3)	31	54.3 (50.9, 57.7)	32	59.3 (56.0, 62.5)	32	59.5 (56.0, 63.0)
Medicine	84	49.9 (47.5, 52.3)	75	53.9 (51.5, 56.3)	68	55.6 (53.5, 57.8)	64	57.1 (54.7, 59.4)	58	57.8 (55.6, 60.0)
Nursing	54	63.9 (61.1, 66.7)	52	63.6 (61.0, 66.1)	43	61.7 (59.0, 64.5)	46	62.4 (59.6, 65.1)	43	63.3 (60.4, 66.2)
Occupational Therapy	53	54.6 (51.4, 57.8)	50	59.9 (56.7, 63.1)	41	58.2 (54.9, 61.5)	40	61.9 (58.2, 65.7)	40	60.8 (57.7, 63.9)
Oral Health	4	51.3 (31.1, 71.4)	6	58.2 (40.7, 75.7)	6	52.0 (37.0, 67.0)	6	52.5 (37.2, 67.8)	6	52.3 (39.7, 65.0)
Pharmacy	140	53.7 (51.8, 55.6)	128	56.6 (54.4, 58.8)	95	55.1 (52.8, 57.3)	95	54.8 (52.6, 57.0)	90	56.7 (54.5, 58.8)
Physiotherapy	88	55.6 (53.3, 58.0)	80	56.7 (54.5, 58.9)	75	55.5 (53.1, 57.9)	71	58.7 (56.4, 61.0)	65	59.9 (57.6, 62.2)

TSS, Team Skills Scale; TIPE, Tairāwhiti Interprofessional Education programme

Table S10. Attitudes to Health Care Teams Scale scores: collected data and multiple imputation including variables in the analysis model and demographic variables

	Collected data	Multiple imputation
Number of Observations Used	1598	2292
Survey	F=5.32 d.f.=3,1156 p=0.001	F=3.43 d.f.=3,26749 p=0.016
TIPE x survey interaction	F=0.48 d.f.=3,1156 p=0.70	F=0.55 d.f.=3,77565 p=0.65
TIPE	F=10.17 d.f.=1,435 p=0.002	F=9.76 d.f.=1,1399 p=0.002
Mean TIPE minus non-TIPE	1.4 (95%CI 0.6 to 2.3) p=0.002	1.4 (95%CI 0.5 to 2.2) p=0.002
TIPE minus non-TIPE at graduation	1.9 (95%CI 0.8 to 3.0) p=0.001	1.9 (95%CI 0.8 to 3.0) p=0.0009
TIPE minus non-TIPE at one year postgraduation	1.4 (95%CI 0.2 to 2.6) p=0.024	1.2 (95%CI 0.1 to 2.4) p=0.039
TIPE minus non-TIPE at two years postgraduation	1.3 (95%CI 0.1 to 2.5) p=0.032	1.3 (95%CI 0.1 to 2.5) p=0.029
TIPE minus non-TIPE at three years postgraduation	1.1 (95%CI -0.1 to 2.4) p=0.070	1.1 (95%CI -0.1 to 2.3) p=0.078

TIPE, Tairāwhiti Interprofessional Education programme

Table S11. Teams Skill Scale scores: collected data and multiple imputation including variables in the analysis model and demographic variables

	Collected data	Multiple imputation
Number of Observations Used	1593	2292
Survey	F=8.91 d.f.=3,1134 p<0.0001	F=7.25 d.f.=3,24563 p<0.0001
TIPE x survey interaction	F=2.78 d.f.=3,1134 p=0.040	F=2.05 d.f.=3,66695 p=0.10
TIPE	F=4.05 d.f.=1,431 p=0.045	F=4.67 d.f.=1,1448 p=0.031
Mean TIPE minus non-TIPE	1.7 (95%CI 0.0 to 3.3) p=0.045	1.7 (95%CI 0.2 to 3.3) p=0.031
TIPE minus non-TIPE at graduation	3.5 (95%CI 1.5 to 5.5) p=0.0008	3.3 (95%CI 1.3 to 5.2) p=0.0010
TIPE minus non-TIPE at one year postgraduation	0.5 (95%CI -1.6 to 2.6) p=0.64	0.7 (95%CI -1.3 to 2.8) p=0.49
TIPE minus non-TIPE at two years postgraduation	1.4 (95%CI -0.7 to 3.5) p=0.20	1.4 (95%CI -0.7 to 3.5) p=0.18
TIPE minus non-TIPE at three years postgraduation	1.3 (95%CI -0.8 to 3.5) p=0.22	1.6 (95%CI -0.5 to 3.7) p=0.14

Adjusted for baseline TSS, baseline ATHCTS, discipline, gender, age, ethnicity, and previous location
TIPE, Tairāwhiti Interprofessional Education programme

Supplementary 5: Additional verbatim examples of themes derived from free-text comments made after completing Attitude to Health Care Teams and Teams Skills Scales

Darlow, B., Brown, M., McKinlay, E., Gray, L. Purdie, G., Pullon, S. (2022). Longitudinal impact of pre-registration interprofessional education on the attitudes and skills of health professionals during their early careers: a non-randomised trial with 4-year outcomes. BMJ Open

Interprofessional teamwork – attitudes and experiences	**Examples (TIPE and non-TIPE)**
Benefits of interprofessional teams or collaboration	[Teamwork] is really good and important. Not taught enough about it in Med school. -Survey 4, non-TIPE, Medicine, #8376 On [the] whole very beneficial. -Survey 3, TIPE, Pharmacy, #6844 I really enjoying working with a variety of disciplines, it has helped me see patient care in a broader perspective. I have also gained valuable skills and extended my assessment skills to recognise when other MDT members input is required. -Survey 3, TIPE, Nursing #0014
• *Enjoyable or positive*	Love it!! [Teamwork is] such an incredible way to collaborate and integrate ideas. It strengthens relationships and improves overall treatment quality and success. -Survey 5, TIPE, Physiotherapy, #2205 [Teamwork is] excellent and essential in palliative care. -Survey 5, TIPE, Medicine, #0135
• *Others' expert perspectives, support, learning*	I love team work and working with other clinicians, you have so much to learn from them, it is a morale booster. -Survey 3, non-TIPE, Occupational Therapy, #2274
• *Patient care, experiences and outcomes*	I find working as a collaborative team is very successful and important for the patient. They receive better care if it comes from a team who have good communication to ensure everyone works together. -Survey 4, TIPE, Pharmacy, #3922 [TIPE] has influenced me to look for workplaces where interprofessionalism is present as it demonstrated why it is so important for a patient's health outcomes. -Survey 3, TIPE, Oral Health, #2830
Challenges of interprofessional teams or collaboration	It can be a challenging but very rewarding part of your role in hospital. - Survey 5, non-TIPE, Dietetics, #3590 In rehab it is excellent as we are all on the same page. In medical, although we are supposed to be an IDT, other health professionals often go behind the wider MDT's back and organise what they think is best, not what the patient and the rest of the team think is best. -Survey 5, TIPE, Occupational Therapy, #4455
• *Not on the same page, role/input not understood or valued*	At times it can be very difficult when other members of the team don't value your opinion. -Survey 3, TIPE, Nursing, #0258 I feel on the acute wards, there is still often a divide between medical and allied health staff. Where there should be a more team feel and trust in each other's clinical judgment. Often there is still a battle to be heard and listened to. -Survey 4, TIPE, Physiotherapy, #7271
• *Inefficient, inconvenient e.g. time pressures, paperwork*	Satisfying and effective cooperation from those at the "coalface", frustration from admin side. - Survey 5, TIPE, Dentistry, #4926
• *Hard to communicate e.g. availability, staffing issues, incompatible software*	I've found it hard to communicate with other disciplines (aside from GP) as they're usually based at the hospital - the communication software they use is different from the ones used in my current private practice. Getting a hold of them via email or phone calls often result in a long series of voice messages. -Survey 5, TIPE, Physiotherapy, #8880 Our job as pharmacists would be much easier if there was a clear line of communication with GPs… There is such little time in community for multidisciplinary meetings and discussions, and until there is funding for this input, businesses simply could not afford to hire more pharmacists to fill these roles. -Survey 3, non-TIPE, Pharmacy, #2872
Interprofessional interaction outside of formal team	Limited opportunities with regards to true interdisciplinary discussion… [but] I am more confident now in talking to patients and explaining long term care and concerns as well as speaking to GPs and pharmacist with regards to medical and drug histories. -Survey 5, TIPE, Dentistry, #3243 It is difficult when you are working in isolation in a location as a dietitian. MDT meetings don't happen at our PHO - something I would like more of. -Survey 5, non-TIPE, Dietitian, #6653

TIPE = Tairāwhiti Interprofessional Education program; MDT = multi-disciplinary team; IDT = inter-disciplinary team; GP = general practitioner; PHO = primary health organisation

Supplementary 6: Verbatim examples of themes derived from free-text comments made by Tairāwhiti Interprofessional Education programme graduates about influence of pre-registration training on their professional practice

Darlow, B., Brown, M., McKinlay, E., Gray, L. Purdie, G., Pullon, S. (2022). Longitudinal impact of pre-registration interprofessional education on the attitudes and skills of health professionals during their early careers: a non-randomised trial with 4-year outcomes. BMJ Open

Influence of pre-registration training on preparation for workforce and TIPE on career*	**Number of comments**** One year post-graduation (n=113)	Two years post-graduation (n=111)	Three years post-graduation (n=114)	**Example (TIPE)**
Participated in an IPE course	**102**	**90**	**93**	TIPE program in Gisborne . -Survey 3, Oral Health, #5620
• *TIPE helpful*	*34*	*21*	*32*	The TIPE programme in Gisborne was THE BEST experience that set me up to work interprofessionally as a student. Before that we hardly touched on it. I think everyone needs to be doing this!! -Survey 3, Physiotherapy, #7271
The way I do my job	**102**	87	83	I don't think TIPE has had much, if any, influence on my career choice (to be a radiologist) but it certainly has influenced how I practise in my role as a junior doctor. -Survey 3, Medicine, #479
• *Understand others' roles/perspectives*	*17*	*16*	*6*	[TIPE] made me appreciate the roles of others and value their input. -Survey 5, Nursing, #0077
• *Connecting with other health professionals*	*48*	*30*	*43*	[TIPE] encouraged me to be more assertive and reach out to other health professionals first to initiate an interprofessional team approach for a patient when I feel it is appropriate. - Survey 3, Physiotherapy, #8880
• *Collaborating to prioritise patient wellbeing*	*15*	*10*	*7*	[TIPE] has been an awesome program, as I now think of patients' wellbeing as a whole, rather than focusing on what my profession does. I know that I can liaise with GPs or other health professionals if I need to for the best treatment outcome and benefit of the patient. -Survey 3, Dentistry, #8826
• *Thriving in interprofessional teams*	*15*	*15*	*16*	[TIPE] has made me more open to dealing with people and professions who may not share the same view, and working out how we can make things work with the goal of the client in mind. -Survey 3, Occupational Therapy, #3643
• *Hit the ground running*	*4*	*5*	*5*	[TIPE] allowed me to hit the ground running when I began my role in the hospital. -Survey 3, Pharmacy, #7374
• *Interprofessional champions*	*0*	*2*	*1*	I am an advocate for more multi-disciplinary discourse in our pharmacy chain. -Survey 4, Pharmacy, #3878
No perceived influence	**22**	**14**	**24**	It hasn't, since there are hardly any jobs for dietitians. You just take what you can get. -Survey 3, Dietetics, #4766

TIPE = Tairāwhiti Interprofessional Education programme; IPE = interprofessional education; GP = General Practitioner

* Two additional themes, related to influence on geographical location and clinical setting, are reported in a separate paper

** Participants could make more than one free-text comment within an item response.