

# Changes in health-related quality of life before and after a 12-month enhanced primary care model among chronically ill primary care patients in Australia.

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## Research

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## Abstract

**Purpose:** Evidence suggests that Patient-centred Medical Home (PCMH) model facilitates person-centred care and improves health-related quality of life for patients with chronic illness. This study aims to evaluate changes in health-related quality of life (HRQoL), before and after enrolment into a 12-month integrated care program called 'WellNet'.

**Methods:** This study includes 616 eligible consented patients aged 40 years and above with one or more chronic conditions from six general practices across Sydney, Australia. The WellNet program included a team of general practitioners (GPs) and clinical coordinators (CCs) providing patient-tailored care plans configured to individual risk and complexity. HRQoL was recorded using the validated EuroQol EQ-5D-5L instrument at baseline and 12 months. Additionally, patients diagnosed with osteoarthritis also reported HRQoL using short versions of Knee and/or Hip disability and osteoarthritis outcome scores (KOOSjr and HOOSjr). A case-series study design with repeated measures analysis of covariance (ANCOVA) was used to assess changes in mean differences of EQ-5D index scores after controlling for baseline covariates. Per-protocol (Model 1) and multiple imputation models (Model 2), the latter using a fully conditional specification (FCS) of Markov Chain Monte Carlo (MCMC) algorithm was analysed. Additionally, backward stepwise multivariable linear regression models were conducted to determine significant predictors of EQ-5D index scores at follow-up.

**Results:** Out of 616 patients, 417 (69%) reported EQ-5D scores at follow-up. Almost half (48%) of the WellNet patients reported improved EQ-5D index scores at follow-up. After controlling for baseline covariates, the adjusted mean difference was statistically significant whilst also meeting the bare minimal clinically important difference (MCID) with a change of 0.03 (95% CI 0.01, 0.05). However, the imputed model failed to meet statistical significance. The multivariable regression models determined that baseline EQ-5D scores, positive diagnosis of a respiratory illness, and private health insurance status were significant predictors of HRQoL at follow-up. There were significant improvements across both KOOS and HOOS assessments, specifically, the pain and symptom scores in both scales met statistical significance in addition to meeting the MCID.

**Conclusion:** Patient-tailored CDM plans designed by team of GPs and CDM clinical coordinators could lead to better HRQoL among primary care patients.

## Introduction

The exponential rise in chronic disease prevalence presents significant public health burden to health care systems worldwide and challenges the need to revisit strategies towards effective prevention and management [1, 2]. In Australia, chronic conditions have accounted for 87% of deaths and a collective 61% of fatal and non-fatal burden in 2015 [3, 4]. Moreover, there is an increasing trend of multimorbidity among the ageing population resulting in greater demand for integration of health services [5, 6]. The health and economic ramifications of chronic illness in terms of premature mortality [7], polypharmacy [8], complexity of care [9], and diminished health-related quality of life [10] are well documented. Additionally, the increased health service utilisation among chronic disease sufferers is especially of interest, given Australia's current fragmented health care framework which lacks continuity of care and care coordination [11, 12]. On the contrary, there is increasing evidence of improved HRQoL in patients receiving collaborative and patient-centred care [13, 14].

In recent decades, there has been a paradigm shift in the measure of health care evaluation from the traditional health indicators of mortality and morbidity towards a broader perspective of patient reported outcome measures (PROMS) including daily functioning, quality of life, symptoms, and other aspects of their health [15, 16]. HRQoL is a multi-dimensional concept that measures the impact and quality of health encompassing an individual's physical, mental, and social functioning [17, 18]. Determining the HRQoL for patients with chronic illness in primary care setting is beneficial as it enables understanding of patient's insights and perception on where care needs to be directed in relation to their condition [19, 20]. This in turn allows providers to improve self-management behaviours among patients to effectively manage their conditions and symptoms [21]. There is evidence showing strong association between patient-provider communication and improved HRQoL [22, 23].

Australia has a long-standing use of surveys to measure population health quality and status, including recent incorporation of health utility measures. Data from the South Australia's annual Health Omnibus Survey (HOS) and New South Wales' 45 and Up Study have been extensively used to study HRQoL in several wide-level population norms [24, 25]. For instance, trends in the HRQoL study by Atlantis et al shows that HRQoL significantly worsened over a 10-year period (1998-2008) for individuals with comorbid conditions compared to those with a single chronic condition [26]. Despite recent work, current knowledge of the HRQoL among specific population groups, like primary care patients with multimorbidity, remains largely unknown. Therefore, the aim of this study is to evaluate the HRQoL, before and one-year after enrolment into an enhanced primary care program, and to investigate predictors of change in the HRQoL among primary care patients presenting with one or more chronic conditions.

## Methods

### *WellNet program - Overview, intervention, and study design*

The 'WellNet' program developed by Sonic Clinical Services (SCS) is a general practitioner (GP) led, multidisciplinary team-based (MDT) care delivery model within primary care settings. The 12-month program is built upon best practice clinical care models, including the Patient-Centred Medical Home (PCMH), which aims to deliver care that is tailored to individual risk and comorbidity burden [27].

The enhanced primary care program is designed to provide individualised 'whole-person' care with focus on self-management support, health coaching and education, care coordination, shared decision making, and long-term continuity of care. Ongoing support and monitoring were provided through a total of 14 possible consultations with the care team in the form of in-practice visits and telephone contacts throughout the 12-month period. In addition, patients were also supported with a user-friendly online platform called 'GoShare' providing patient-tailored educational materials and a mobile application 'MediTracker'

enabling access and reminders to the next scheduled GP appointments and prescriptions. Further details on how CCs monitored usage of GoShare and MediTracker are reported elsewhere [27].

Patients were recruited between December 2016 and October 2017 using a targeted convenience sampling technique if they met the eligibility criteria. Targeted convenience sampling is a commonly used non-probability sampling in clinical research where members of the target population that meet certain practical eligibility criteria are included for the purpose of the study [28]. A case-series study design was used to determine changes in the HRQoL before and after WellNet care among patients enrolled in six primary care practices across Northern Sydney, Australia. Informed consent was obtained from all participants upon enrolment into the WellNet program.

### ***Participants***

A computerised algorithm was executed to identify potentially eligible patients from the electronic medical records of SCS GP practices. The overarching criteria for eligibility include patients aged 40 years and over; having one or more chronic condition/s with or without one or more elevated clinical risk factors; and had visited a general practitioner (GP) at least thrice in the previous two years. Patients living in nursing homes and those with severe cognitive impairment or terminal illness (n=10) were excluded. More details on the risk algorithm, enrolment, and data collection are reported elsewhere [27]. Of the 636 consenting participants, 616 who completed the baseline EQ-5D questionnaire were analysed in this study. Flowchart of the enrolment outcomes is shown in Figure 1.

### ***EQ-5D-5L instrument***

The HRQoL was measured using the standardised UK version of the five dimensions and five levels of the EuroQoL (EQ-5D-5L) instrument [29]. The questionnaire covers five dimensions of health: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. The levels of severity range from no problems to extreme problems for each of the five dimensions are recorded. The raw scores are then converted to a single EQ-5D index value (Time-trade off value) using a scoring algorithm ranging from 0 (worst perceived health state) to 1 (best perceived health state) [30]. In the WellNet program, EQ-5D-5L questionnaire was recorded at baseline and 12 months (at program completion).

### ***KOOS and HOOS assessments (short versions)***

The Hip disability and Osteoarthritis Outcome Scores (HOOS) and Knee injury and Osteoarthritis Outcome Scores (KOOS) are shortened but validated versions of the HOOS and KOOS surveys indicated for patients with a positive diagnosis of osteoarthritis and reporting different forms of hip and knee disability [31, 32]. These surveys are intended for use over short and long-term intervals to assess patient-reported changes in the quality of life in terms of changes in the levels of function, symptoms, and pain induced by a particular treatment [31, 32]. Both the questionnaires contain subscales of items recording patient's QoL in terms of pain, function, daily living, and stiffness. The scores range from 0 to 100: 0 indicates total disability, whilst 100 indicates perfect functionality. As MCIDs were not established at the start of this study, previous body of literature estimations were adopted where minimal clinically important difference (MCID) values ranging between 9.6 and 16.2 for HOOS; and between 8 and 10 for KOOS [33, 34]. In this study, the HOOS and KOOS scales were only used as a supplement to EQ-5D instrument.

### ***Study outcomes and exploratory variables***

The primary outcome of interest was changes in the EQ-5D index value and increase in the proportion of patients at a lower severity level in all five dimensions at follow-up. The secondary outcomes included: 1) predictors of change in EQ-5D index over time; 2) adjusted mean difference in KOOS and HOOS scales recorded among subsample of patients diagnosed with osteoarthritis.

The explanatory or predictor variables analysed and adjusted for in this study as follows: age, gender, diagnosis of chronic conditions, number of co-existing conditions, private insurance status (PHI), and number of scheduled consultations.

### ***Data analysis***

Descriptive statistics for continuous variables are expressed as mean and standard deviation (SD) whereas frequency counts of categorical variables are shown in percentages. Normality of distribution was assessed using the Shapiro-Wilk test for normality and by analysis of normal quantile-quantile plots. Independent samples t-tests and Pearson's chi-square tests were conducted to determine significant differences between completers and those who withdrew (non-completers) before program completion. Additionally, Pearson's product-moment correlation coefficient was conducted to determine the level of association between EQ5D scores and different chronic condition groups at baseline.

Two models were employed for primary analyses: 1) per-protocol model (Model 1) – those who reported both baseline and follow-up EQ5D scores and 2) imputed model (Model 2) where missing follow-up scores are replaced by valid values using other available information from the dataset as a result of repeated draws from the fully conditional specification (FCS) of Markov Chain Monte Carlo (MCMC) algorithm [35]. A total of 25 iterations were computed and pooled estimates of the imputed models were reported. The multiple imputation model allowed for inclusion of dependent variable of follow-up EQ5D scores as a covariate to enable unbiased estimates of model coefficients [36]. The rationale for imputing missing data was supplemented with primary analysis to test the hypothesis whether the overall WellNet sample (N=616), including patients who withdrew prematurely before program completion without reporting their follow-up EQ5D scores would have reported similar trends in EQ5D scores, if they had completed the program as the cohort of patients who did complete the program.

Unadjusted mean differences between baseline and follow-up were computed using paired samples t-test and adjusted mean differences for both models and instruments were determined by using the repeated measures ANCOVA whilst adjusting for potential baseline covariates. Additionally, a subgroup analysis

was also conducted to evaluate adjusted differences in EQ5D scores up among proportion of patients with two or more conditions and patients who had more than median contacts ( $\geq 12$  contacts) with WellNet care team.

To determine predictors of change in EQ-5D over time, multivariable linear regression models were employed using post-EQ5D index scores as outcome variable. Post-EQ5D index scores were preferred over change scores (follow-up minus baseline) as outcome variable because change scores fail to allow for optimal control of the baseline imbalance owing to potential regression to the mean [37, 38]. Univariate linear regression was conducted for each variable separately and variables with  $p$ -value $<0.20$  were included in the multivariable model. The backward stepwise regression approach was used to reduce and create the final model while simultaneously assessing the fitness of model in order to avoid dropping of non-significant variables that may affect the model fitness. The final model constitutes variables, which when excluded, cause a prominent deviance change ( $p < 0.05$ ) as compared to the corresponding  $X^2$  test statistic on the relevant degrees of freedom.

Finally, the internal consistency of EQ-5D, KOOS, and HOOS scales in this study were evaluated using Cronbach's alpha. All analyses were conducted using SPSS (version 25) and R statistical software.

## Results

### Baseline characteristics and EQ-5D-5L scores

Baseline characteristics of patients including chronic disease prevalence, overall and stratified by completion status (completed or withdrawn), are presented in Table 1. With exception to slight differences in age and Body Mass Index (BMI), no significant differences were observed between completers and non-completers. Patients were on average 68.9 years old with almost similar gender distribution and had a mean number of  $2 \pm 1$  chronic conditions. Diabetes (49%) was observed to be the most prevalent of the chronic conditions with cancer (14%) being the least prevalent among the WellNet patients. Additionally, more than two-thirds (69%) of the participating patients had private insurance.

**Table 1. Baseline patient characteristics (Overall, by completion status)**

Variable	Overall (N=616)	Completed (n=441)	Withdrawn (n=175)	p-value
Age in years, Mean (SD)*	68.9 (12.9)	69.6 (12.3)	67.2 (14.2)	0.05
<b>Gender</b>				
<i>Males</i>	306 (49.7)	211 (47.8)	95 (54.3)	0.149
<i>Females</i>	310 (50.3)	230 (52.2)	80 (45.7)	
<b>History of co-existing conditions</b>				
<i>Cardiovascular disease</i>	211 (34.3)	152 (34.5)	59 (33.7)	0.859
<i>Respiratory disease</i>	179 (29.1)	126 (28.6)	53 (30.3)	0.673
<i>Diabetes</i>	302 (49.0)	226 (51.2)	76 (43.4)	0.080
<i>Musculoskeletal disorders</i>	263 (42.7)	198 (44.9)	65 (37.1)	0.079
<i>Mental illness</i>	126 (20.5)	86 (19.5)	40 (22.9)	0.352
<i>Cancer</i>	89 (14.4)	60 (13.6)	29 (16.6)	0.345
<b>Number of co-existing conditions, Mean (SD)</b>	1.9 (0.9)	1.9 (0.9)	1.8 (0.9)	0.332
<b>Insurance status</b>				
<i>Private</i>	391 (68.5)	283 (68.7)	108 (67.9)	0.860
<i>Uninsured</i>	180 (31.5)	129 (31.3)	51 (32.1)	
<b>Mean EQ-5D-5L score</b>	0.79 (0.19)	0.80 (0.17)	0.77 (0.22)	0.088
<b>Clinical measures</b>				
<i>Systolic Blood Pressure (mmHg), Mean (SD)</i>	138.8 (19.2)	139.0 (18.9)	138.0 (19.7)	0.558
<i>Diastolic Blood Pressure (mmHg), Mean (SD)</i>	75.8 (18.0)	75.8 (17.8)	75.9 (18.5)	0.966
<i>Body Mass Index Kg/m<sup>2</sup>, Mean (SD)*</i>	29.9 (7.3)	29.5 (6.4)	30.9 (9.1)	0.03
<i>Glycated Haemoglobin (%), Mean (SD)</i>	6.8 (1.4)	6.8 (1.4)	6.7 (1.5)	0.629
<i>High Density Lipoprotein Cholesterol (mmol/L), Mean (SD)</i>	1.3 (0.4)	1.3 (0.4)	1.3 (0.4)	0.567
<i>Low Density Lipoprotein Cholesterol (mmol/L), Mean (SD)</i>	2.7 (1.1)	2.7 (1.1)	2.8 (1.1)	0.177
<i>Total Cholesterol (mmol/L), Mean (SD)</i>	4.8 (1.4)	4.8 (1.3)	5.0 (1.6)	0.201
<i>Triglyceride (mmol/L), Mean (SD)</i>	1.7 (1.1)	1.6 (1.1)	1.7 (1.4)	0.329

Data presented as N (%) unless specified otherwise

Variables reported as percentages were tested with chi-square analyses and variables reported as means and standard deviations were tested with independent samples t-test.

HARP - Hospital Admission Risk Profile

\* $p$ -value $<0.05$

The overall mean (SD) EQ-5D index value of the sample at baseline was 0.79 (0.19). Of the 616 patients who reported their baseline EQ-5D scores, 91 (15%) patients reported 'no problems' across all five dimensions at baseline. 417 out of 616 (68%) participants reported follow-up EQ-5D upon program completion. In terms of the type of chronic condition, people diagnosed with a mental illness reported the least mean (SD) EQ-5D index value of 0.70 (0.23) at baseline. Additionally, results of Pearson's product-moment correlation coefficient showed a small but statistically significant negative association between baseline EQ-5D index value and history of a mental illness ( $r = -0.24, p < 0.001$ ) and musculoskeletal disorder ( $r = -0.21, p < 0.001$ ) at baseline. The distribution of baseline EQ-5D index value by type of chronic conditions with Pearson's correlation coefficients are presented in Figure 2.

The internal consistency of EQ-5D items in this study was sound (Cronbach's alpha coefficients = 0.85). Additionally, HOOS and KOOS items also showed high reliability with Cronbach's alpha coefficients of 0.91 and 0.89 respectively.

### Changes in the EQ-5D-5L scores

In the per-protocol analysis (Model 1), the unadjusted within-group changes in the index value scores between baseline and follow-up showed statistically significant improvement with mean difference of 0.03 (95% CI 0.02, 0.05). After controlling for baseline covariates, the adjusted mean difference remained significant with 0.03 (95% CI 0.01, 0.05). However, in the imputed model (Model 2), the adjusted mean difference of 0.01 (95% CI -0.01, 0.02) did not meet statistical significance (Table 2).

**Table 2. Repeated measures ANCOVA (main and imputed model)**

Variable	Main model (Model 1) (N=417)		Imputed model (Model 2) (N=616)	
	Unadjusted mean difference (95% CI)	Adjusted mean difference (95% CI)	Unadjusted mean difference (95% CI)	Adjusted mean difference (95% CI)
	0.03 (0.02, 0.05)**	0.03 (0.01, 0.05)**	0.01 (0.01, 0.02)	0.01 (-0.01, 0.02)
Analyses				
More chronic	0.04 (0.02, 0.06)**	0.04 (0.02, 0.06)*	0.02 (0.01, 0.03)**	0.02 (0.01, 0.03)*
Median visits	0.03 (0.01, 0.05)**	0.03 (0.00, 0.04)*	0.02 (0.01, 0.03)**	0.02 (0.02, 0.03)*

\*\*\*p < 0.001

\*\*p < 0.05

Additionally, the subgroup analysis of patients with two or more chronic conditions (N=264) showed higher adjusted mean difference in EQ5D scores of 0.04 (95% CI 0.02 to 0.06; p-value < 0.05). However, patients who had more than average contacts (N=287) with the care team had similar improvements in EQ5D scores as the overall population of 0.03 (95% CI 0.01 to 0.05; p-value < 0.05) (Table 2).

Changes in the proportion of EQ-5D levels by dimensions at baseline and follow-up using Monte Carlo method are shown in Table 3. Generally, there was a statistically significant increase in the proportion of those reporting 'no problem' at 12-month follow-up.

**Table 3. Proportion of levels in EQ5D by dimension at baseline and follow-up**

EQ-5D dimensions	Levels	Baseline n (%)	Follow-up n (%)	p-value*
Mobility	No problem	194 (46.5)	225 (54.0)	<0.001
	Slight	116 (27.8)	93 (22.3)	
	Moderate	74 (17.7)	74 (17.7)	
	Severe	31 (7.4)	22 (5.3)	
	Unable	2 (0.5)	3 (0.7)	
Self-care	No problem	353 (84.7)	379 (90.9)	<0.001
	Slight	51 (12.2)	20 (4.8)	
	Moderate	12 (2.9)	13 (3.1)	
	Severe	1 (0.2)	3 (0.7)	
	Unable	0 (0.0)	2 (0.5)	
Usual activities	No problem	209 (50.1)	256 (61.4)	<0.001
	Slight	130 (31.2)	106 (25.4)	
	Moderate	63 (15.1)	41 (9.8)	
	Severe	13 (3.1)	13 (3.1)	
	Unable	2 (0.5)	1 (0.2)	
Pain/discomfort	No problem	97 (23.3)	137 (32.9)	<0.001
	Slight	161 (38.6)	158 (37.9)	
	Moderate	120 (28.8)	87 (20.9)	
	Severe	35 (8.4)	33 (7.9)	
	Unable	4 (1.0)	2 (0.5)	
Anxiety/Depression	No problem	219 (52.5)	255 (61.2)	<0.001
	Slight	125 (30.0)	110 (26.4)	
	Moderate	62 (14.9)	37 (8.9)	
	Severe	8 (1.9)	10 (2.4)	
	Unable	3 (0.7)	5 (1.2)	

\*p-values obtained from Monte Carlo method.

#### ***Predictors of change in EQ-5D-5L scores over 12 months***

Findings of the multivariable linear regression analyses showing significant predictors of EQ-5D scores at 12 months are presented in Table 5. In Model 1, higher baseline EQ-5D-5L score was significantly positively associated with follow-up EQ-5D-5L scores ( $\beta=0.60$ ; 95% CI 0.52 to 0.67 at  $p<0.001$ ). In addition, a positive diagnosis of respiratory disease was significantly negatively associated with EQ-5D-5L scores at 12 months compared to those without respiratory disease ( $\beta= -0.03$ ; 85% CI -0.06 to -0.01 at  $p=0.034$ ). Consistent with Model 1, the imputed model showed similar trends in the regression slope in relation to baseline EQ-5D-5L scores and positive diagnosis of respiratory disease. In addition, lack of PHI was also significantly negatively associated with EQ-5D-5L scores at 12 months ( $\beta= -0.03$ ; 85% CI -0.05 to -0.01 at  $p=0.024$ ).

#### ***Changes in KOOS and HOOS assessment at follow-up***

Of the 97 patients with diagnosis of osteoarthritis, 55 reported KOOS outcomes and 30 reported HOOS outcomes at baseline and follow-up. There were significant improvements across all subscales of both the KOOS and HOOS assessments. Specifically, the pain and symptom scores in both scales met statistical significance in addition to meeting the MCID (Table 4).

**Table 4. Adjusted mean differences in HOOS and KOOS assessment (short version) at baseline and follow-up**

Variables	Baseline Mean (SD)	Follow-up Mean (SD)	Adjusted mean difference <sup>†</sup> (95% CI)	P value
<b>scales (N=55)</b>				
pain score	65.0 (21.7)	76.2 (22.0)	10.6 (3.1, 18.2)	0.05
function score	62.5 (24.8)	69.8 (25.7)	6.5 (-1.6, 14.6)	0.114
symptom score	63.1 (17.8)	70.7 (18.7)	7.2 (1.2, 13.1)	0.019
stiffness score	61.8 (27.9)	68.2 (26.1)	7.0 (-1.1, 15.1)	0.090
<b>scales (N=30)</b>				
pain score	65.0 (23.1)	77.5 (25.1)	11.6 (3.2, 20.0)	0.008
function score	71.7 (17.8)	81.2 (20.4)	8.6 (1.1, 16.1)	0.026
symptom score	67.6 (16.6)	78.5 (19.6)	10.3 (3.7, 16.8)	0.003

Table 5. Multivariate linear regression analyses showing predictors of quality of life at 12-month follow-up using post EQ-5D-5L value (main and imputed model)

Predictors	Main model (N=417)		Imputed model (N=616)	
	β (95%CI)	p-value	β (95%CI)	p-value
Baseline EQ-5D-5L score	0.60 (0.52, 0.67)	<0.001	0.55 (0.50, 0.60)	<0.001
Respiratory disease: Yes	-0.03 (-0.06, -0.01)	0.034	-0.03 (-0.05, -0.01)	0.004
Insurance status: Uninsured	NS		-0.03 (-0.05, -0.01)	0.024

β - unstandardized beta coefficient (slope)

## Discussion

To our knowledge, WellNet study is the first study to evaluate the changes in HRQoL among patients with one or more chronic conditions in Australian primary care settings based on the principles of PCMH model. Findings of this study are consistent with the growing body of evidence showing strong association between patients' HRQoL and several core elements of the PCMH such as involvement of a MDT [39, 40], continuity of care [41, 42], and shared decision making and patient-provider communication [22, 23]. Previous Australian studies by McCaffrey et al [24] and others [43] have reported on health utilities and HRQoL on the general population norms using cross-sectional data. However, studies reporting on the disease-specific, high risk sub-group population using GP data are relatively less, which is of interest, as primary care is the forefront of care delivery in Australia with at least 85% of Australians consulting a GP every year [3]. In view of this, the WellNet study is novel as it closely examines the outcome of integrating care delivery on HRQoL at two different time points whilst determining predictors of change using GP data.

In this study, the use of EuroQol EQ-5D-5L over other instruments owes to its simplicity in accruing several aspects of an individual's self-perceived health status in a relatively short duration through use of a short 5-item questionnaire [44]. Moreover, the EQ-5D-5L has also been reported as one of the sensitive instruments in terms of better discriminative power in effectively detecting changes in the HRQoL [45]. In addition, it is reported to have better known-group validity where subjective patient scores are shown to be in accordance with the objective investigator findings of changes in the HRQoL [46].

For studies measuring the impact of treatment outcome/s, the minimal clinically important difference (MCID) reports on the smallest change in the outcome of interest that is considered to be clinically significant or meaningful [47]. A comprehensive review of 18 studies by Coretti et al [48] estimated the overall MCID for EQ-5D range to be between 0.03 and 0.54. In view of this, findings of our study showed both statistical significance whilst also meeting the bare minimal threshold of clinical significance in EQ-5D index scores after adjusting for baseline covariates. However, considering that our sample is chronically ill with many patients having multiple diseases, MCID may not even be a significant indicator on population level. In this population, we would typically expect that many patients would have progressed in their disease, so even small change or no change in the EQ5D scale may be a positive outcome for the program. The effectiveness of PCMH model on improving patients' HRQoL is consistent with studies by Schuttner et al [13] and Hynes et al [14].

Of the five dimensions of EQ-5D, WellNet patients reported substantial improvement particularly on two domains of pain/discomfort and usual activities in terms of a 33% and 28% increase, respectively, in the 'no problem' level at follow-up. This could be attributed to the primary objective of the WellNet program in improving self-management behaviour among patients to effectively manage symptoms associated with their chronic conditions [27]. Improved self-management behaviours are strongly associated with improved HRQoL [49, 50].

Findings of the multivariable regression models (Model 1 and 2) show that higher baseline index value and positive diagnosis of respiratory disease were significantly associated with EQ-5D index at 12 months. Higher baseline EQ-5D index value as significant predictor of increased follow-up index scores is consistent with other study findings by Van Eck et al [38]. This could be because patients who already reported better HRQoL at baseline benefitted through further patient education and self-management from the WellNet care team.

A positive history of respiratory disease was negatively associated with HRQoL at follow-up compared to those without prior respiratory disease. The poor HRQoL reported among patients with respiratory disease due to several reasons of duration and severity of the condition supplemented with or without harmful lifestyle behaviours is well documented [51, 52]. Furthermore, lack of PHI was associated with poor HRQoL at follow-up in the imputed model. This could be because patients without PHI coverage are less likely to receive appropriate and timely care leading to poor health outcomes and subsequently poor HRQoL [53, 54].

KOOS and HOOS assessments were recorded in parallel with EQ5D instrument in the WellNet study. Changes in the KOOS and HOOS scores were supplemented with the primary outcome of EQ5D changes. Besides statistical significance, the scores also met the MCID rendering them clinically relevant for changes in the patient management. The favourable changes in this study is consistent with findings of other studies of collaborative care [55, 56].

Our study has several strengths and limitations. This is the first study in Australia to evaluate the outcome of a PCMH model on HRQoL among patients in primary care setting. The study includes an effectively targeted sample with longitudinal measurements at two different time intervals enabling determining predictors of change in the HRQoL scores. This study also adds to the relatively less than adequate research conducted using GP-data. Although the aim of this study was to evaluate changes in HRQoL after the 12-month WellNet intervention, this study was not designed as an effectiveness study, but rather as a proof-of-concept study.

In regard to study limitations, although WellNet program comprises an effectively matched comparison group, the EuroQol EQ-5D-5L was recorded only among treatment group, thereby limiting to within-group analysis. The lack of control group means that the possibility of potential bias cannot be excluded, and we cannot be sure that improvement in EQ5D scores may have occurred anyway without the enhanced PCMH intervention. However, that seems unlikely based on research conducted with use of control groups reporting similar outcomes [57, 58]. Additionally, some key socio-economic variables such as annual income were unavailable due to privacy concerns, which may also have impacted prediction of the index scores over time. With exception of HOOS and KOOS surveys, we did not have other validated instruments to determine HRQoL in parallel with the EQ-5D-5L instrument, which could have further increased the reliability of the findings. Finally, consistent with other originally designed programs, reproducibility of findings is constrained by potential barriers in the form of uniqueness of data and by patient and provider-level determinants [27, 59].

## Conclusion

Evaluating the HRQoL for patients with chronic illness enables understanding of patient's insights and perception on where care needs to be directed in relation to their condition. The integration of GPs and trained CDM coordinators proves critical for provision of individualised care for patients presenting with multiple chronic conditions. This study demonstrates outcome of integrating care delivery on HRQoL at two different time points whilst determining predictors of change using GP data. Besides statistical significance, patients also met the MCID rendering them clinically relevant for change in patient management. Future research should seek to evaluate the sustained effects and cost-benefits of the WellNet program.

## List Of Abbreviations

ANCOVA: Analysis of covariance

BMI: Body mass index

CC: Clinical coordinator

CDM: Chronic disease management

CI: Confidence interval

CVD: Cardiovascular disease

EQ-5D-5L: EuroQol Five Dimensions Five Levels

FCS: Fully conditional specification

GP: General practitioner

HOS: Health Omnibus Survey

HOOS: Hip disability and osteoarthritis outcome scores

HRQoL: Health-related quality of life

KOOS: Knee injury and Osteoarthritis Outcome Scores

MCID: Minimal clinically important difference

MCMC: Markov Chain Monte Carlo

MDT: Multidisciplinary team

NSW: New South Wales

PCMH: Patient Centred Medical Home

PHI: Private health insurance

PROMS: patient reported outcome measures

SCS: Sonic Clinical Services

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

## Declarations

**Ethical considerations:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was reviewed by the Western Sydney University Human Research Ethics Committee (REDI Reference: H12215).

**Informed consent:** Informed consent was obtained from all individual participants included in the study.

**Consent for publication:** Not applicable

**Availability of data and material:** WellNet data may not be available to the general public for security reasons.

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**Conflict of interest:** JRJ and KT have no competing interests. AJ is employed by SCS as the Operational Manager Integrated Care and is responsible for the implementation of WellNet. However, SCS and WellNet partners had no control or influence over the decision to submit the final manuscript for publication.

**Author's contributions:** AJ was responsible for program administration and contributed to data acquisition; JRJ, WKT, and AJ contributed to methodology; Data curation and formal data analysis was performed by JRJ; JRJ was responsible for writing the original draft preparation; All authors have read and agreed to the submitted version of the manuscript.

## References

1. van Oostrom SH, Gijzen R, Stirbu I, Korevaar JC, Schellevis FG, Picavet HSJ, Hoeymans N: Time trends in prevalence of chronic diseases and multimorbidity not only due to aging: data from general practices and health surveys. *PLoS one*. 2016;11:e0160264.
2. Harrison C, Britt H, Miller G, Henderson J: Prevalence of chronic conditions in Australia. *PLoS one*. 2013;8:e67494.
3. Australian Institute of Health and Welfare: Australia's health 2018. AIHW. Canberra; 2018. <https://www.aihw.gov.au/getmedia/fe037cf1-0cd0-4663-a8c0-67cd09b1f30c/aihw-aus-222.pdf.aspx?inline=true> Accessed 21 Jan 2020.
4. Australian Bureau of Statistics: Causes of Death, Australia, 2017. <https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/3303.0~2017~Main%20Features~Australia's%20leading%20causes%20of%20death>, Accessed 23 Jan 2020.
5. Garin N, Koyanagi A, Chatterji S, Tyrovolas S, Olaya B, Leonardi M, Lara E, Koskinen S, Tobiasz-Adamczyk B, Ayuso-Mateos JL: Global multimorbidity patterns: a cross-sectional, population-based, multi-country study. *J Gerontol A-Biol*. 2015;71:205-214.
6. Hay SI, Abajobir AA, Abate KH, Abbafati C, Abbas KM, Abd-Allah F, Abdulkader RS, Abdulle AM, Abebo TA, Abera SF: Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet*. 2017;390:1260-1344.
7. Gallacher KI, McQueenie R, Nicholl B, Jani BD, Lee D, Mair FS: Risk factors and mortality associated with multimorbidity in people with stroke or transient ischaemic attack: a study of 8,751 UK Biobank participants. *JOC*. 2018;8:1-8.
8. Vyas A, Pan X, Sambamoorthi U: Chronic condition clusters and polypharmacy among adults. *Intern J Family Med*. 2012;193168
9. Marengoni A, Angleman S, Melis R, Mangialasche F, Karp A, Garmen A, Meinow B, Fratiglioni L: Aging with multimorbidity: a systematic review of the literature. *Ageing Res Rev*. 2011;10:430-439.

10. Fortin M, Lapointe L, Hudon C, Vanasse A, Ntetu AL, Maltais D: Multimorbidity and quality of life in primary care: a systematic review. *Health Qual Life Outcomes*. 2004;2:51.
11. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B: Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet*. 2012;380:37-43.
12. Salisbury C, Johnson L, Purdy S, Valderas JM, Montgomery AA: Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. *Br J Gen Pract*. 2011;61:e12-e21.
13. Schuttner L, Reddy A, Rosland A-M, Nelson K, Wong ES: Association of the Implementation of the Patient-Centered Medical Home with Quality of Life in Patients with Multimorbidity. *J Gen Intern Med*. 2020;35:119-125.
14. Hynes DM, Fischer M, Fitzgibbon M, Porter AC, Berbaum M, Schiffer L, Chukwudozie IB, Nguyen H, Arruda J: Integrating a medical home in an outpatient dialysis setting: effects on health-related quality of life. *J Gen Intern Med*. 2019;34:2130-2140.
15. Bowling A, Banister D, Sutton S, Evans O, Windsor J: A multidimensional model of the quality of life in older age. *Aging Ment Health*. 2002;6:355-371.
16. Asadi-Lari M, Tamburini M, Gray D: Patients' needs, satisfaction, and health related quality of life: towards a comprehensive model. *Health Qual Life Outcomes*. 2004;2:32.
17. Guyatt GH, Feeny DH, Patrick DL: Measuring health-related quality of life. *Ann Intern Med*. 1993;118:622-629.
18. Karimi M, Brazier J: Health, health-related quality of life, and quality of life: what is the difference? *Pharmacoeconomics*. 2016;34:645-649.
19. Higginson IJ, Carr AJ: Using quality of life measures in the clinical setting. *BMJ*. 2001;322:1297-1300.
20. Greenhalgh J, Gooding K, Gibbons E, Dalkin S, Wright J, Valderas J, Black N: How do patient reported outcome measures (PROMs) support clinician-patient communication and patient care? A realist synthesis. *JPRO*. 2018;2:42.
21. Jonkman NH, Schuurmans MJ, Groenwold RH, Hoes AW, Trappenburg JC: Identifying components of self-management interventions that improve health-related quality of life in chronically ill patients: Systematic review and meta-regression analysis. *Patient Educ Couns*. 2016;99:1087-1098.
22. Lim J-w, Paek M-s: The relationship between communication and health-related quality of life in survivorship care for Chinese-American and Korean-American breast cancer survivors. *Support Care Cancer*. 2013;21:1157-1166.
23. Detmar SB, Muller MJ, Schornagel JH, Wever LD, Aaronson NK: Health-related quality-of-life assessments and patient-physician communication: a randomized controlled trial. *JAMA*. 2002;288:3027-3034.
24. McCaffrey N, Kaambwa B, Currow DC, Ratcliffe J: Health-related quality of life measured using the EQ-5D-5L: South Australian population norms. *Health Qual Life Outcomes*. 2016;14:133.
25. Up Study Collaborators. Cohort profile: the 45 and up study. *Int J Epidemiol*. 2007; 37:941-947.
26. Atlantis E, Goldney RD, Eckert KA, Taylor AW, Phillips P: Trends in health-related quality of life and health service use associated with comorbid diabetes and major depression in South Australia, 1998-2008. *Soc Psych Psych Epid*. 2012;47:871-877.
27. John JR, Jones A, Neville AM, Ghassempour S, Girosi F, Tannous WK: Cohort Profile: Effectiveness of a 12-Month Patient-Centred Medical Home Model versus standard care for chronic disease management among primary care patients in Sydney, Australia. *Int J Environ Res Public Health*. 2020;17:2164.
28. Sedgwick P: Convenience sampling. *BMJ*. 2013;347:f6304.
29. Devlin NJ, Shah KK, Feng Y, Mulhern B, van Hout B: Valuing health-related quality of life: An EQ-5 D-5 L value set for England. *Health Econ*. 2018;27:7-22.
30. Oppe M, Devlin NJ, van Hout B, Krabbe PF, de Charro F: A program of methodological research to arrive at the new international EQ-5D-5L valuation protocol. *Value Health*. 2014;17:445-453.
31. Lyman S, Lee Y-Y, Franklin PD, Li W, Cross MB, Padgett DE: Validation of the KOOS, JR: a short-form knee arthroplasty outcomes survey. *Clin Orthop Relat Res*. 2016;474:1461-1471.
32. Lyman S, Lee Y-Y, Franklin PD, Li W, Mayman DJ, Padgett DE: Validation of the HOOS, JR: a short-form hip replacement survey. *Clin Orthop Relat Res*. 2016; 474:1472-1482.
33. Nilsson A, Bremander A: Measures of hip function and symptoms: Harris hip score (HHS), hip disability and osteoarthritis outcome score (HOOS), Oxford hip score (OHS), Lequesne index of severity for osteoarthritis of the hip (LISOH), and American Academy of orthopedic surgeons (AAOS) hip and knee questionnaire. *Arthritis Care Res*. 2011;63(S11):S200-S207.
34. Roos EM, Lohmander LS: The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. *Health Qual Life Outcomes*. 2003;1(1):1-8.
35. Spratt M, Carpenter J, Sterne JA, Carlin JB, Heron J, Henderson J, Tilling K: Strategies for multiple imputation in longitudinal studies. *Am J Epidemiol*. 2010;172:478-487.
36. Schafer JL: Analysis of incomplete multivariate data: CRC press; 1997.
37. Bland JM, Altman DG: Regression towards the mean. *BMJ*. 1994;308:1499.
38. van Eck JM, van Hemel NM, van den Bos A, Taks W, Grobbee DE, Moons KG: Predictors of improved quality of life 1 year after pacemaker implantation. *Am Heart J*. 2008;156:491-497.
39. Hogg W, Lemelin J, Dahrouge S, Liddy C, Armstrong CD, Legault F, Dalziel B, Zhang W: Randomized controlled trial of anticipatory and preventive multidisciplinary team care: for complex patients in a community-based primary care setting. *Can Fam Physician*. 2009;55:e76-e85.
40. Raz DJ, Sun V, Kim JY, Williams AC, Koczywas M, Cristea M, Reckamp K, Hayter J, Tiep B, Ferrell B: Long-term effect of an interdisciplinary supportive care intervention for lung cancer survivors after surgical procedures. *Ann Thorac Cardiovasc Surg*. 2016;101:495-503.
41. Nelson K, Sylling PW, Taylor L, Rose D, Mori A, Fihn SD: Clinical quality and the patient-centered medical home. *JAMA Intern Med*. 2017;177:1042-1044.

42. Reddy A, Pollack CE, Asch DA, Canamucio A, Werner RM: The effect of primary care provider turnover on patient experience of care and ambulatory quality of care. *JAMA Intern Med.* 2015;175:1157-1162.
43. Banham D, Hawthorne G, Goldney R, Ratcliffe J: Health-related quality of life (HRQoL) changes in South Australia: comparison of burden of disease morbidity and survey-based health utility estimates. *Health Qual Life Outcomes.* 2014;12:113.
44. Feng Y, Devlin N, Herdman M: Assessing the health of the general population in England: how do the three-and five-level versions of EQ-5D compare? *Health Qual Life Outcomes.* 2015;13:171.
45. Alvarez JA, Rezende K, Marocho SMS, Alves FB, Celiberti P, Ciamponi AL: Dental fluorosis: exposure, prevention and management. *J Clin Exp Dent.* 2009;1:14-18.
46. Janssen M, Pickard AS, Golicki D, Gudex C, Niewada M, Scalone L, Swinburn P, Busschbach J: Measurement properties of the EQ-5D-5L compared to the EQ-5D-3L across eight patient groups: a multi-country study. *Qual Life Res.* 2013;22:1717-1727.
47. Barrett B, Brown D, Mundt M, Brown R: Sufficiently important difference: expanding the framework of clinical significance. *Med Decis Making.* 2005;25:250-261.
48. Coretti S, Ruggeri M, McNamee P: The minimum clinically important difference for EQ-5D index: a critical review. *Expert Rev Pharm Out.* 2014;14:221-233.
49. Tickle-Degnen L, Ellis T, Saint-Hilaire MH, Thomas CA, Wagenaar RC: Self-management rehabilitation and health-related quality of life in Parkinson's disease: A randomized controlled trial. *Mov Disord.* 2010;25:194-204.
50. Joekes K, Van Elderen T, Schreurs K: Self-efficacy and overprotection are related to quality of life, psychological well-being and self-management in cardiac patients. *J Health Psychol.* 2007;12:4-16.
51. Zamzam MA, Azab NY, El Wahsh RA, Ragab AZ, Allam EM: Quality of life in COPD patients. *Egyptian Journal of Chest Diseases and Tuberculosis.* 2012;61:281-289.
52. Ahmed MS, Neyaz A, Aslami AN: Health-related quality of life of chronic obstructive pulmonary disease patients: Results from a community based cross-sectional study in Aligarh, Uttar Pradesh, India. *Lung India.* 2016;33:148.
53. Levy H, Meltzer D: The impact of health insurance on health. *Annu Rev Public Health.* 2008;29:399-409.
54. Duckett SJ: Private care and public waiting. *Aust Health Rev.* 2005;29:87-93.
55. Fernandes L, Roos EM, Overgaard S, Villadsen A, Sogaard R: Supervised neuromuscular exercise prior to hip and knee replacement: 12-month clinical effect and cost-utility analysis alongside a randomised controlled trial. *BMC Musculoskelet Disord.* 2017;18:5.
56. Voorn VM, Vermeulen HM, Nelissen RG, Kloppenburg M, Huizinga TW, Leijerzapf NA, Kroon HM, Vlieland TPV, van der Linden HM: An innovative care model coordinated by a physical therapist and nurse practitioner for osteoarthritis of the hip and knee in specialist care: a prospective study. *Rheumatol Int.* 2013;33:1821-1828.
57. Casañas R, Catalán R, Del Val JL, Real J, Valero S, Casas M: Effectiveness of a psycho-educational group program for major depression in primary care: a randomized controlled trial. *BMC Psychiatry.* 2012;12:230.
58. Kessler D, Lewis G, Kaur S, Wiles N, King M, Weich S, Sharp DJ, Araya R, Hollinghurst S, Peters TJ: Therapist-delivered Internet psychotherapy for depression in primary care: a randomised controlled trial. *Lancet.* 2009;374:628-634.
59. John JR, Tannous WK, Jones A. Effectiveness of a patient-centered medical home model of primary care versus standard care on blood pressure outcomes among hypertensive patients. *Hypertens Res.* 2020;1:1-1.

## Figures

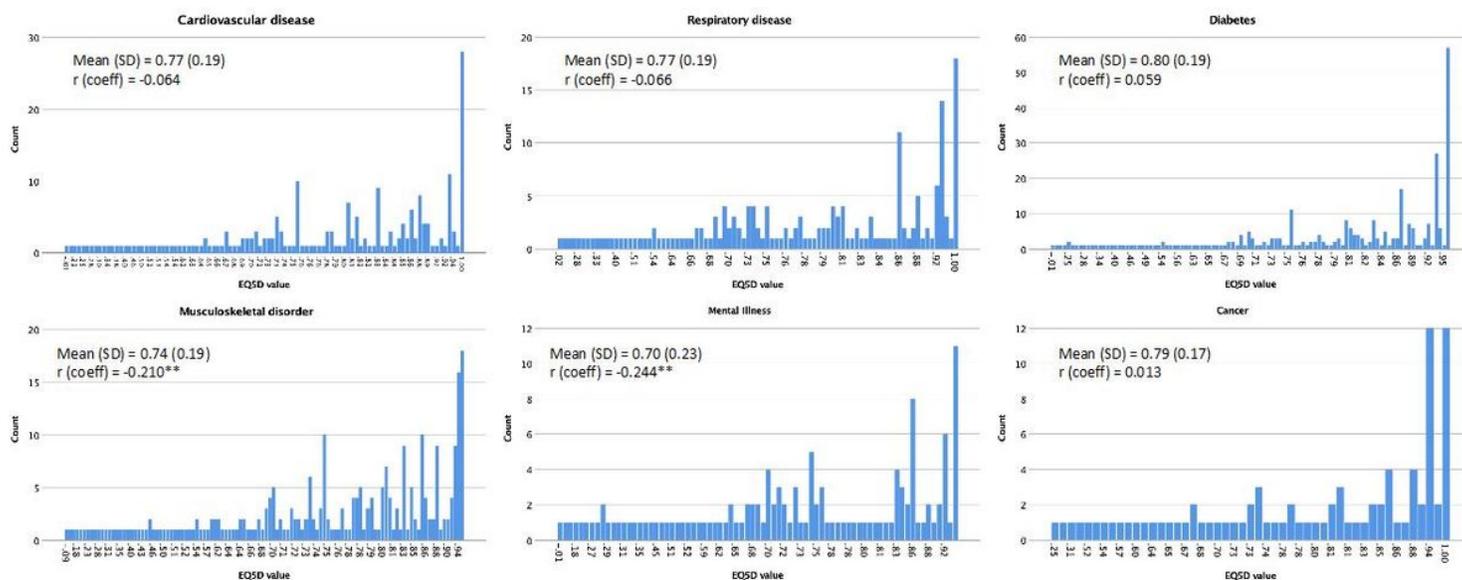


Figure 1

Distribution of baseline EQ5D index value by type of chronic condition  $r$  (coeff) - Pearson's product-movement correlation coefficient SD - Standard Deviation  
\*\*Significant at  $p < 0.01$  (two-tailed)

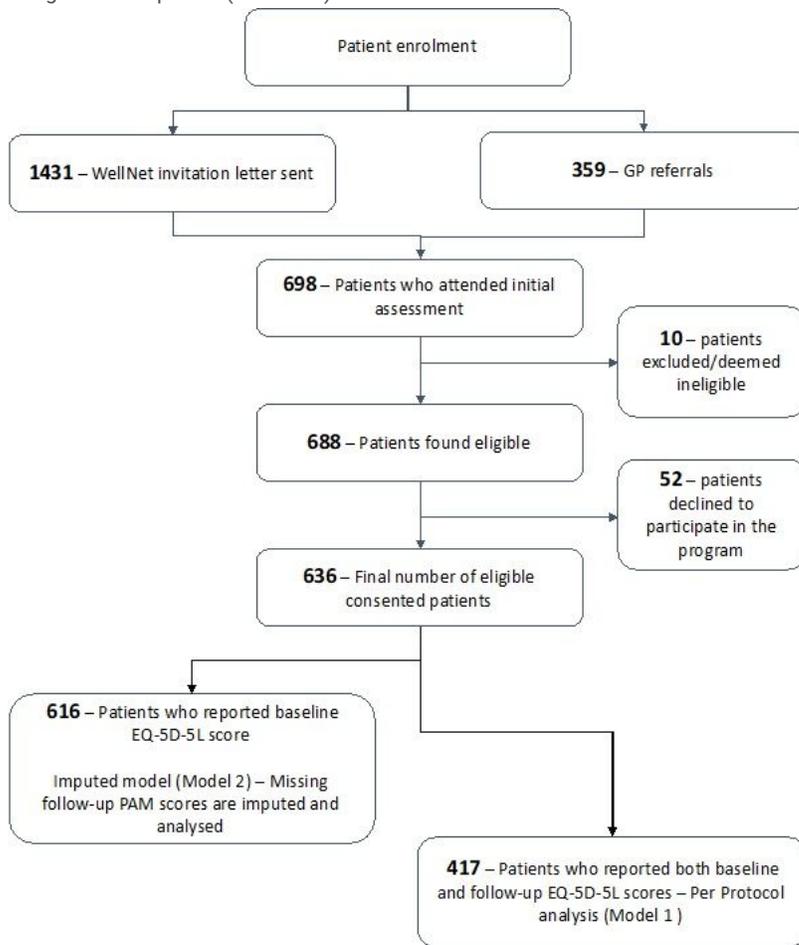


Figure 2

Flowchart of patient participation.