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Evaluation of a multicomponent educational intervention to decrease general practice registrars' prescribing of benzodiazepines and related drugs: the BENEFIT prospective controlled study.

Jordan Tait[1], Simon Holliday[2,3], Elizabeth Holliday[2], Irena Patsan[1,2], Amanda Tapley[1,2], Anna Ralston[1,2], Jean Ball[4], Mieke van Driel[5], Andrew Davey[1,2], Alison Fielding[1,2], Michael Nicholas[6], Parker Magin[1,2]

Abstract

Background: *Benzodiazepines and medicines (including Z-drugs) are associated with frequent and serious related adverse effects. Despite this, they are frequently prescribed by general practitioners (GPs). We aimed to evaluate the effectiveness of a multi-component educational intervention designed to decrease the prescribing and initiation of these drugs by GPs in training ('registrars').*

Methods/design: *A pragmatic non-randomised, non-equivalent control-group design nested within the Registrar Clinical Encounters in Training (ReCEnT) cohort study was used to assess an educational intervention delivered to registrars in Australia. The intervention was underpinned by the Behaviour Change Wheel framework and included face-to-face workshops with pre- and post-session readings, a webinar for supervisors, and facilitation of registrar-supervisor dyad interactions. Analyses employed univariable and multivariable logistic regression. The p-value of an interaction term in the multivariable regression was used to determine the statistical significance of intervention-related change.*

Results: *Analyses included data of 1,088 intervention registrars and 1,003 control registrars. While some decrease in prescribing was seen, compared to the change from pre-post in controls, there were no statistically significant decreases in the 'Intention to Treat' (interaction aOR = 0.92, 95%CI: 0.70, 1.20,*

p = 0.52) or 'On Treatment' (interaction aOR = 0.87, 95%CI: 0.65, 1.16, p = 0.33) populations, and no statistically significant decrease in new prescriptions in the 'Intention to Treat' population (interaction aOR = 0.88, 95%CI: 0.58, 1.35, p = 0.57).

Implications: *Our study may have implications for further research aiming to identify effective strategies to promote appropriate benzodiazepine prescribing among GP registrars. Continued education for registrars around rational benzodiazepine prescribing is essential. This study is an initial step in evaluating the behaviour change intervention and further investigation and extended observation is warranted. This study highlights the educational challenges in improving rational benzodiazepine prescribing.*

Limitations: *Randomisation in the study design was not practicable.*

Trial registration: *Australian New Zealand Clinical Trials Registry, ACTRN12618000824268*

Keywords: *general practice training, education medical graduate, practice patterns, physicians' inappropriate prescribing, polypharmacy*

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[1] General Practice Training Research, Royal Australian College of General Practitioners, Australia.
[2] School of Medicine and Public Health, College of Health, Medicine and Wellbeing, The University of Newcastle, Australia.
[3] HealthHub Taree, Australia.
[4] Clinical Research Design IT and Statistical Support Unit (CReDITSS), Hunter Medical Research Institute (HMRI), Australia.
[5] General Practice Clinical Unit, Faculty of Medicine, The University of Queensland, Australia.
[6] Pain Management Research Institute, Kolling Institute of Medical Research, University of Sydney, Australia.

Corresponding author: Parker Magin, Conjoint Professor, The University of Newcastle, School of Medicine and Public Health, University Drive, Callaghan, NSW, 2308, Australia, parker.magin@newcastle.edu.au

INTRODUCTION

Considerable evidence-practice and guideline-practice gaps exists in the prescribing of benzodiazepines and molecularly distinct but functionally similar drugs, including the 'Z-drugs' such as zopiclone and zolpidem, by Australian general practice (GP) registrars ('trainees' or 'residents') (Holliday et al. 2017; Magin, Tapley, Dunlop et al. 2018). Hereafter in this article, benzodiazepines and Z-drugs will be collectively referred to as 'benzodiazepines'. Outside the infrequent (in general practice) indications such as acute alcohol withdrawal, epilepsy/seizures, and acute behavioural disturbance (Therapeutic Guidelines 2017; Therapeutic Guidelines 2021), guidelines and international recommendations reserve benzodiazepines for cautious, second-line, usually short-term use in severe or disabling anxiety or insomnia (Qaseem et al. 2016; Therapeutic Guidelines 2021). The Australian Therapeutic Guidelines: Psychotropic state, 'The role of benzodiazepines in anxiety disorders is controversial' (Therapeutic Guidelines 2021). Benzodiazepine use is 'usually restricted to acute crises and the immediate short term' and 'pharmacological therapy has a limited role in the treatment of insomnia' (Therapeutic Guidelines 2021). However, prescription of benzodiazepines for long-term use is very common in general practice in Australia, as it is worldwide (Airagnes et al. 2019; Davies, Rae & Montagu 2017; Donoghue & Lader 2010; Hwang et al. 2017; Kaufmann et al. 2018; Kurko et al. 2018; Takano et al. 2019; Zheng et al. 2020).

There are important clinical implications for patients and health systems of a lack of adherence to evidence-based guidelines for benzodiazepine prescribing. Conditions associated with benzodiazepine use include falls and fractures, worsening insomnia, adverse drug reactions, pneumonia, deliberate overdose, dependence, markedly increased overall mortality, and increased risk of dementia (Bénard-Laribière et al. 2016; Bourgeois et al. 2013; De Gage et al. 2014; Ferreira et al. 2022; Glass et al. 2005; Hood et al. 2014; Parsaik et al. 2016; Penninkilampi & Eslick 2018; Taipale et al. 2017). Benzodiazepine use can also increase the risk of these adverse drug reactions and related complications by contributing to psychotropic medicines polypharmacy and to polypharmacy-related anticholinergic and sedative drug burden (Hilmer et al. 2007; Magin et al. 2020). In Australia, benzodiazepine-induced deaths have increased four-fold from 2004–18 (Chrzanowska et al. 2023), with benzodiazepines the most commonly involved single drug type in drug-induced deaths in 2021 (Australian Institute of Health and Welfare 2023). There are also considerable economic costs of unnecessary benzodiazepine prescribing (Davies et al. 2022).Sleep consistency is gaining traction as an important measure of sleep (Zuraikat et al. 2024). Inconsistent sleep schedules can lead to greater sleep disturbances, thus poorer sleep (Chaput et al. 2020). This poorer sleep could lead to adverse health outcomes (Chaput et al. 2020; Zuraikat et al. 2024), while greater sleep consistency has been shown to improve performance (Okano et al. 2019; Sletten et al. 2023).

Benzodiazepines have a high potential for dependence and misuse (Votaw et al. 2019), and discontinuation remains challenging (Fluyau, Revadigar & Manobianco 2018). An Israeli population study found that one in five first-time users initiated on benzodiazepines were still using them regularly 10-years later (Schonmann et al. 2018). Benzodiazepine acute phase withdrawal phenomena range from trivial to major in nature (e.g., seizures, psychosis) (Brandt & Leong 2017; Curreen & Lidmila 2014; Donnelly et al. 2017; Gustavsen et al. 2008; Hood et al. 2014; Victorri-Vigneau et al.

2007; Yu et al. 2017). Protracted withdrawal phenomena have been reported following as little as 3–6 weeks of use and can last over a year (Hood et al. 2014). Withdrawal attempts are thus difficult, with reported relapse rates of 49–57% (Hood et al. 2014). Furthermore, the evidence for the hypnotic efficacy of benzodiazepines is unconvincing (Huedo-Medina et al. 2012; Wilt et al. 2016). In recent years, the promotion of Z-drugs as safer alternatives to benzodiazepines (Olson 2008) has been successful in shaping GP attitudes (Siriwardena et al. 2006). However, the clinical efficacy of these drugs is questionable (Huedo-Medina et al. 2012) and they demonstrate adverse side-effect profiles comparable with benzodiazepines (Brandt & Leong 2017).

In Australia, there has been a reduction in the total number of benzodiazepine prescriptions in recent years (Australian Institute of Health and Welfare 2023). However, despite clinical guidelines and campaigns, long-term benzodiazepine prescribing among Australian GPs has been rising, with the median duration for long-term benzodiazepine prescriptions 11 times higher than recommendations in 2017 (Woods et al. 2022). Furthermore, long-term prescriptions were six times more likely among elderly patients (Woods et al. 2022). Most benzodiazepines are prescribed in primary care by GPs (Hollingworth & Siskind 2010). In previous analyses of GP registrars' prescribing patterns in the Registrar Clinical Encounters in Training (ReCEnT) study, we found benzodiazepines/Z-drugs are prescribed in 2.1% of all registrar consultations and comprise 2.2% of all prescriptions (Holliday et al. 2017). The Z-drugs zopiclone and zolpidem comprised 6.6% of these prescriptions (Magin, Tapley, Dunlop et al. 2018). However, while benzodiazepines were prescribed most frequently for insomnia (28.2%) or anxiety (21.8%), half of all benzodiazepine prescriptions were for 'off-label' indications (Holliday et al. 2017). Contrary to clinical guidelines, registrars were prescribing benzodiazepines mainly as maintenance therapy to older patients and patients they were unfamiliar with (Holliday et al. 2017). This may indicate that registrars are simply repeating their senior colleagues' prescriptions and potentially perpetuating inappropriate prescribing. This represents problematic prescribing behaviour and a compelling target for cognitive and behavioural-based education.

For such a problematic prescribing behaviour, there has been limited research testing interventions targeting prescribers (including GPs as the most prominent prescribers) (Mokhar et al. 2018). Furthermore, previous interventions for reducing GPs' benzodiazepine prescriptions have concentrated on 'pharmacological' aspects of benzodiazepine prescribing and deprescribing (Vicens et al. 2022). There has been little attention to the behavioural aspects (explicitly providing cognitive and behavioural management strategies for insomnia and anxiety).

For GP registrars, our longitudinal analyses of temporal changes in overall benzodiazepine prescribing in the ReCEnT study indicate a moderate reduction in overall registrar benzodiazepine prescribing rates between 2010 and 2016 (by a statistically significant 6% per year) (Magin, Tapley, Dunlop et al. 2018). However, prescribing rates remained problematically high and longitudinal within-registrar analyses showed that individual registrars' benzodiazepine prescribing does not reduce during their 18-month general practice training program (Magin, Tapley, Dunlop et al. 2018). Carefully designed and delivered educational interventions to promote rational prescribing of benzodiazepines in current and future cohorts of GP registrars are much needed. There is a need to address benzodiazepine prescribing behaviours at an early stage of the development of clinical

practices and attitudes among registrars, as established GP prescribing behaviours can remain consistent over time (Björnsdóttir et al. 2010).

There are few previous studies of interventions to reduce benzodiazepine prescribing in GP registrars (Creupelandt et al. 2017; Zwar et al. 2000). However, our previous research has shown that a multicomponent educational intervention targeting both GP registrars and supervisors can produce significant reductions in GP registrars' antibiotic prescribing for acute bronchitis/bronchiolitis (Magin, Tapley, Morgan et al. 2018). We aimed to develop and test the efficacy of an educational intervention designed to reduce GP registrars' prescribing of benzodiazepines in patients aged 16 years and older by employing a multicomponent approach with a focus on education about skills in non-pharmacological management of anxiety and insomnia as well as specific instruction around the limited therapeutic role for benzodiazepines.

METHODS

DESIGN

The BENzodiazepines: Enhancing compliance For reduced prescribing In Training (BENEFIT) project employed a non-equivalent control-group study design, nested within an ongoing cohort study of Australian GP registrars' in-consultation clinical and educational practice, the Registrar Clinical Encounters in Training (ReCEnT) study (Davey et al. 2022; Magin et al. 2015).

THE REGISTRAR CLINICAL ENCOUNTERS IN TRAINING PROJECT

ReCEnT is an ongoing prospective multi-site cohort study, conducted since 2010, documenting GP registrars' in-consultation experience and clinical and educational actions, including prescribing behaviours. Within an apprenticeship-like model, GP registrars practice with considerable autonomy, including having full prescribing rights. The ReCEnT methodology has been described previously (Davey et al. 2022). In brief, registrars complete case report forms (CRFs) recording details of 60 consecutive consultations at approximately the midpoint of their three compulsory training terms. During the period of this ReCEnT sub-study, CRFs were paper based. For each patient consultation, patient demographics, clinical details (including diagnoses or problems addressed and medications prescribed in the consultation), and educational actions are recorded on the CRF. Registrar and practice demographics are also documented via a registrar-completed questionnaire. The longitudinal methodology facilitates evaluation of the efficacy of educational innovations.

ReCEnT data collection includes only office-based consultations. Consultations conducted in residential aged care facilities or during home visits are not recorded.

Registrars complete ReCEnT as an integral component of their educational/training program (Magin et al. 2015; Morgan et al. 2015), and may also provide informed consent for their data to be used for research purposes.

SETTING AND PARTICIPANTS

The study population included GP registrars in three of Australia's nine Regional Training Organisations (RTOs). At the time of this study, RTOs were government-funded, not-for-profit, geographically-defined general practice vocational training organisations which oversee registrar training programs and provide a program of educational sessions and resources. Most registrar learning, however, is experiential and occurs in the practice setting. Registrars train in accredited independent practices under the supervision of an accredited GP supervisor ('trainer', 'preceptor'). Registrars also receive structured away-from-practice teaching organised by their RTO. The intervention and control RTOs and their training practices include New South Wales, the Australian Capital Territory, Tasmania, and the eastern half of Victoria, representing 43.6% of Australian registrars and covering the full range of Australian GP training settings including practices located in major cities to remote areas (Taylor, Clarke & Edwards et al. 2018).

METHODOLOGY

Assignment to intervention or control in this study was at the level of RTO. Education- or control-group assignment was not random. A randomised design was not appropriate for this project due to educational practice at the ReCEnT-participating RTOs – with randomisation of the content of teaching sessions within educational programs not being acceptable to the RTOs. Assignment at the registrar level or other within-RTO smaller unit level was impracticable due to the risk of contamination resulting from registrars sharing educational and professional contacts within each RTO. Cluster randomisation was not viable due to the small number of RTOs participating in the ReCEnT cohort study in which BENEFIT is nested. Additionally, program planning involves scheduling of individual educational sessions (which would include any randomised intervention sessions) a year or more ahead of delivery. This imposes considerable logistic constraint on randomised intervention studies.

The intervention group consisted of registrars at one RTO (GP Synergy). Registrars of two other RTOs (Eastern Victoria General Practice Training [EVGPT] and General Practice Training Tasmania [GPTT]) formed the control group.

EDUCATIONAL INTERVENTION

The educational intervention for GP Synergy registrars was conducted as part of their routine out-of-practice training program and comprised four components designed to influence registrars' clinical behaviour. The first two components, a face-to-face 40-minute workshop and associated pre- and post-workshop educational resources, were delivered to GP registrars.

The 40-minute interactive presentation was delivered by a GP, a drug and alcohol specialist, and a clinical psychologist and covered:

- The epidemiology of anxiety and insomnia
- The pharmacotherapy for anxiety and insomnia management: common side-effects, low rate of cessation, and the similarity between GP registrar prescribing patterns and risk factors for fatal overdoses
- Three interactive case-based discussions: anxiety-, phobia-, and insomnia-related cases were presented. For each case, two registrars from the audience were invited to offer and discuss management

strategies they would consider. The clinical psychologist presenter then focused the discussion on developing confidence and competencies in offering a cognitive and behavioural approach (or referral for such). The behavioural strategies involved distraction exercises; techniques of mindful self-calming; cognitive behavioural therapy (CBT); behavioural activation; CBT for insomnia; and sleep (or bedtime) restriction strategies

- Finally, we discussed the principles of deprescribing benzodiazepines
- Registrars were encouraged to ask questions both during and after each individual section of the face-to-face interactive presentation, as well as in a Q&A to close the presentation.

The third component was a 60-minute webinar for supervisors of these registrars based on the content of the face-to-face workshop. This was similar to the registrars' session with added material on guidelines, an equivalence conversion table, practical use of CBT, and further information adjuncts to de-prescribing. Supervisors were also provided with the same pre-readings as the registrars.

The fourth component was an optional joint GP registrar-supervisor education activity for each registrar-supervisor dyad to use in their weekly one-on-one teaching meetings. A guide was provided to facilitate the supervisor-registrar dyad on the management of insomnia and anxiety with a focus on non-pharmacological therapies. The guide covered three clinical vignettes with suggestions for structured teaching sessions and random case analysis (Morgan & Ingham, 2013; Morgan et al. 2015). Participants were advised that this intervention component was best delivered proximate to the other components of the intervention delivered in June and July 2018.

The four intervention components were designed to be delivered sequentially. The first three components of the educational intervention were delivered in June and July 2018. The fourth component was delivered at the discretion of supervisors and registrars during July to August 2018.

See Supplementary Box 1 for the detailed components of the educational intervention.

The various materials were prepared with reference to the literature on the topic, the considerable clinical experience of the research team in the area, and an understanding of registrars' benzodiazepine prescribing provided by our previous ReCEnT project analyses (Magin, Tapley, Dunlop et al. 2018). The whole educational intervention was underpinned by Michie's Behaviour Change Wheel (Michie, Atkins & West 2014; Michie, Van Stralen & West 2011), aiming to change registrars' clinical behaviour (that is reduce prescriptions for benzodiazepines).

CONTROL

During the study period, registrars in the control group received 'usual education' comprising teaching/education as scheduled by the two control RTOs. This may have included some education on benzodiazepines, anxiety, and insomnia but did not include any of the materials prepared for the 'active education' group.

OUTCOMES

The primary outcome was:

- Whether a benzodiazepine was prescribed by registrars for patients aged 16 years or older.
- The secondary outcome was:
- Whether a benzodiazepine prescription was initiated (i.e., a new benzodiazepine prescription was commenced) by registrars for patients aged 16 years or older.

Benzodiazepines and related drugs were defined using the International Anatomical Therapeutic Chemical codes 'N05B' and 'N05C'.

INDEPENDENT VARIABLES

Independent variables related to registrar, patient, practice, and consultation factors. Independent variables in the model also included treatment group (education group/control group), time (before intervention/after intervention) and an interaction term of treatment group by time (see below, in statistical analyses).

See Box 1 for independent variables included in the analysis.

Box 1: Independent variables from ReCEnT included in the analysis

Consultation Factors • Number of diagnoses/problems managed during the consultation • Number of imaging test/s ordered • Number of pathology test/s ordered • Follow-up ordered for the diagnoses/problems • Referrals made for the diagnoses/problems • Whether the registrar sought clinical information during the consultation • Whether the registrar generated a learning goal related to the problem/diagnosis • Duration of consultation in minutes
Practice Factors • The size of the practice measured as the number of full-time-equivalent GPs • Whether the practice routinely bulk bills all patients (i.e., patients pay no fee for the consultation) • Rurality of the practice location • Socioeconomic status of the practice location
Patient Factors • Gender • Age group (16 – 34 years; 35 – 64 years; 65 years or older) • Aboriginal and/or Torres Strait Islander status • Non-English-speaking background • Whether the patient was new to the practice • Whether the patient was new to the registrar
Registrar Factors • Age • Gender • Part-time/full-time status • Training term at the time of data collection (Term 1, 2, or 3) • Whether the registrar worked at the practice during a previous term • Place of basic medical qualification (Australia or international) • Year of medical graduation • Number of years of pre-GP training spent in hospital practice

The practice size dichotomised to 'large' (greater than five full-time equivalent GPs) or 'small' (less than six full-time equivalent GPs).

The practice postcode was used to define the Australian Standard Geographical Classification-Remoteness Area (ASGC-RA) classification (the degree of rurality) of the practice location and to define the practice location's Socio-economic Indexes for Areas-Index of Relative Socio-economic Disadvantage (SEIFA-IRSD).

STATISTICAL ANALYSES

Registrar data from ReCEnT collection rounds first semester 2010 to first semester 2018 (pre-intervention) and second semester 2018 (post-intervention) were used in analyses (data from predecessor training organisations in the footprint of each of the three participating RTOs was included in pre-intervention data).

Analyses were at the level of problem/diagnosis. Only problems/diagnoses for patients aged 16 years and older were included. In the analyses of the secondary outcome (new prescription for benzodiazepine) problems/diagnoses for which there were ongoing/continuing benzodiazepine prescriptions were excluded from the analyses.

Descriptive statistics included frequencies for categorical variables and mean with standard deviation (SD) for continuous variables. The frequencies of categorical variables were compared between outcome categories using Chi-square tests for all variables, except when Fisher's exact test was used (due an expected count less than 5 in 25% or more cells). For continuous variables, means were compared using a t-test.

Logistic regression was employed within the generalised estimating equations (GEE) framework to account for repeated measures within registrars. An exchangeable working correlation structure was assumed.

Univariable analyses were conducted on each covariate, with the outcome. Covariates with a univariable p-value < 0.20 were considered for inclusion in the multiple regression model.

Once the model with all significant covariates was fitted, model reduction was assessed. Covariates that were no longer significant (at $p<0.2$) in the multivariable model were each tested for removal from the model. If the covariate's removal did not substantively change the resulting model, the covariate was removed from the final model. A substantive change to the model was defined as any covariate in the model having a change in the effect size (odds ratio) of greater than 10%.

The regressions modelled the log-odds that a benzodiazepine was prescribed.

The p-value of the interaction term (treatment group by time) was used to determine statistical significance, and the intervention odds ratio was used to reflect the intervention effect (difference in post vs pre odds of deprescribing, between intervention and control registrars).

For the primary outcome of 'benzodiazepine prescription', we analysed the data using both 'Intention to Treat (that is, intention to educate)' and a sensitivity analysis of 'On Treatment' populations. The 'Intention to Treat' population included all registrars in the intervention and control RTOs, regardless of whether they participated in the educational activities or not. The sensitivity analysis 'On Treatment' population included all registrars in the control RTOs, but from the education RTO only those registrars who attended the face-to-face educational session. For the secondary outcome of 'new prescription for benzodiazepine', we analysed the data only on an 'Intention to Treat' basis. Analyses were programmed using STATA 14.1 and SAS V9.4.

Statistical significance was declared at the conventional 0.05 level with the magnitude and precision of effect estimates also used to interpret results.

RESULTS

A total of 2,091 registrars (response rate 94.9%) participated, contributing 4,941 rounds of data collection. Of these, 1,088 registrars were from the intervention RTO and 1,003 were from the control RTOs. Of registrar-rounds, 1,991 were pre-intervention, and 590 were post-intervention. Table 1 presents the demographic details of participating registrars and registrar-rounds in the intervention and control RTOs.

Table 1: Demographics of registrars and their practices in the intervention and control groups: n (%) presented unless otherwise specified

Registrar variables		Intervention n=1,088 (%)	Control n=1,003 (%)
Age	Years	33.36 (6.91)	31.50 (5.46)
Gender	Female	679 (62.41)	641 (63.91)
	Male	409 (37.59)	362 (36.09)
Workload	Full-time	785 (75.77)	752 (76.11)
	Part-time	251 (24.23)	236 (23.89)
Training term	Term 1	909 (83.55)	875 (87.24)
	Term 2	120 (11.03)	93 (9.27)
	Term 3	59 (5.42)	35 (3.49)
Worked at the practice during a previous term	Yes	49 (4.58)	47 (4.72)
	No	1,022 (95.42)	949 (95.28)
Qualified as a doctor in Australia	Yes	829 (76.62)	857 (85.87)
	No	253 (23.38)	141 (14.13)
Year of medical graduation	Median (IQR)	2012 (2006–2014)	2010 (2007–2012)
Number of years worked in hospital prior to entering GP training	Mean ± SD	3.57 (3.86)	3.22 (2.81)
Pathway with which registrar enrolled	RACGP	747 (69.62)	785 (78.74)
	ACRRM	326 (30.38)	212 (21.26)

Registrar variables		Intervention n=1,088 (%)	Control n=1,003 (%)
Practice variables			
Practice size	Small (1 – 4 GPs) Large (5+ GPs)	484 (46.54) 556 (53.46)	339 (34.28) 650 (65.72)
Practice routinely bulk bills	Yes No	373 (34.44) 710 (65.56)	224 (22.60) 767 (77.40)
Practice rurality	Major city Inner regional Outer regional / remote	606 (56.16) 380 (35.22) 93 (8.62)	650 (60.76) 224 (22.67) 114 (11.54)
Practice location SES status (SEIFA-IRSD)	Mean ± SD	4.88 (2.46)	5.88 (3.06)

The number of full-time equivalent GPs dichotomised to 'large' (greater than five full-time equivalent GPs) or 'small' (less than six full-time equivalent GPs).

The practice postcode was used to define the Australian Standard Geographical Classification-Remoteness Area (ASGC-RA) classification (the degree of rurality) of the practice location and to define the practice location's SEIFA-IRSD.

PRIMARY OUTCOME

Benzodiazepine prescription

For the 'Intention to Treat' population, data for the primary analyses included 240,603 consultations where the patient was aged 16 years or over. This included 4,406 (1.8%) consultations where a benzodiazepine was prescribed. Characteristics associated with a benzodiazepine being prescribed in the 'Intention to Treat' population are presented in Supplementary Table 1.

Table 2 presents the results from the final multivariable model for the 'Intention to Treat' population with outcome 'benzodiazepine prescribed'. The odds ratio (aOR = 0.92, 95%CI: 0.70, 1.20) for the interaction term for pre/post-intervention and control/intervention group indicated a relative decrease of 8% in the odds of benzodiazepine prescribing after the intervention for registrars in the intervention RTO, compared to the control RTOs. This difference, however, was not statistically significant (p = 0.52).

Table 2: Univariable and adjusted logistic regression for

consultations with a benzodiazepine being prescribed in the 'Intention to Treat' population (n = 240,603 consultations)

Factor group	Variable	Class	Univariable OR (95% CI)	p	Adjusted OR (95% CI)	p
Intervention factors	Pre/post Control/intervention interaction	Post-intervention/ Intervention			0.92 (0.70, 1.20)	0.52
	Pre/post-intervention	Post-intervention	0.85 (0.76, 0.95)	0.0055	0.97 (0.80, 1.19)	0.80
	Control/intervention group	Intervention	0.74 (0.68, 0.80)	<0.001	0.79 (0.72, 0.87)	<0.001
Patient factors	Patient age group Referent: 16 – 34 years	35 – 64 years 65+ years	1.95 (1.80, 2.11) 1.92 (1.75, 2.11)	<0.001 <0.001	1.80 (1.65, 1.98) 1.57 (1.41, 1.75)	<0.001 <0.001
	Patient gender Referent: Male	Female	1.04 (0.98, 1.11)	0.19	1.12 (1.04, 1.21)	0.002
	Aboriginal and/or Torres Strait Islander status	Yes	1.87 (1.53, 2.30)	<0.001	1.97 (1.58, 2.46)	<0.001
	Non-English-Speaking Background	Yes	0.48 (0.41, 0.57)	<0.001 0.51 <0.001	0.46 (0.38, 0.56)	<0.001
	Patient/practice status	New to registrar	0.98 (0.92, 1.04)		1.05 (0.98, 1.14)	0.17
	Referent: Existing patient	New to practice	0.64 (0.55, 0.74)		0.72 (0.61, 0.85)	0.002
Registrar factors	Term Referent: Term 1	Term 2 Term 3	0.94 (0.87, 1.01) 0.90 (0.82, 0.98)	0.08 0.02	0.94 (0.86, 1.03) 0.84 (0.76, 0.92)	0.19 <0.001
Practice factors	Practice routinely bulk bills	Yes	0.78 (0.71, 0.85)	<0.001	0.91 (0.82, 1.00)	0.06
Consultation factors	Pathology ordered	Yes	0.08 (0.07, 0.10)	<0.001	0.06 (0.05, 0.08)	<0.001
	Imaging ordered	Yes	0.08 (0.06, 0.11)	<0.001	0.08 (0.06, 0.12)	<0.001
	Follow-up ordered	Yes	0.57 (0.53, 0.61)	<0.001	0.65 (0.59, 0.70)	<0.001
	Referral ordered	Yes	0.50 (0.45, 0.55)	<0.001	0.33 (0.30, 0.38)	<0.001
	Learning goals generated	Yes	0.52 (0.47, 0.57)	<0.001	0.60 (0.54, 0.67)	<0.001
	Sought help any source	Yes	0.56 (0.51, 0.61)	<0.001	0.62 (0.55, 0.69)	<0.001
	Consultation duration		1.02 (1.02, 1.02)	<0.001	1.04 (1.03, 1.04)	<0.001
	Number of problems		1.68 (1.63, 1.73)	<0.001	1.91 (1.83, 1.98)	<0.001

For the sensitivity analysis 'On Treatment' population, data for the primary analyses included 233,690 consultations where the patient was aged 16 years or over. This included 4,306 (1.8%) consultations where a benzodiazepine was prescribed. Characteristics associated with a benzodiazepine being prescribed in the 'On Treatment' population are presented in Supplementary Table 2.

Table 3 presents the results from the final multivariable model for the 'On Treatment' population with outcome 'benzodiazepine prescribed'. The odds ratio (aOR = 0.87, 95%CI: 0.65, 1.16) for the interaction term for pre/post-intervention and control/intervention group indicated a relative decrease of 13% in the odds of benzodiazepine prescribing after the intervention for registrars in the intervention RTO. This difference, however, was not statistically significant (p = 0.33).

Table 3: Univariable and adjusted logistic regression for consultations with a benzodiazepine being prescribed in the 'On Treatment' population (n = 233,690 consultations)

Factor group	Variable	Class	Univariable OR (95% CI)	p	Adjusted OR (95% CI)	p
Intervention factors	Pre/post Control/intervention interaction	Post-intervention/ Intervention			0.87 (0.65, 1.16)	0.33
	Pre/post-intervention	Post-intervention	0.87 (0.77, 0.98)	0.03	1.00 (0.82, 1.23)	0.96
	Control/intervention group	Intervention	0.74 (0.68, 0.80)	<0.001	0.79 (0.72, 0.87)	<0.001
Patient factors	Patient age group Referent: 16 – 34 years	35 – 64 years 65+ years	1.95 (1.80, 2.12) 1.93 (1.76, 2.12)	<0.001 <0.001	1.80 (1.64, 1.97) 1.57 (1.42, 1.75)	<0.001 <0.001
	Aboriginal and/or Torres Strait Islander status	Yes	1.91 (1.55, 2.34)	<0.001	2.02 (1.62, 2.51)	<0.001
	Non-English-Speaking Background	Yes	0.47 (0.40, 0.55)	<0.001	0.46 (0.38, 0.56)	<0.001
	Patient/practice status	New to registrar	0.97 (0.91, 1.04)	0.45	1.05 (0.97, 1.13)	0.25
	Referent: Existing patient	New to practice	0.64 (0.55, 0.74)	<0.001	0.72 (0.61, 0.86)	<0.001
Registrar factors	Term Referent: Term 1	Term 2 Term 3	0.93 (0.87, 1.01) 0.89 (0.81, 0.97)	0.08 0.008	0.95 (0.86, 1.04) 0.83 (0.75, 0.92)	0.24 <0.001
Practice factors	Practice routinely bulk bills	Yes	0.78 (0.71, 0.86)	<0.001	0.90 (0.81, 1.00)	0.05

Factor group	Variable	Class	Univariable OR (95% CI)	p	Adjusted OR (95% CI)	p
Consultation factors	Pathology ordered	Yes	0.08 (0.07, 0.10)	<0.001	0.07 (0.05, 0.08)	<0.001
	Imaging ordered	Yes	0.08 (0.06, 0.11)	<0.001	0.08 (0.06, 0.12)	<0.001
	Follow-up ordered	Yes	0.57 (0.54, 0.61)	<0.001	0.65 (0.60, 0.70)	<0.001
	Referral ordered	Yes	0.50 (0.45, 0.56)	<0.001	0.34 (0.30, 0.38)	<0.001
	Learning goals generated	Yes	0.51 (0.47, 0.56)	<0.001	0.60 (0.54, 0.67)	<0.001
	Sought help any source	Yes	0.56 (0.51, 0.62)	<0.001	0.63 (0.56, 0.70)	<0.001
	Consultation duration		1.02 (1.02, 1.02)	<0.001	1.04 (1.03, 1.04)	<0.001
	Number of problems		1.68 (1.63, 1.73)	<0.001	1.90 (1.83, 1.98)	<0.001

SECONDARY OUTCOME

New benzodiazepine prescription

The secondary analysis was conducted using the 'Intention to Treat' population. Data for the secondary analysis included 237,397 consultations where the patient was aged 16 years or over. Of these, 1,200 (0.5%) involved a new benzodiazepine prescription.

Table 4 presents the results from the final multivariable model for the secondary outcome population with outcome 'new prescription for benzodiazepine'. The odds ratio (aOR = 0.88, 95%CI: 0.58, 1.35) for the interaction term for pre/post-intervention and control/intervention group indicated a relative decrease of 12% in the odds of newly prescribed benzodiazepines after the intervention for registrars in the intervention RTO. This difference, however, was not statistically significant (p = 0.57).

Table 4: Univariable and adjusted logistic regression for consultations with a new prescription for benzodiazepine in the 'Intention to Treat' population (n=237,397 consultations)

Factor group	Variable	Class	Univariable OR (95% CI)	p	Adjusted OR (95% CI)	p
Intervention factors	Pre/post Control/intervention interaction	Post-intervention/ Intervention			0.88 (0.58, 1.35)	0.57
	Pre/post-intervention	Post-intervention	0.93 (0.77, 1.13)	0.48	1.06 (0.77, 1.47)	0.72

Factor group	Variable	Class	Univariable OR (95% CI)	p	Adjusted OR (95% CI)	p
	Control/intervention group	Intervention	0.92 (0.81, 1.04)	0.18	0.98 (0.85, 1.15)	0.84
Patient factors	Patient age group	35 – 64 years	1.29 (1.14, 1.47)	<0.001	1.17 (1.02, 1.36)	0.03
	Referent: 16 – 34 years	65+ years	0.66 (0.54, 0.79)	<0.001	0.58 (0.47, 0.72)	<0.001
	Aboriginal and/or Torres Strait Islander status	Yes	1.83 (1.22, 2.75)	0.003	1.51 (0.98, 2.35)	0.06
	Non-English-Speaking Background	Yes	0.54 (0.42, 0.71)	<0.001	0.57 (0.42, 0.76)	<0.001
Registrar factors	Registrar gender Referent: Male	Female	0.86 (0.75, 0.98)	0.02	0.84 (0.73, 0.98)	0.02
Practice factors	Practice routinely bulk bills	Yes	0.86 (0.74, 1.00)	0.04	0.83 (0.70, 0.98)	0.03
Consultation factors	Pathology ordered	Yes	0.18 (0.14, 0.23)	<0.001	0.15 (0.12, 0.20)	<0.001
	Imaging ordered	Yes	0.20 (0.14, 0.28)	<0.001	0.18 (0.12, 0.27)	<0.001
	Follow-up ordered	Yes	0.87 (0.77, 0.97)	0.016	0.90 (0.79, 1.03)	0.12
	Learning goals generated	Yes	0.84 (0.72, 0.97)	0.019	0.73 (0.62, 0.86)	<0.001
	Consultation duration		1.04 (1.04, 1.04)	<0.001	1.04 (1.04, 1.05)	<0.001
	Number of problems		1.38 (1.31, 1.46)	<0.001	1.43 (1.33, 1.54)	<0.001

DISCUSSION

MAIN FINDINGS AND COMPARISON WITH PREVIOUS STUDIES

There was no statistically significant effect of our educational intervention on prescribing of benzodiazepines (either for the main Intention to Treat/educate analysis or for the sensitivity analysis including only intervention RTO registrars who had attended the face-to-face education session). There were statistically non-significant, relative reductions of 8% in the odds of benzodiazepine prescribing and 12% in the odds of benzodiazepine initiation.

Few studies have examined interventions aiming to reduce benzodiazepine prescribing among GP trainees/registrars. In a randomized trial of Australian GP registrars examining the effectiveness of a 20-minute

educational outreach visit, notable decreases in continuing benzodiazepine prescriptions were observed in both intervention and control-group registrars. However, there were no statistically significant differences between groups (Zwar et al. 2000). In a Flemish study, GPs in vocational training were offered a voluntary e-module focusing on avoiding initial benzodiazepine prescriptions and using psychological interventions as alternative treatment. Significant improvements in the GP trainees' self-reported attitudes, perceptions, and self-efficacy, regarded as determinants of benzodiazepine prescribing, were observed post-intervention. However, the study did not measure actual prescribing behaviours (Creupelandt et al. 2017).

Previous interventions aiming to reduce GPs' prescribing of benzodiazepines for community-dwelling patients via interventions directed at the GPs' clinical practice (rather than directed at patients, pharmacists, or at a community level) have yielded somewhat inconsistent results. Large decreases (19 – 27%) in prescribing have resulted from interventions involving face-to-face education plus printed materials (Berings, Blondeel & Habraken 1994), academic detailing of GPs (by both physicians and pharmacists) (Midlöv et al. 2006), and mailed educational materials plus individualised mailed prescribing feedback (Smith et al. 1998).

A more modest reduction in benzodiazepine prescribing (4%) was achieved with a face-to-face educational workshop plus individualised mailed prescribing feedback (Smith et al. 1998). Some studies, however, did not find statistically significant reductions in benzodiazepine prescribing with individualised feedback on prescribing (Pimlott et al. 2003) or pharmacist detailing (Lacroix et al. 2023), and structured individual patient risk assessment (Pit et al. 2007).

Studies targeting patients and communities in addition to GPs have the potential for substantive reductions in benzodiazepine use (Navaratnam et al. 2023) but are not directly relevant to our study which is situated within a training program with scope only for GP-level intervention.

INTERPRETATION OF FINDINGS

We designed and implemented an educational intervention aimed at reducing benzodiazepine prescribing among GP registrars, underpinned by the Behaviour Change Wheel framework (Michie, Atkins & West 2014; Michie, Van Stralen & West 2011). We found no statistically significant reduction in benzodiazepine prescribing in our study. But, given the detection of clinically significant effect sizes (8% and 13%), with wide confidence intervals, the utility of our approach of augmenting pharmacological education with cognitive-and-behavioural-strategy education for benzodiazepine prescribing remains uncertain. Several factors may have influenced the non-significant findings.

There are considerable demonstrated barriers to reducing benzodiazepine prescribing among GPs, including the perceived risks and effectiveness of benzodiazepines or alternative treatments, the patient presentation, the context of the GPs' practice, and their view of the role (Sirdifield et al. 2013). Benzodiazepine prescribing decisions are complex and demanding for GPs, made in the context of short timescales and pressures of the consultation which can influence over-prescribing (Marquina-Márquez et al. 2022). These decisions require GPs to balance rational prescribing with the process of engaging patients in patient-centred shared decision-making (Sirdifield et al. 2013). It is reasonable to

believe that barriers to reduced benzodiazepine prescribing may be especially problematic among GP registrars, given their junior status and limited ability to establish continuous therapeutic relationships with patients due to training location requirements. Qualitative research on the opioid prescribing practices of Australian GP registrars has shown that some registrars intentionally prescribe non-indicated opioids if they feel declining to prescribe would compromise the therapeutic relationship with their patient (Prathivadi, Barton & Mazza 2021).

In line with the Behaviour Change Wheel framework, the education component of the intervention delivered to registrars was only one factor aimed at changing their behaviour. Our prior research in this population has indicated that a registrar's antibiotic prescribing can be influenced by the practice-based apprenticeship model of GP training and the prescribing patterns of GPs within the registrar's practice (Dallas et al. 2014; Dallas et al. 2015; Magin, Tapley, Morgan et al. 2018). As such, we also designed the intervention to address the practice environment/culture around the prescribing of benzodiazepines. In the apprenticeship model of GP training, this can be achieved by the encouragement of structural changes in the practice environment and procedures and the functioning of the registrar-supervisor dyad. However, for the present study, it is possible that changes in the practice environment and culture may have required longer to bed down than the duration of data collection for our analysis. The clinically significant effect sizes with wide confidence intervals, together with the consideration of the timeframe needed for practice-level changes to influence prescribing behaviour, indicate that further analyses over a longer timeframe are warranted.

STRENGTHS AND LIMITATIONS

Strengths of the study include the high response rate of registrars, and a study population with characteristics comparable to the national GP registrar population. The use of online modules and a relatively brief large-audience presentation format is an efficient and scalable delivery methodology for a complex intervention.

The lack of randomisation (dictated by Australian general practice training structure), is an important limitation. However, adjustment for a large set of relevant independent variables on multivariable analyses mitigated to a considerable extent the lack of randomisation.

Interpretation of the findings should also recognise that only practice-based consultations are included in ReCEnT. The findings are, thus, not generalisable to the nursing home patient population.

The short post-education follow-up period was also a limitation. Changes in the practice environment and practice prescribing culture may have needed longer to bed down.

DEVIATIONS FROM PROTOCOL

The protocol stated that participating registrars would be in training in Terms 1 and 2. The intervention was delivered to registrars in Terms 1 and 2, but the post-intervention data was collected when most of these registrars had progressed to Terms 2 and 3. However, some part-time registrars may still have been in Term 1. Thus, analyses were performed on all registrars. As some of the intervention-group registrars included in the analyses had not received the intervention, this may have biased results to the null.

IMPLICATIONS FOR PRACTICE, EDUCATION, AND FUTURE RESEARCH

It may be that it is more difficult to change prescribing of medicines being used (albeit inappropriately) medium- or long-term than it is to change one-off prescribing such as that of antibiotics for acute bronchitis (Pimlott et al. 2003) previously found using a similar registrar population and a similar educational approach and research methodology (Deckx et al. 2018; Magin, Tapley, Morgan et al. 2018). The issue of dependence is a further barrier to deprescribing (though not to initiation) in this situation.

This, along with the somewhat mixed trial findings, suggests that interventions for benzodiazepine prescribing may need to be intense and, likely, multifactorial, addressing further components of the Behaviour Change Wheel framework, targeting more extensive supervisor and practice-based changes. Despite our study failing to find a statistically significant reduction in prescribing, offering GPs cognitive and behavioural strategies as well as pharmacological strategies to change prescribing behaviour may be worth further evaluation.

A practical problem with the current evidence in this area is that some of the interventions in trials that reduced prescribing would be not readily scalable – being resource-intensive (individual academic detailing) or requiring construction and maintenance of a sophisticated data extraction and processing program (individualised prescribing feedback).

A further consideration is that the kind of individual-prescriber-level interventions considered here may be more effective if complemented by individual-patient-level and community-level interventions. It is also possible that concurrent regulatory interventions may be synergistic. Introduction of mandatory usage of a prescription drug monitoring program for benzodiazepines in Wisconsin has been found to reduce benzodiazepine prescribing (Manders & Abd-Elsayed 2020). In Australia, changing alprazolam availability and subsidisation reduced prescribing but at the cost of increased prescriber burden and possibly without effect on the alprazolam poisoning rate (Schaffer et al. 2019).

CONCLUSION

A complex intervention did not produce a statistically significant reduction in GP registrars' benzodiazepine prescribing. Despite this, our study may have implications for further studies of interventions to promote rational benzodiazepine prescribing.

Conflicts of interest

Dr Simon Holliday has received honorariums from Indivior for presentations subsequent to and unrelated to this intervention.

Data availability statement

The data that support this study cannot be publicly shared due to ethical or privacy reasons.

Ethics approval

Ethical approval for the ReCEnT study has been granted by the Human Research Ethics Committee (HREC) from the University of Newcastle (reference, H-2009-0323).

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SUPPLEMENTARY INFORMATION

Supplementary Box 1: Components of the educational intervention

Educational Resources

- Pre-workshop and webinar resources:
  - Three journal articles covering the areas of benzodiazepine misuse and dependence (Stein & Craske 2017), anxiety management (Lack 2016), and non-pharmacological management of insomnia (Brett & Murnion 2015)
  - Made available to registrars and supervisors two weeks prior to the face-to-face workshop and webinar, respectively
- Post-workshop resources:
  - Sleep diary for patient use
  - Patient information materials concerning sleep hygiene, management of stress and anxiety, and simple Cognitive Behaviour tools for dealing with anxiety
  - e-Mental Health Programs for patient use

Educational Workshop Session for GP Registrars

- 40-minute educational presentation
- Scheduled as part of standard training program for GP Synergy registrars
- Led by an addiction specialist who is also a GP and supervisor of GP registrars
- Co-delivered by an experienced clinical psychologist with expertise in the education of non-psychologists in non-pharmacological anxiety and stress management strategies
- Content constructed by the research team consisting of GPs, GP vocational training educators, academic GPs, addictions specialists, and a clinical psychologist
- Content informed by the current literature in the area and our previous work in documenting GP registrars' benzodiazepine prescribing, including the prevalence and associations of this prescribing (Morgan et al. 2015)
- Data on GP registrars' benzodiazepine prescribing collected in the ReCEnT project used to contextualize and reinforce the practical relevance and importance of the educational message
- Session focused on:
  - Practicalities of how to teach patients distracting, mindfulness, and relaxation/self-calming techniques and Cognitive-Behavioural Therapy for insomnia within a general practice setting
  - Promotion of collaborative models of registrars, supervisors and practices working together to implement appropriate practices and policies regarding benzodiazepine use

Webinar for Supervisors
- Based on the content of the registrar face-to-face workshop
- Emphasised the need for supervisors to work towards practice cultures where registrars' evidence-based management of anxiety and insomnia, and appropriate use of benzodiazepines, is supported
- Explored the role of the supervisor and registrar to work collaboratively in managing patients who may have an expectation of benzodiazepine prescription and in managing safe withdrawal of patients from benzodiazepines

Joint Registrar/Supervisor Activity
- Registrar-supervisor dyads encouraged to include a case-based discussion of appropriate management of anxiety and insomnia, and of avoidance of benzodiazepine initiation or unquestioned continuation, in their regular weekly one-on-one teaching meetings
- Supervisors offered a set of three structured cases to include in these meetings
- Registrar-supervisor dyads encouraged to perform an informal audit and notes review of patients who have received benzodiazepine prescriptions from registrar or supervisor
- Joint registrar/supervisor activities were optional as the content of registrar-supervisor weekly meetings is at discretion of supervisors

Supplementary Table 1: Univariable associations of a benzodiazepine being prescribed in the 'Intention to Treat' population (n=240,603 consultations)

Factor group	Variable	Class	Benzodiazepine prescribed No	Benzodiazepine prescribed Yes	p
Intervention factors	Pre/post-intervention	Pre-intervention	207702 (88%)	3948 (90%)	0.0051
		Post-intervention	28495 (12%)	458 (10%)	
	Control/intervention group	Control	122171 (52%)	2607 (59%)	<0.0001
		Intervention	114026 (48%)	1799 (41%)	
Patient factors	Patient age group	15-34	76400 (33%)	860 (20%)	<0.0001
		35-64	105247 (45%)	2362 (54%)	
		65+	50044 (22%)	1125 (26%)	
	Patient gender	Male	85740 (37%)	1554 (36%)	0.1924
		Female	144387 (63%)	2741 (64%)	
	Aboriginal and/or Torres Strait Islander status	No	216985 (99%)	4014 (97%)	<0.0001
		Yes	2981 (1%)	106 (3%)	
	Non-English-Speaking Background	No	201431 (91%)	3965 (96%)	<0.0001
		Yes	19813 (9%)	180 (4%)	

Factor group	Variable	Class	Benzodiazepine prescribed No	Benzodiazepine prescribed Yes	p
	Patient/practice status	Existing patient New to registrar New to practice	96438 (42%) 117636 (51%) 16691 (7%)	1874 (44%) 2215 (52%) 199 (5%)	<0.0001
Registrar factors	Registrar gender	Male Female	88855 (38%) 147342 (62%)	1672 (38%) 2734 (62%)	0.8821
	Registrar FT or PT	Part-time Full-time	52149 (23%) 176163 (77%)	960 (22%) 3332 (78%)	0.4406
	Term	Term 1 Term 2 Term 3	95069 (40%) 84393 (36%) 56735 (24%)	1855 (42%) 1547 (35%) 1004 (23%)	0.0366
	Worked at practice previously	No Yes	182863 (78%) 50511 (22%)	3403 (78%) 956 (22%)	0.8739
	Qualified as doctor in Australia	No Yes	42285 (18%) 192768 (82%)	756 (17%) 3628 (83%)	0.3457
	Registrar age Year of graduation Years prior to GP training	mean (SD) mean (SD) mean (SD)	33 (6) 2009 (5) 3 (3)	33 (6) 2009 (5) 3 (4)	0.0962 0.0722 0.0641
Practice factors	Practice size	Small Large	85638 (38%) 142469 (62%)	1600 (37%) 2677 (63%)	0.7243
	Practice routinely bulk bills	No Yes	168677 (72%) 64775 (28%)	3377 (77%) 982 (23%)	<0.0001
	Rurality	Major city Inner regional Outer regional remote	144966 (62%) 66117 (28%) 22218 (10%)	2598 (60%) 1279 (29%) 468 (11%)	0.0795
	SEIFA index	mean (SD)	5 (3)	6 (3)	0.5459
Consultation factors	Pathology ordered	No Yes	177768 (75%) 58429 (25%)	4287 (97%) 119 (3%)	<0.001
	Imaging ordered	No Yes	205745 (87%) 30452 (13%)	4351 (99%) 55 (1%)	<0.001
	Follow-up ordered	No Yes	100855 (43%) 135342 (57%)	2495 (57%) 1911 (43%)	<0.001
	Referral ordered	No Yes	192542 (82%) 43655 (18%)	3955 (90%) 451 (10%)	<0.001
	Learning goals generated	No Yes	165663 (74%) 59027 (26%)	3539 (84%) 662 (16%)	<0.001

Factor group	Variable	Class	Benzodiazepine prescribed No	Benzodiazepine prescribed Yes	p
	Sought help any source	No Yes	178974 (76%) 57223 (24%)	3738 (85%) 668 (15%)	<0.001
	Consultation duration	mean (SD)	18 (10)	21 (11)	<0.001
	Number of problems	mean (SD)	2 (1)	2 (1)	<0.001

Supplementary Table 2: Univariable associations of a benzodiazepine being prescribed in the 'On Treatment' population (n=233,690 consultations)

Factor group	Variable	Class	Benzodiazepine prescribed No	Benzodiazepine prescribed Yes	p
Intervention factors	Pre/post-intervention	Pre-intervention Post-intervention	207702 (91%) 21682 (9%)	3948 (92%) 358 (8%)	0.0256
	Control/intervention group	Control Intervention	121457 (53%) 107927 (47%)	2598 (60%) 1708 (40%)	<0.0001
Patient factors	Patient age group	15-34 35-64 65+	74105 (33%) 102365 (45%) 48575 (22%)	838 (20%) 2309 (54%) 1102 (26%)	<0.0001
	Patient gender	Male Female	83237 (37%) 140297 (63%)	1523 (36%) 2676 (64%)	0.2458
	Aboriginal and/or Torres Strait Islander status	No Yes	211427 (99%) 2875 (1%)	3939 (97%) 105 (3%)	<0.0001
	Non-English-Speaking Background	No Yes	196439 (91%) 19042 (9%)	3893 (96%) 170 (4%)	<0.0001
	Patient/practice status	Existing patient New to registrar New to practice	94059 (42%) 114082 (51%) 16131 (7%)	1843 (44%) 2156 (51%) 194 (5%)	<0.0001
Registrar factors	Registrar gender	Male Female	86785 (38%) 142599 (62%)	1646 (38%) 2660 (62%)	0.8560
	Registrar FT or PT	Part-time Full-time	49755 (22%) 172424 (78%)	920 (22%) 3279 (78%)	0.4105
	Term	Term 1 Term 2 Term 3	91137 (40%) 82503 (36%) 55744 (24%)	1797 (42%) 1524 (35%) 985 (23%)	0.0234

Factor group	Variable	Class	Benzodiazepine prescribed No	Benzodiazepine prescribed Yes	p
	Worked at practice previously	No Yes	176957 (78%) 49696 (22%)	3316 (78%) 943 (22%)	0.8245
	Qualified as doctor in Australia	No Yes	39850 (17%) 188390 (83%)	717 (17%) 3567 (83%)	0.3913
	Registrar age Year of graduation Years prior to GP training	mean (SD) mean (SD) mean (SD)	32 (6) 2009 (5) 3 (3)	33 (6) 2009 (5) 3 (4)	0.1311 0.1129 0.1127
Practice factors	Practice size	Small Large	82814 (37%) 138956 (63%)	1560 (37%) 2622 (63%)	0.6321
	Practice routinely bulk bills	No Yes	164605 (73%) 62162 (27%)	3307 (78%) 952 (22%)	<0.0001
	Rurality	Major city Inner regional Outer regional remote	141796 (62%) 63780 (28%) 21669 (10%)	2555 (60%) 1242 (29%) 460 (11%)	0.0613
	SEIFA index	mean (SD)	5 (3)	6 (3)	0.5621
Consultation factors	Pathology ordered	No Yes	172706 (75%) 56678 (25%)	4188 (97%) 118 (3%)	<0.001
	Imaging ordered	No Yes	199935 (87%) 29449 (13%)	4252 (99%) 54 (1%)	<0.001
	Follow-up ordered	No Yes	97975 (43%) 131409 (57%)	2435 (57%) 1871 (43%)	<0.001
	Referral ordered	No Yes	186960 (82%) 42424 (18%)	3864 (90%) 442 (10%)	<0.001
	Learning goals generated	No Yes	161981 (74%) 56616 (26%)	3475 (85%) 636 (15%)	<0.001
	Sought help any source	No Yes	174312 (76%) 55072 (24%)	3655 (85%) 651 (15%)	<0.001
	Consultation duration	mean (SD)	18 (10)	20 (11)	<0.001
	Number of problems	mean (SD)	2 (1)	2 (1)	<0.001

Supplementary Table 3: Univariable associations of a new prescription for benzodiazepine in the 'Intention to Treat' population (n=237,397 consultations)

Factor group	Variable	Class	Benzodiazepine newly prescribed No	Benzodiazepine newly prescribed Yes	p
Intervention factors	Pre/post-intervention	Pre-intervention Post-intervention	207702 (88%) 28495 (12%)	1063 (89%) 137 (11%)	0.4767
	Control/intervention group	Control Intervention	122171 (52%) 114026 (48%)	647 (54%) 553 (46%)	0.1747
Patient factors	Patient age group	15-34 35-64 65+	76400 (33%) 105247 (45%) 50044 (22%)	367 (31%) 660 (56%) 160 (13%)	<0.0001
	Patient gender	Male Female	85740 (37%) 144387 (63%)	465 (40%) 707 (60%)	0.0914
	Aboriginal and/or Torres Strait Islander status	No Yes	216985 (99%) 2981 (1%)	1088 (97%) 28 (3%)	0.0033
	Non-English-Speaking Background	No Yes	201431 (91%) 19813 (9%)	1069 (95%) 56 (5%)	<0.0001
	Patient/practice status	Existing patient New to registrar New to practice	96438 (42%) 117636 (51%) 16691 (7%)	474 (41%) 608 (52%) 83 (7%)	0.7237
Registrar factors	Registrar gender	Male Female	88855 (38%) 147342 (62%)	495 (41%) 705 (59%)	0.0222
	Registrar FT or PT	Part-time Full-time	52149 (23%) 176163 (77%)	267 (23%) 894 (77%)	0.7268
	Term	Term 1 Term 2 Term 3	95069 (40%) 84393 (36%) 56735 (24%)	516 (43%) 411 (34%) 273 (23%)	0.1807
	Worked at practice previously	No Yes	182863 (78%) 50511 (22%)	946 (80%) 243 (20%)	0.2679
	Qualified as doctor in Australia	No Yes	42285 (18%) 192768 (82%)	216 (18%) 978 (82%)	0.9290
	Registrar age Year of graduation Years prior to GP training	mean (SD) mean (SD) mean (SD)	33 (6) 2009 (5) 3 (3)	33 (7) 2009 (6) 3 (3)	0.0094 0.1122 0.1949
Practice factors	Practice size	Small Large	85638 (38%) 142469 (62%)	408 (35%) 747 (65%)	0.2084
	Practice routinely bulk bills	No Yes	168677 (72%) 64775 (28%)	895 (75%) 294 (25%)	0.0428
	Rurality	Major city Inner regional	144966 (62%) 66117 (28%)	714 (60%) 361 (30%)	0.3192

Factor group	Variable	Class	Benzodiazepine newly prescribed No	Benzodiazepine newly prescribed Yes	p
		Outer regional remote	22218 (10%)	112 (9%)	
	SEIFA index	mean (SD)	5 (3)	6 (3)	0.2682
Consultation factors	Pathology ordered	No Yes	177768 (75%) 58429 (25%)	1133 (94%) 67 (6%)	<0.0001
	Imaging ordered	No Yes	205745 (87%) 30452 (13%)	1166 (97%) 34 (3%)	<0.0001
	Follow-up ordered	No Yes	100855 (43%) 135342 (57%)	557 (46%) 643 (54%)	0.0160
	Referral ordered	No Yes	192542 (82%) 43655 (18%)	991 (83%) 209 (17%)	0.3298
	Learning goals generated	No Yes	165663 (74%) 59027 (26%)	881 (77%) 263 (23%)	0.0190
	Sought help any source	No Yes	178974 (76%) 57223 (24%)	909 (76%) 291 (24%)	0.9153
	Consultation duration	mean (SD)	18 (10)	24 (11)	<0.0001
	Number of problems	mean (SD)	2 (1)	2 (1)	<0.0001