

The effectiveness of patient-centred medical home-based models of care versus standard primary care in chronic disease management: a systematic review and meta-analysis of randomised and non-randomised controlled trials

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Abstract

Background

Patient-centred care by a coordinated primary care team may be more effective than standard care in chronic disease management. We synthesised evidence to determine whether patient-centred medical home (PCMH)-based care models are more effective than standard general practitioner (GP) care in improving clinical, hospital, and economic outcomes.

Methods

MEDLINE, CINAHL, Embase, Cochrane Library, and Scopus were searched to identify randomised (RCTs) and non-randomised controlled trials that evaluated two or more principles of PCMH among primary care patients with chronic diseases. Study selection, data extraction, quality assessment using Joanna Briggs Institute (JBI) appraisal tools, and grading of evidence using Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach were conducted independently. A quantitative synthesis, where possible, was pooled using random effects models and the effect size estimates of standardised mean differences (SMDs) and odds ratios (ORs) with 95% confidence intervals were reported.

Results

Of the 13820 citations, we identified 78 eligible RCTs and 7 quasi trials which included 60617 patients. The findings suggested that PCMH-based care was associated with significant improvements in depression episodes (SMD - 0.24; 95% CI -0.35, -0.14) and increased odds of remission (OR 1.79; 95% CI 1.46, 2.21). There were significant improvements in the health-related quality of life (SMD 0.10; 95% CI 0.04, 0.15); self-management outcomes (SMD 0.24; 95% CI 0.03, 0.44) and hospital admissions (OR 0.83; 95% CI 0.70, 0.98). In terms of clinical outcomes, with exception to total cholesterol, PCMH-based care led to significant improvements in blood pressure, glycated haemoglobin, and low-density lipoprotein cholesterol outcomes. The incremental cost of PCMH care was identified to be small and significantly higher than standard care (SMD 0.17; 95% CI 0.08, 0.26). The quality of individual studies ranged from 'fair' to 'good' by meeting at least 60% of items on the quality appraisal checklist. Additionally, moderate to high heterogeneity across studies in outcomes resulted in downgrading the included studies as moderate or low grade of evidence.

Conclusion

PCMH-based care has been found to be superior to standard GP care in chronic disease management. Results of the review have important implications that may inform patient, practice, and policy-level changes.

Background

Chronic diseases have contributed to increased mortality and morbidity worldwide with the disease burden accelerating across both developed and developing nations [1, 2]. The Global Burden of Diseases (GBD) Study in 2017 reported that chronic diseases accounted for 41% of increased disability and 73% of all deaths [1, 2]. Moreover, with increasing life expectancy and ageing population, the global prevalence of multiple chronic conditions or multimorbidity is also on the rise, further exacerbating complications in quality and delivery of care [3, 4]. As a result, patients with one or more chronic diseases often experience poor mental and physical functioning with increased psychological distress affecting their overall health-related quality of life (HRQoL) [5, 6]. Besides negative health outcomes, chronic diseases also contribute to significant economic ramifications to both patients and health care system in the form of increased health care utilisation and costs of care [7, 8].

The long-term nature of chronic diseases and complexities of care require health care systems, worldwide, to revisit guidelines on effective chronic disease management [7]. The health and economic repercussions of chronic diseases are partly connected to the fragmented design and delivery of health care systems to focus on 'single disease framework' as opposed to a 'whole-person

approach' [9]. However, there has been an increasing advocacy towards shift from a reactive health care system to one that is proactive, enabling an integrated systems approach towards chronic disease management [10]. In view of this, the World Health Organisation (WHO) and other leading organisations have acknowledged the importance of primary care as an ideal setting to facilitate patient-centred care, which could result in better patient outcomes [11, 12]. There is a large body of evidence suggesting that coordinated team-based approaches in primary care are effective in chronic disease management [13, 14].

The patient-centred medical home (PCMH) model is one of the chronic care models (CCM) that has reportedly shown to provide a multidimensional solution to effectively managing chronic illness and multimorbidity in primary care [15]. This enhanced primary care model typically consists of a general practitioner (GP)-led care, as part of a multidisciplinary team (MDT) that aims to provide patient-centred care that is also comprehensive and coordinated, with emphasis on self-management and patient education [12]. There is a growing body of literature, particularly in United States and several parts of United Kingdom and other European countries, reporting the effectiveness of PCMH care models in improving clinical [16, 17], HRQoL [18, 19], hospital [20, 21], and economic outcomes [22] compared to standard GP care.

A comprehensive systematic review and meta-analysis of PCMH care published in 2013 [23] reported improvements in patient experiences and some reduction in health utilisation among patients with multimorbidity. However, the effect of PCMH models on patients with single-disease care management was not reviewed. Whilst the review focuses on clinical quality and processes of care, there was insufficient evidence to estimate clinical outcomes and quality of life. In addition, the review also included patients from non-primary care settings such as tertiary care hospitals, thereby limiting understanding of the true effectiveness of PCMH model in primary care settings. The current review was warranted as there has been increased advocacy for PCMH-based care models resulting in a number of new studies evaluating PCMH models being published since 2013 [18–21].

A systematic review and meta-analysis was conducted to assess the effectiveness of PCMH-based models of care when compared to standard GP care in improving clinical, hospital, and economic outcomes of primary care patients with one or more chronic diseases. The findings of this review may help inform guidelines and practices.

Methods

This review conformed to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [24]. The systematic review protocol (CRD42018085378), registered in the International Prospective Register of Systematic Reviews (PROSPERO) database, has been published elsewhere [25].

Search strategy

We conducted literature searches on electronic databases like MEDLINE, CINAHL, Embase, Cochrane library, and Scopus from inception until March 31, 2020. The search strategy and syntaxes were developed in collaboration with an experienced university librarian. The syntax explored a broad range of terms used in definitions of PCMH, collaborative care, chronic care models, RCTs, and Quasi trials (full electronic search strings are listed in Appendix 1). We supplemented electronic searches by hand-searching bibliographies of several key systematic reviews [23, 26–28] and retrieved studies to identify any relevant articles missed by the search strategy. Endnote (Version X9, Thompson Reuters, New York) software was used for reference management.

Eligibility criteria and study selection

A detailed inclusion and exclusion criteria for this review is reported elsewhere [25]. A summary of Population, Interventions, Comparators, Outcomes, and Study designs (PICOS) framework is presented in Fig. 1. Two reviewers (JRJ and KP) independently screened the titles and abstracts of all articles for eligibility. Following the title and abstract screening, a full text screening was conducted on articles which passed the title and abstract screening by two reviewers (JRJ and HJ) independently. Discrepancies were resolved and clarified through discussion.

Data extraction

Data extraction of included articles was carried out independently by two reviewers (JRJ and HJ) using Excel spreadsheet (Microsoft Excel, Microsoft Corporation). Data extracted from included articles included key characteristics: first author and

publication year; country of origin; sample size, age and gender distribution; chronic disease profile; baseline characteristics reported as mean (SD) or proportions; PCMH components implemented; duration of follow-up; and outcomes. Whilst data extraction was performed using a customised spreadsheet, the Centre for Reviews and Dissemination's (CRD) guidance for undertaking reviews in health care was followed [29]. Authors of studies with missing data were contacted by email up to two times, however, no response was received.

Quality assessment and Risk of bias

Two reviewers (JRJ and HJ) independently evaluated the methodological validity of included articles using relevant Joanna Briggs Institute (JBI) critical appraisal checklists (RCTs, quasi trials, and economic evaluations) [30, 31]. Quality of studies were rated as good (≥ 8), fair (6–7), or poor (≤ 5) based on the summary scores. We also used Risk of Bias In Non-randomised Studies of Interventions (ROBINS-I) tool to supplement JBI appraisal for non-randomised trials [32]. Additionally, the quality of evidence across included studies reporting similar outcomes was determined by applying the Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria [33].

Outcomes

Outcomes identified from the studies include changes in mean differences or proportion of patients achieving recommended levels in:

- 1) Biomedical outcomes – blood pressure (BP); glycated haemoglobin (HbA1c); low density lipoprotein cholesterol (LDL-C); high density lipoprotein cholesterol (HDL-C); and serum total cholesterol.
- 2) Self-reported health assessments (using validated questionnaires) – depression; HRQoL (overall, mental and physical functioning components); and self-management.
- 3) Health utilisation outcomes – hospital admissions; emergency department visits; and medications use.
- 4) Economic outcomes – total health care costs and incremental cost-effectiveness.

Data analysis

Data of included studies were pooled together using the inverse-variance method of random-effects meta-analysis [34]. Standardised mean differences (SMD) for continuous data and odds ratios (ORs) for dichotomous data, with 95% confidence intervals (CI), were calculated and graphically presented as forest plots. Statistical heterogeneity was calculated using I^2 and Cochran's Q statistics. Subgroup analyses were considered for outcomes with substantial heterogeneity ($I^2 \geq 85\%$). Publication bias for outcomes with at least 6 studies was assessed using funnel plots and Egger's test of asymmetry [35]. All analyses were conducted using RevMan version 5.3 and R version 4.0 software.

Results

Literature search

The electronic database search resulted in 13820 citations and an additional 16 citations from hand searching key systematic reviews. After exclusion of duplicate records, 6416 articles were screened by titles and abstracts with 201 articles determined to be eligible for full-text assessment. Of these, 85 studies met the eligibility criteria and were included in our systematic review. Flowchart of the selection process from initial identification to inclusion is shown in Fig. 2. Main reasons for exclusion included patients treated in non-primary care settings, not meeting minimum PCMH components or focused on intervention other than PCMH model, lack of control group, and other reasons (list of excluded articles; see Appendix 2).

Descriptive data synthesis

The characteristics of included studies are presented in Appendix 3–4. Of the 85 studies included in the review, 78 studies were RCTs [13, 14, 16, 18–20, 22, 36–106] and 7 studies were of non-RCTs, including quasi trials [17, 21, 107, 108] or cohort studies

with a control group [109–111]. The 85 studies enrolled a total of 60617 patients with sample sizes ranging from 40 to 8366. Whilst 79 studies had sufficient data for quantitative data synthesis, 6 studies [81, 85, 95, 97, 103, 107] did not have usable data and therefore, the findings were narratively summarised.

The common inclusion criteria for all 85 studies was primary care patients with diagnosis of one or more chronic conditions, whereas the predominant reason for exclusion was patients with cognitive impairment and terminal illness. More than half the studies (52%) were conducted in the United States. The mean age of patients ranged between 30 and 83 years. In terms of gender distribution, most studies had a slight female predilection except for studies conducted in Veterans Affairs (VA) primary care settings [16, 50, 52, 53, 56]. The duration of follow-up varied from 3 to 48 months.

Quality assessment and risk of bias

Quality assessment and risk of bias for individual studies are reported in Appendix 5–8. The overall quality of studies ranged from 'fair' to 'good' by meeting at least 60% of items on the checklist. Two studies [62, 104] were rated as poor due to general lack of information on randomisation, unclear methodology, and clarity of results. Given the nature of PCMH-based intervention, most trials employed a cluster randomisation method where a group of patients were seen by the same GP or same general practice providing PCMH care. Thereby, blinding of patients or GPs was not applicable and, as a result, items related to blinding were not necessarily graded down. However, only 32 studies reported blinding of outcome assessment whilst other studies were graded down in quality. The quality of evidence across included studies assessed using GRADE approach is presented in Tables 1–2.

Table 1

GRADE assessment of randomised controlled trials reporting effectiveness of PCMH vs standard GP care on outcomes of interest

Outcome	No of studies	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	GRADE quality of evidence ^b
Depression	30	Serious	Serious	Not serious	Not serious	Undetected	Moderate [‡]
Quality of Life	19	Serious	Not serious	Not serious	Not serious	Undetected	Moderate [‡]
Blood pressure	12	Serious	Not serious	Not serious	Not serious	Undetected	Moderate [‡]
Glycated Hemoglobin	8	Serious	Serious	Not serious	Not serious	Undetected	Low ^{‡¶}
LDL Cholesterol	3	Serious	Serious	Not serious	Not serious	Undetected	Low ^{‡¶}
Total Cholesterol	1	Serious	-	Not serious	Not serious	Undetected	Low ^{‡^}
Hospital admissions	3	Serious	Not serious	Not serious	Not serious	Undetected	Moderate [‡]
Self-management (PACIC scores)	3	Serious	Serious	Not serious	Not serious	Undetected	Low ^{‡¶}
Cost-effectiveness	18	Serious	Serious	Not serious	Not serious	Undetected	Low ^{‡¶}
^b High quality: Further research is very unlikely to change our confidence in the estimate of effect; Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate; Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate; Very low quality: We are very uncertain about the estimate.							
[‡] Most studies did not blind participants or personnel as it was not practical. Therefore, we did not downgrade for these risks/uncertainties. However studies not reporting blinding of outcome assessment were downgraded in quality.							
[§] Most studies did not mention allocation concealment strategies.							
[¶] Significant level of heterogeneity within results (I^2 between 80–90%)							
[^] Single study – Inconsistency not applicable							

Table 2

GRADE assessment of non-randomised studies reporting effectiveness of PCMH vs standard GP care on outcomes of interest

Outcome	No of studies	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Certainty
Depression	1	Serious	-	Not serious	Not serious	Undetected	Low ^{†‡^}
Quality of Life	2	Serious	Not serious	Not serious	Serious	Undetected	Moderate ^{†‡^}
Blood pressure	1	Serious	-	Not serious	Not serious	Undetected	Low ^{†‡^}
Glycated Hemoglobin	1	Serious	-	Not serious	Not serious	Undetected	Low ^{†‡^}
LDL Cholesterol	1	Serious	-	Not serious	Serious	Undetected	Low ^{†‡^}
HDL Cholesterol	1	Serious	-	Not serious	Not serious	Undetected	Low ^{†‡^}
Total Cholesterol	1	Serious	-	Not serious	Not serious	Undetected	Low ^{†‡^}
Hospital admissions	2	Serious	Not serious	Not serious	Not serious	Undetected	Moderate ^{†‡^}
Cost-effectiveness	1	Serious	-	Not serious	Not serious	Undetected	Low ^{†‡^}
†Because of the nature of the quasi-experimental designs risk of bias is unavoidable							
‡Most did not blind participants or personnel as it was not practical. Therefore, we did not downgrade for these risks/uncertainties. However studies not reporting blinding of outcome assessment were downgraded in quality.							
^Single study – Inconsistency not applicable							

Depression outcomes

Meta-analysis of thirty-one studies [13, 14, 18, 19, 36, 38, 40, 42, 43, 46, 50, 51, 53, 55, 57, 63, 67, 68, 70, 76, 78, 83, 84, 86–88, 91, 93, 100, 102, 109] of patients with minor or major depression episodes after PCMH-based care reported significant improvement in depression scores compared to patients with standard primary care. With the exceptions of three studies [46, 91, 102], twenty-two studies reporting changes in mean differences (continuous data) of depression scores showed significant reduction with a pooled SMD of -0.24 (95% CI -0.35, -0.14; p-value < 0.001) (Fig. 3).

Six studies reported that PCMH care was associated with significantly increased odds of remission of depression with pooled OR 1.79 (95% CI 1.46, 2.21; p-value < 0.001) (Fig. 3). Additionally, one other study [85] reported significant improvements among patients with anxiety and mood disorders with an effect size of 0.30 (95% CI 0.05, 0.55; p-value = 0.02) compared to standard care. Given most studies consistently reported improvements, the GRADE of evidence was classified as moderate quality (Tables 1 and 2).

Quality of life outcomes

Twenty-two studies [18, 19, 21, 22, 41, 46, 49–51, 53, 59, 68, 72, 76, 86, 89, 91, 100, 102, 105, 106, 108] evaluated the effectiveness of PCMH-based care on HRQoL (overall, physical component and mental component). Patients enrolled in PMCH-based care reported small but significant improvements in HRQoL compared to standard care with a pooled SMD of 0.10 (95% CI 0.04, 0.15; p-value < 0.001) (Fig. 4). Additionally, one other study [85] reported significant improvements with an effect size of 0.38 (95% CI 0.13, 0.63; p-value = 0.003). Moderate heterogeneity was observed among included studies ($I^2 = 57%$), but test for subgroup differences were not significant. The GRADE of evidence was classified as moderate quality (Tables 1 and 2).

Blood pressure outcomes

Thirteen studies [16, 17, 39, 42, 45, 61, 64, 68, 71, 82, 90, 94, 96] reported on the effect of PCMH care on blood pressure outcomes. Six studies reported that PCMH care was associated with significantly increased odds of BP control with pooled OR 2.03 (95% CI 1.56, 2.65; p-value < 0.001) (Fig. 5). Seven studies reported significant improvements in systolic blood pressure (SBP), in favour of PCMH care, with pooled estimates of SMD - 0.15 (95% CI -0.29, -0.01; p-value = 0.03). Similar reduction was observed across five studies reporting on diastolic blood pressure (DBP), but the pooled estimate of SMD - 0.12 (95% CI -0.27, 0.02; p-value = 0.09) failed to meet significance (Fig. 5). The GRADE of evidence was classified as moderate quality (Tables 1 and 2).

Glycated haemoglobin outcomes

Ten studies [16, 17, 39, 43, 64, 68, 71, 77, 82, 96] reported on the effect of PCMH care on HbA1c outcomes. Three studies reported that PCMH care was associated with increased odds of glycaemic control with pooled OR 2.37 (95% CI 0.86, 6.51; p-value = 0.100). However, the pooled estimate was not statistically significant (Fig. 6). The substantial heterogeneity of 87% in the three studies reporting ORs was due to a shorter follow-up duration of 3 months reported by Bogner et al [43] compared to the other two studies which had follow-up duration of 12 to 13 months. Seven studies reported significant improvements in HbA1c, in favour of PCMH care with pooled estimates of SMD - 0.26 (95% CI -0.43, -0.08; p-value = 0.004) (Fig. 6). Given the substantial amount of heterogeneity, the GRADE of evidence was classified as low quality (Tables 1 and 2).

Cholesterol outcomes

For LDL-cholesterol outcomes, five studies [17, 64, 68, 71, 96] reported significant improvements in favour of PCMH care with pooled SMD of -0.16 (95% CI -0.33, -0.00; p-value = 0.05) compared to standard GP care. Test for subgroup difference between follow-up and change scores showed no statistical significance ($I^2 = 16.8\%$, p-value = 0.27) (Fig. 7A). For total cholesterol outcomes, two studies [17, 82] reported a non-significant increase in total cholesterol with a pooled SMD of 0.07 (95% CI -0.08, 0.23; p-value = 0.34) (Fig. 7B). The GRADE of evidence of both LDL and total cholesterol outcomes were classified as low quality given the limited number of studies (Tables 1 and 2).

Hospital admissions

Five studies [20, 21, 48, 54, 111] reported that PCMH care was associated with significant reduction in hospital admissions compared to standard care with pooled OR 0.83 (95% CI 0.70, 0.98; p-value = 0.02) (Fig. 8). Additionally, one study [110] reported a reduction in mean hospital admission rates related to diabetic complications 12 months after PCMH based care compared to standard care. Nonetheless, the change in mean difference failed to meet statistical significance. The GRADE of evidence was classified as moderate quality (Tables 1 and 2).

Self-management outcomes

Three studies [14, 72, 89] reported significant improvements in self-management scores in favour of PCMH care compared to standard care with pooled estimates of SMD 0.24 (95% CI 0.03, 0.44; p-value < 0.001) (Fig. 9). Given the substantial amount of heterogeneity ($I^2 = 83\%$), the GRADE of evidence was classified as low quality (Tables 1 and 2).

Economic outcomes

A total of 18 studies [13, 22, 37, 44, 46, 52, 58–60, 65, 66, 69, 73, 79, 80, 92, 98, 108] reported cost-effectiveness of PCMH-based models of care compared to standard care. To avoid bias in analysis, all currencies were converted to US Dollars at the time of the respective trials and cost effectiveness was measured in terms of incremental cost of intervention. The incremental cost of PCMH care was small but significantly higher than standard care with a pooled estimate of 0.17 (95% CI 0.08, 0.26; p-value < 0.001) (Fig. 10). The substantial heterogeneity of 81% was due to higher costs of intervention reported by Bosanquet et al [46]. The GRADE of evidence was classified as low quality (Tables 1 and 2).

A summary of results from meta-analyses (where possible) and individual studies from randomised and non-randomised controlled trials are presented in Table 3.

Table 3

Summary of findings from meta-analyses (where possible) or individual studies from randomised and non-randomised controlled trials

Outcome	No of studies	No of participants	Effect size (95% CI)	p-value	Q statistic	I ²	Egger's test p-value [‡]	Citations	Figure
Randomised controlled trials									
Depression	24	7255	SMD - 0.24	< 0.001	78.3	76%	0.275	[13, 14, 18, 19, 36, 38, 40, 42, 43, 46, 50, 51, 53, 55, 57, 63, 67, 68, 70, 76, 78, 83, 84, 86-88, 91, 93, 100, 102, 109]	3
	6	1520	(-0.35, -0.14) OR 1.79 (1.46, 2.21)	< 0.001	3.58	0%	0.608		
Quality of Life	22	12370	SMD 0.12 (0.09, 0.15)	< 0.001	57.38	51%	0.556	[18, 19, 21, 22, 41, 46, 49-51, 53, 59, 68, 72, 76, 86, 89, 91, 100, 102, 105, 106, 108]	4
Blood pressure	6	1202	OR 2.03 (1.56, 2.65)	< 0.001	5.30	6%	0.347	[16, 39, 42, 45, 61, 64, 68, 71, 82, 90, 94, 96]	5
<i>BP control</i>	6	1947		0.09	8.97	44%	0.737		
<i>Systolic BP</i>	5	1836		0.10	7.82	49%	0.260		
<i>Diastolic BP</i>			SMD - 0.08 (-0.17, 0.01) SMD - 0.12 (-0.27, 0.02)						
Glycated haemoglobin	3	726	2.37 (0.86, 6.51)	0.001	15.00	87%	NA	[16, 39, 43, 64, 68, 71, 77, 82, 96]	6
<i>Glycaemic control</i>	6	2044		< 0.001	27.75	82%	0.405		
<i>HbA1c</i>			SMD - 0.21 (-0.30, -0.12)						
LDL Cholesterol	4	1086	SMD - 0.25 (-0.37, -0.13)	< 0.001	1.64	0%	NA	[64, 68, 71, 96]	7A
Total Cholesterol	1	888	SMD 0.00 (-0.13, 0.13)	1.00	NA	NA	NA	[82]	7B
Hospital admissions	3	4770	OR 0.90 (0.80, 1.03)	0.12	0.67	0%	NA	[20, 48, 54]	8

NA – not applicable

[‡]Egger's test was conducted only for outcomes with at least 6 studies.

Outcome	No of studies	No of participants	Effect size (95% CI)	p-value	Q statistic	I ²	Egger's test p-value‡	Citations	Figure
Self-management (PACIC scores)	3	2440	SMD 0.24 (0.03, 0.44)	0.02	11.48	83%	NA	[14, 72, 89]	9
Cost-effectiveness	17	12612	SMD 0.17 (0.07, 0.26)	0.001	87.84	82%	0.206	[13, 22, 37, 44, 46, 52, 58–60, 65, 66, 69, 73, 79, 80, 92, 98]	10
Non-randomised trials									
Depression	1	314	SMD – 0.22 (-0.45, 0.01)	0.06	NA	NA	NA	[109]	3
Quality of Life	2	833	SMD – 0.08 (-0.21, 0.06)	0.28	0.94	0%	NA	[22, 108]	4
Blood pressure <i>Systolic BP</i>	1	727	SMD – 0.30 (-0.45, -0.16)	< 0.001	NA	NA	NA	[17]	5
Glycated haemoglobin	1	727	SMD – 0.20 (-0.35, -0.06)	0.006	NA	NA	NA	[17]	6
LDL Cholesterol	1	727	SMD 0.06 (-0.09, 0.20)	0.43	NA	NA	NA	[17]	7
HDL Cholesterol	1	727	SMD 0.15 (0.00, 0.29)	0.05	NA	NA	NA	[17]	-
Total Cholesterol	1	727	SMD 0.16 (0.01, 0.30)	0.04	NA	NA	NA	[17]	8
Hospital admissions	2	912	OR 0.63 (0.48, 0.83)	0.001	0.02	0%	NA	[21, 111]	9
Cost-effectiveness	1	358	SMD 0.19 (-0.01, 0.40)	0.07	NA	NA	NA	[108]	10
NA – not applicable									
‡Egger's test was conducted only for outcomes with at least 6 studies.									

Publication bias

Six or more articles with similar outcomes were inspected for publication bias visually by using funnel plots and statistically by determining the significance from Egger's test of asymmetry. Visual inspection of included studies reporting similar outcomes did not indicate any obvious sign of asymmetry (Figs. 11 and 12). Consistent with visual findings, no evidence of publication bias was detected with Egger's test, as all outcomes had $p > 0.05$, showing evidence of funnel plot symmetry (Table 3).

Discussion

Summary of findings

This systematic review comprehensively summarised current evidence on the effectiveness of PCMH-based models on chronic disease management among primary care patients. Compared to standard GP care, PCMH-based care led to significant improvements in depression episodes, quality of life, HbA1c, LDL cholesterol, hospital admissions, and self-management outcomes. Whilst PCMH care was significantly associated with increased odds of blood pressure control, reductions in both pooled estimates of SBP and DBP were not statistically significant. In contrast, the findings suggest that PCMH-based interventions have higher costs and was not cost-effective when compared to standard care. Additionally, the narrative synthesis of studies also corroborated with pooled estimates of the meta-analyses.

Consistency with other systematic reviews

The most commonly reported PCMH principles in the included studies were patient engagement through education and self-management, and care coordination in addition to team-based care. Findings of this review, underscoring these PCMH elements in primary care, are consistent with previous systematic reviews reporting quality of care and overall patient experiences [26, 112]. In terms of study outcomes, depression and HRQoL were frequently reported outcomes in the included studies. Systematic reviews focussing on depression outcomes as a result of collaborative care reported similar improvements, which were consistent with our pooled estimates of SMDs and ORs [113, 114]. Similarly, our review showed small but significant improvements in the self-reported HRQoL and self-management scores, which is consistent with previous reviews [115, 116]. Variabilities in the duration of intervention and baseline severity of chronic illness may explain smaller pooled estimates of HRQoL outcome.

Changes in clinical outcomes are common measures employed in evaluating the effectiveness of chronic disease management interventions. With the exception of total cholesterol outcomes, findings of our studies were consistent with previous reviews [117, 118], showing improvements in clinical outcomes in favour of PCMH-based care compared to standard care. In terms of cost-effectiveness of PCMH-based models, some meta-analytic reviews on economic evaluations showed that PCMH care was associated with decreases in total costs compared to standard care [119, 120]. However, our review supports evidence from prior reviews [115, 121], suggesting that PCMH-based care was not associated with improvement in cost outcomes compared to standard care. This discordance could be due to the variability in the initial and sustained amount of costs incurred as a result of additional staffing and other infrastructure as well as the sample of patients and their comorbidity profile in the included trials [121].

Strengths and limitations

Quality assessment for risk of bias was assessed within and across studies of similar outcomes. As aforementioned, blinding of patients and GPs was not possible due to the nature of intervention and design of trials, as reported in other systematic reviews conducted in primary care settings [114, 122]. A substantial amount of heterogeneity was observed for measures of depression, HbA1c, and incremental cost of intervention, justifying the choice of random effects model. Higher heterogeneity is expected when pooling results of complex interventions, given the varying levels of intensity of different interventions and country's primary care setting [115]. Nonetheless, pooled estimates must be interpreted with caution because of unexplained variation observed in outcomes with higher heterogeneity. The review did not consider unpublished data or non-English language studies given the exhaustive number of citations identified. This may have had potential impact on effect size estimates.

Whilst previous reviews and meta-analyses on collaborative care for either single specific disease or multimorbidity have been studied, this review provides a comprehensive current evidence with quantitative synthesis on the effectiveness of PCMH-based

care models exclusively on primary care patients with one or more chronic diseases. Other strengths include a registered and published protocol, with a peer-reviewed search strategy, conducted on a wide range of electronic databases.

Patient, provider, and policy-level implications and future directions

Findings of our systematic review have important implications at patient, practice, and policy-level. The evidence may inform patients on the enhanced clinical outcomes and quality of life resulting from improved education and self-management support. The transformational changes at practice level may enable GPs to better target and deliver care according to the level and complexity of different patients [123]. Additionally, our study findings may also impact policy and implementation guidelines given the growing advocacy towards patient-centred care. Future research should focus on evaluating sustained benefits of PCMH-based care as well as supporting holistic experiences of patients receiving patient-centred care.

Conclusion

Current evidence suggests that PCMH-based care is superior to standard GP care in chronic disease management. Findings of our review showed significant improvements in depression, HRQoL, self-management, clinical, and health utilisation outcomes. Whilst studies included for pooled estimates showed consistent trend for several outcomes, high heterogeneity in some outcomes resulted in low to moderate grade of evidence, limiting firmer conclusion from the pooled evidence. Further research is needed to evaluate the long-term cost-effectiveness of PCMH-based care after the initial higher costs incurred for intervention, which may prove to be more cost-effective than standard care.

Abbreviations

BP: blood pressure; CCM:chronic care model; CI:confidence interval; CINAHL:Cumulative Index to Nursing and Allied Health Literature; CRD:Centre for Reviews and Dissemination; DBP:Diastolic blood pressure; GBD:Global Burden of Diseases; GP:general practitioner; GRADE:Grading of Recommendations, Assessment, Development and Evaluation; HbA1c:glycated haemoglobin; HDL-C:high-density lipoprotein cholesterol; HRQoL:health-related quality of life; JBI:Joanna Briggs Institute; LDL-C:low-density lipoprotein cholesterol; MDT:multidisciplinary team; OR:odds ratio; PCMH:Patient-centred medical home; PICOS:Population, Interventions, Comparators, Outcomes, and Study designs; PRISMA:Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PROSPERO:Prospective Register of Systematic Reviews; RCT:randomised controlled trial; SBP:systolic blood pressure; SD:standard deviation; SMD:standardised mean difference; VA:Veterans Affairs; WHO:World Health Organisation.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this article and its supplementary information files.

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

JRJ was involved in the conception, design, data screening, data extraction, quality assessment and grading, data analysis and interpretation and write up of the manuscript. HJ was involved in the data screening, quality assessment and grading, and review of the manuscript. KP was involved in the data screening and review of the manuscript. KA was contributed to data analysis and review of the manuscript. WKT was involved in PhD supervision and review of the manuscript. All authors have approved the submitted version.

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Figures

Participants	Primary care patients aged at least 18 years with one or more chronic disease/s
Intervention	AMA recognised PCMH principles (must meet 1 and 2 criteria) <ul style="list-style-type: none"> 1) Integrated or MDT care AND 2) One or more of the following principles: <ul style="list-style-type: none"> i. Coordination of care ii. Data driven quality of care iii. Long-term patient-provider relationship iv. Patient empowerment and patient engagement
Comparison	Standard GP care
Outcomes	Patient outcomes (clinical and self-reported surveys) Hospital outcomes (hospital or emergency department visits) Economic outcomes (direct healthcare costs, incremental costs)
Study design	Randomised and non-randomised controlled trials

Figure 1

Summary of PICOS components

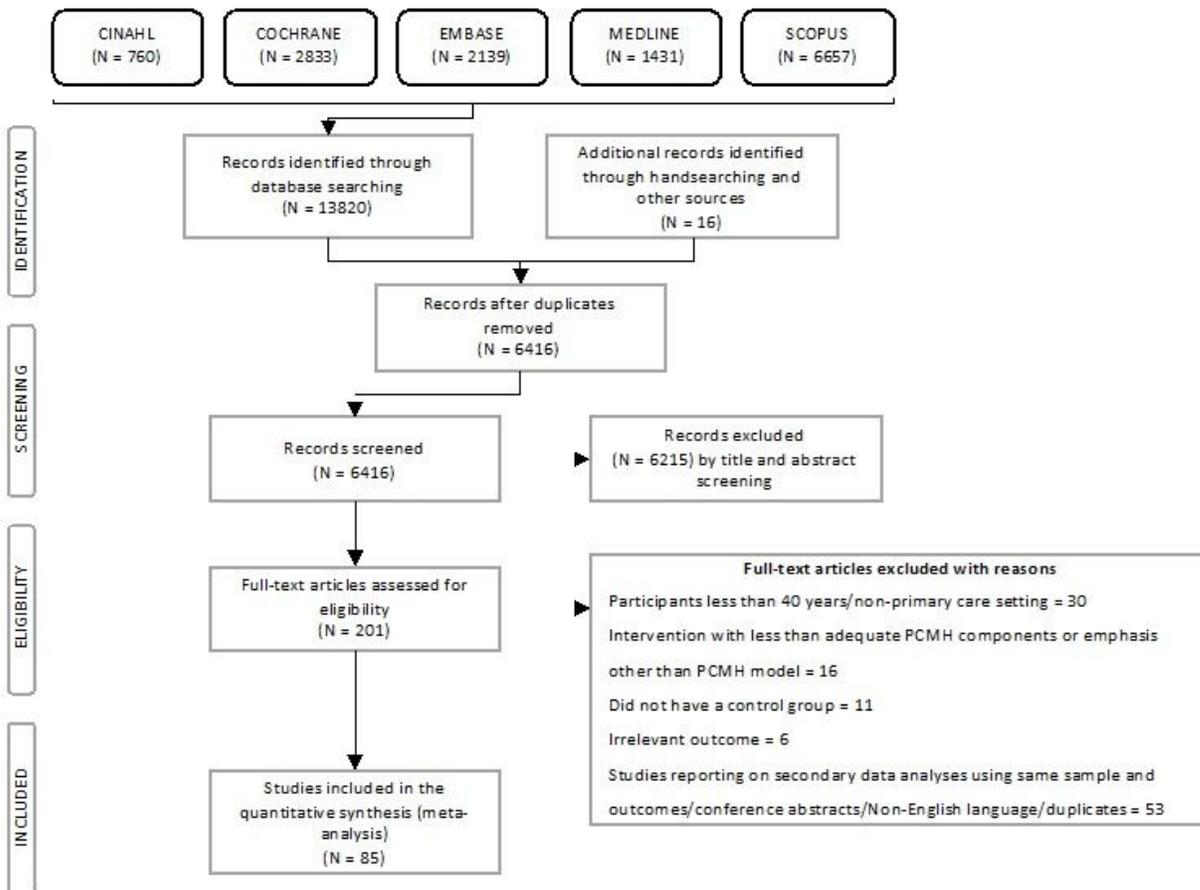


Figure 2

PRISMA Flowchart

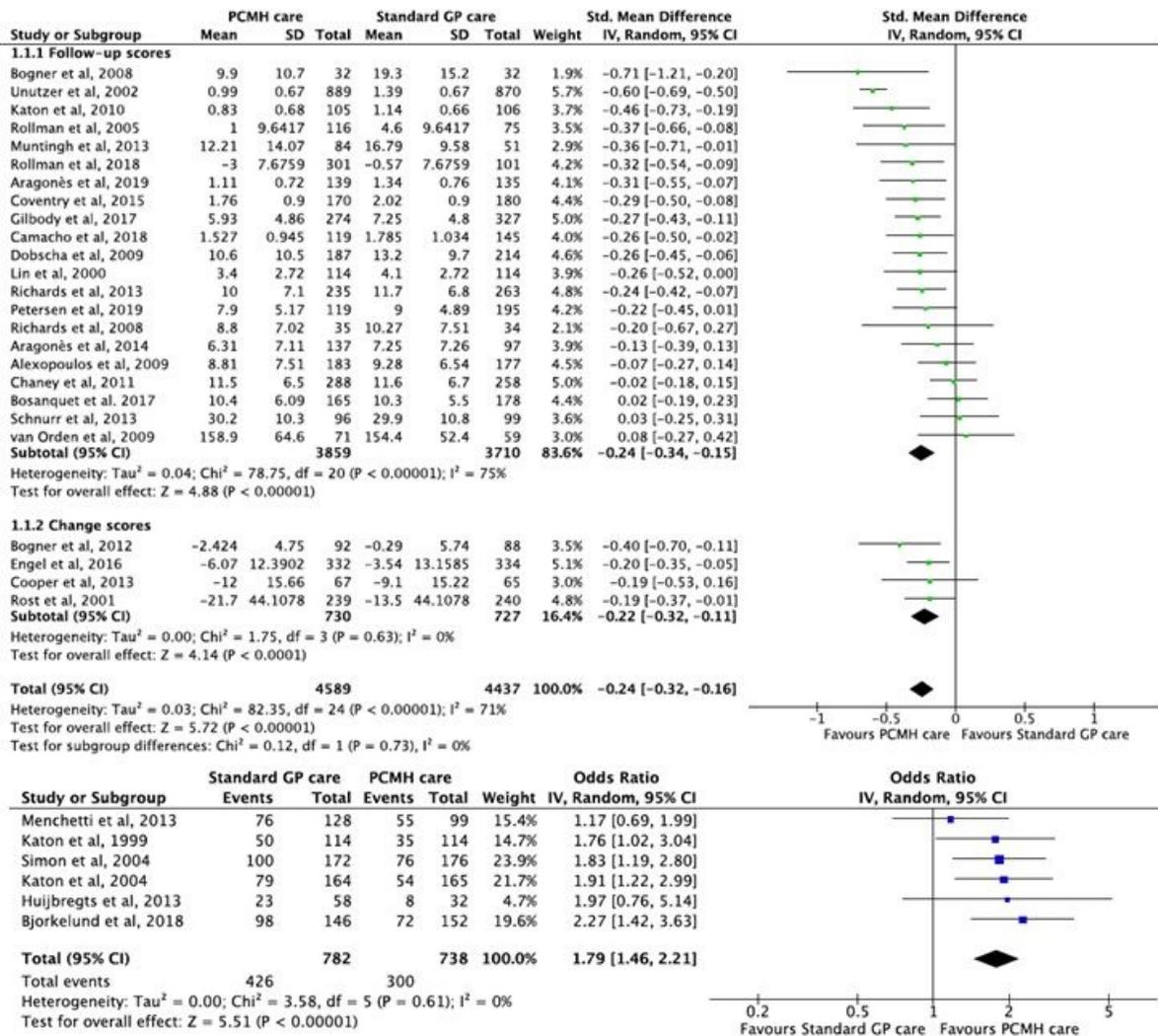


Figure 3

Forest plots of depression outcomes between the PCMH care and Standard GP care.

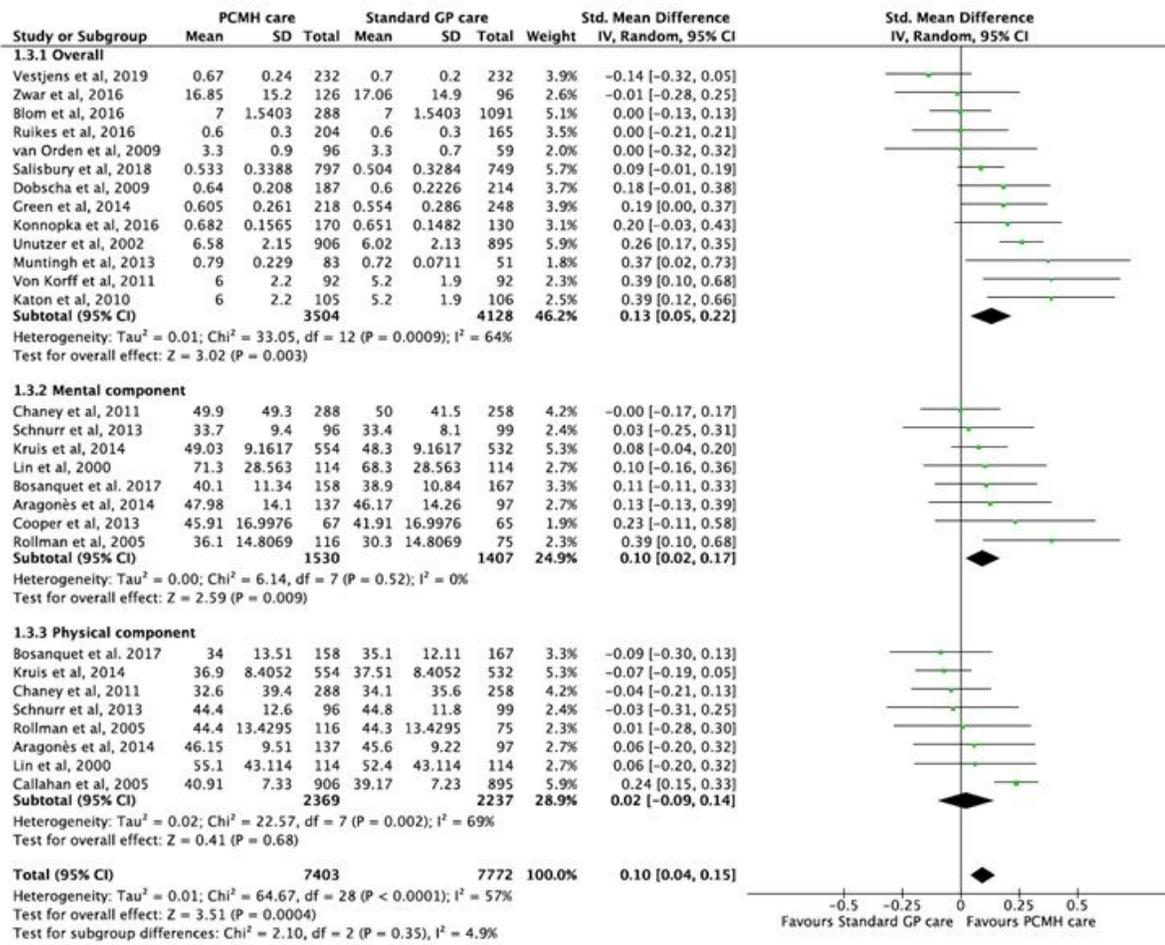


Figure 4

Forest plots of Quality of life (QoL) outcomes between the PCMH care and Standard GP care.

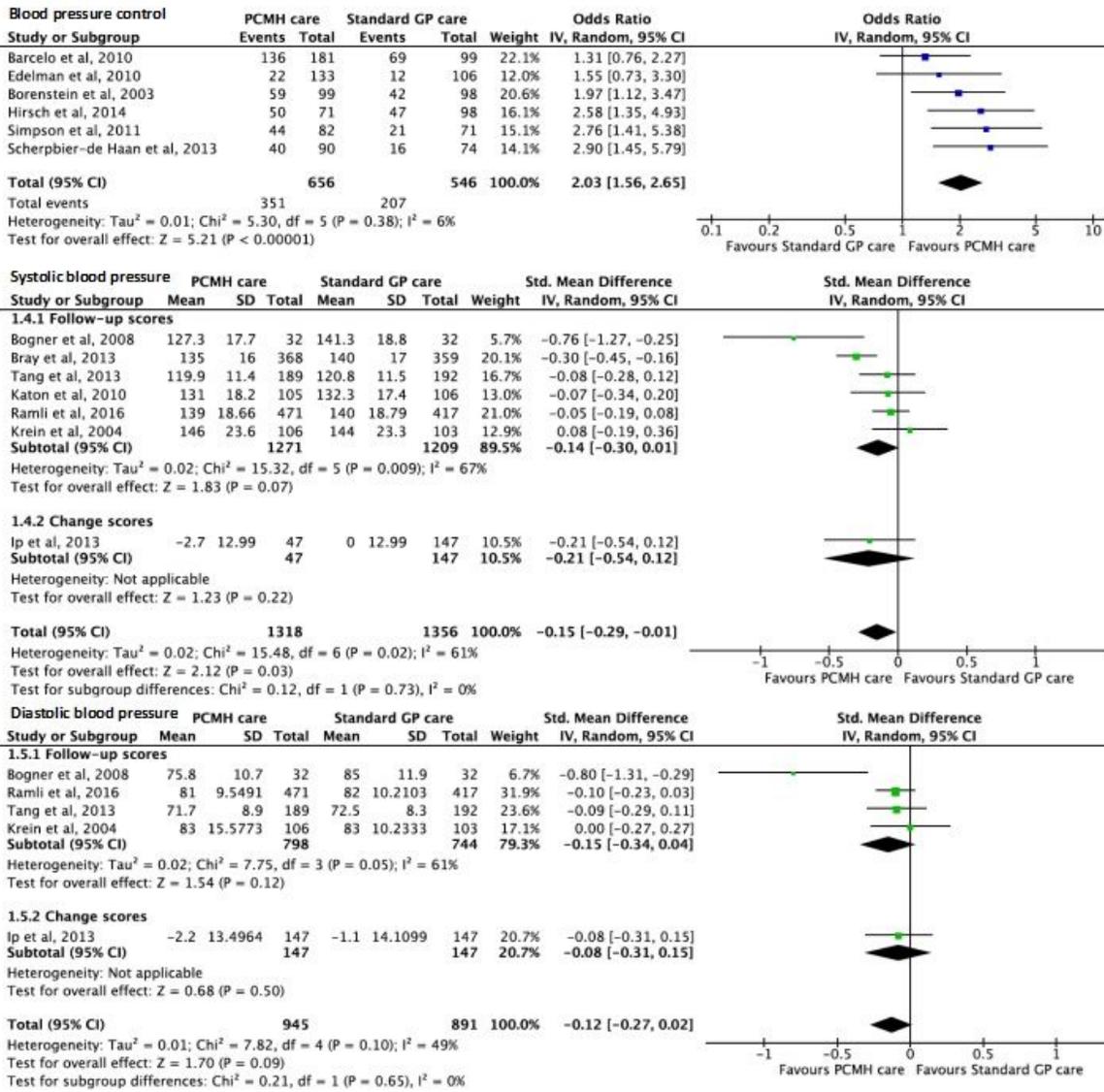


Figure 5

Forest plots of blood pressure outcomes between the PCMH care and Standard GP care.

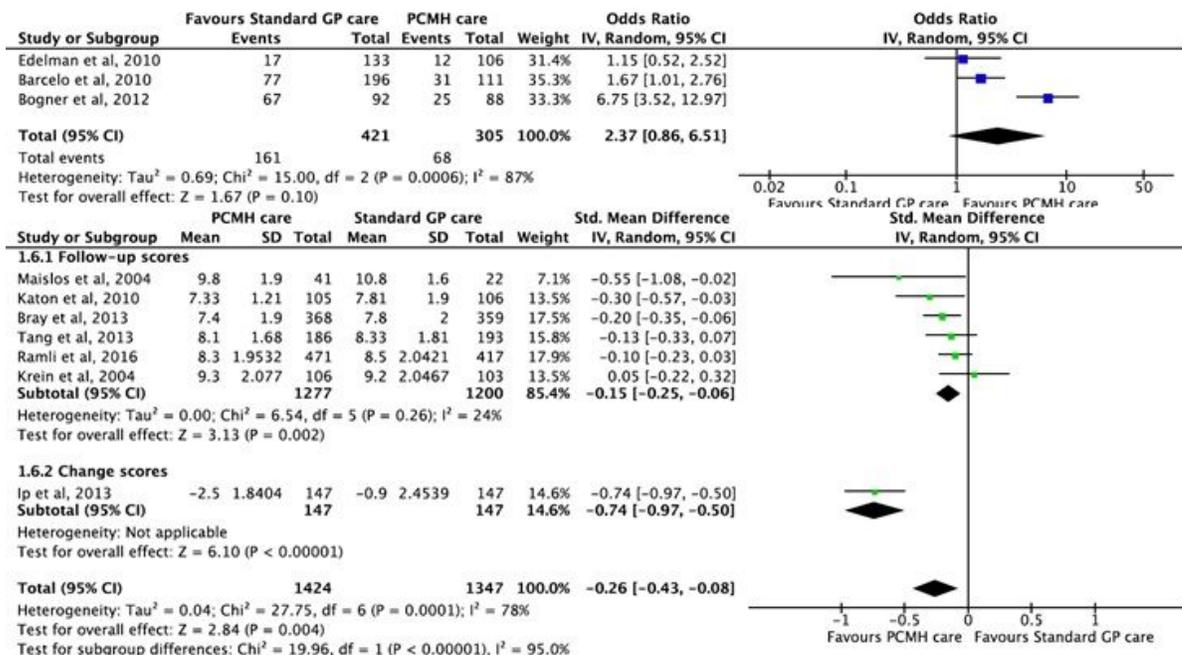


Figure 6

Forest plots of HbA1c outcomes between the PCMH care and Standard GP care.

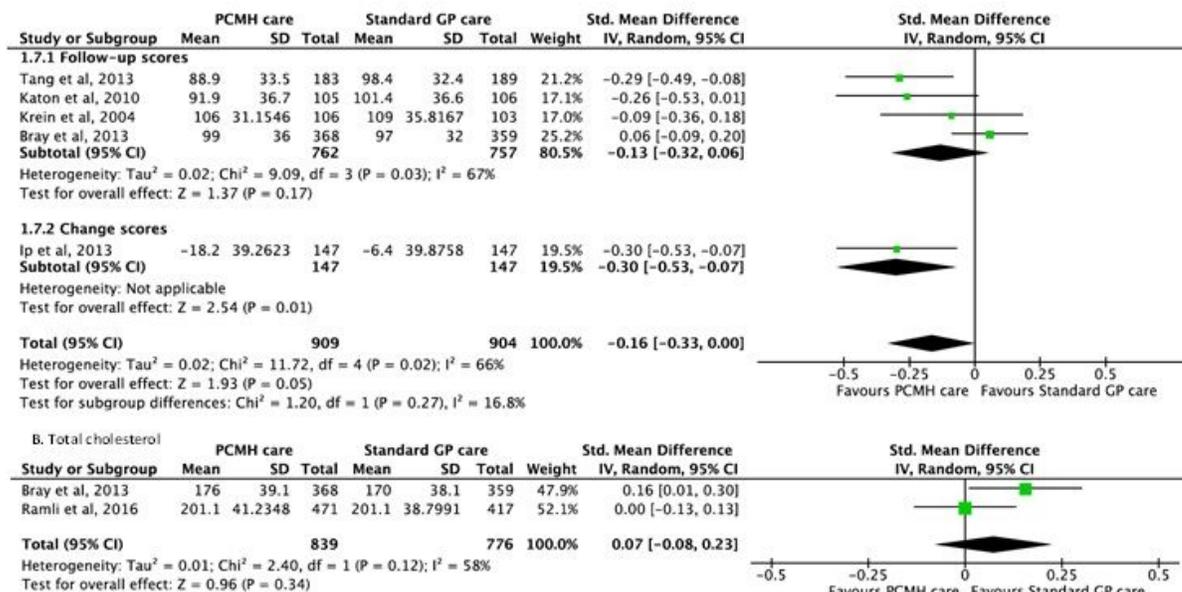


Figure 7

Forest plots of cholesterol outcomes between the PCMH care and Standard GP care.

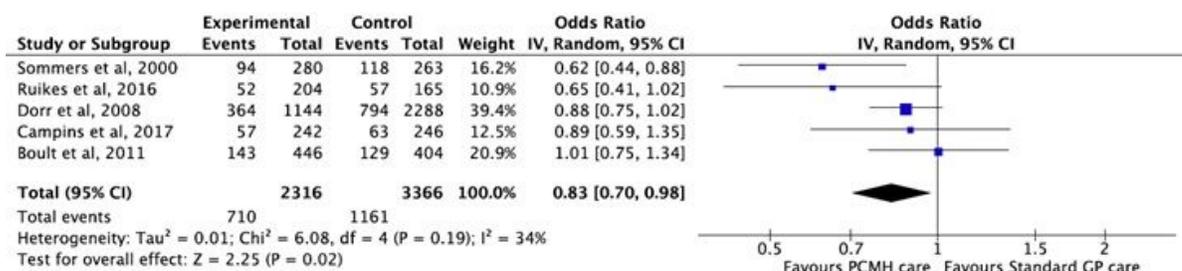


Figure 8

Forest plot for hospital admissions between PMCH care and Standard GP care.

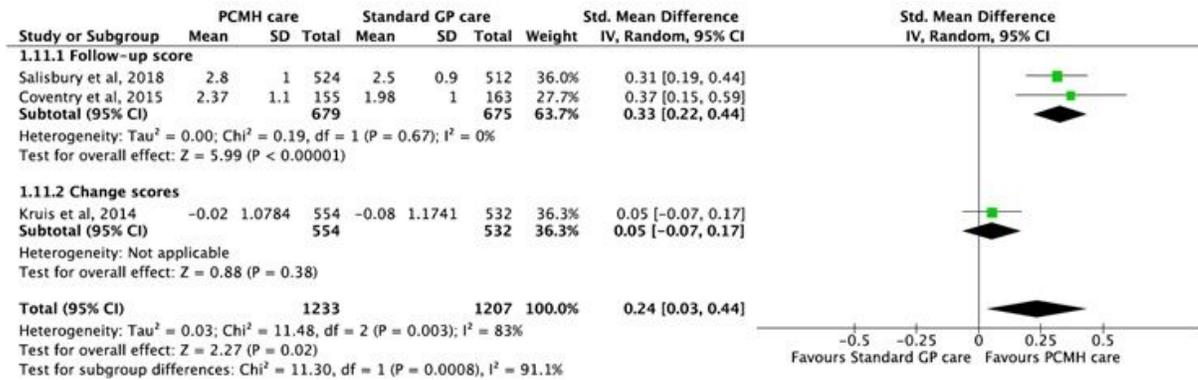


Figure 9

Forest plots of self-management outcomes (PACIC scores) between the PCMH care and Standard GP care.

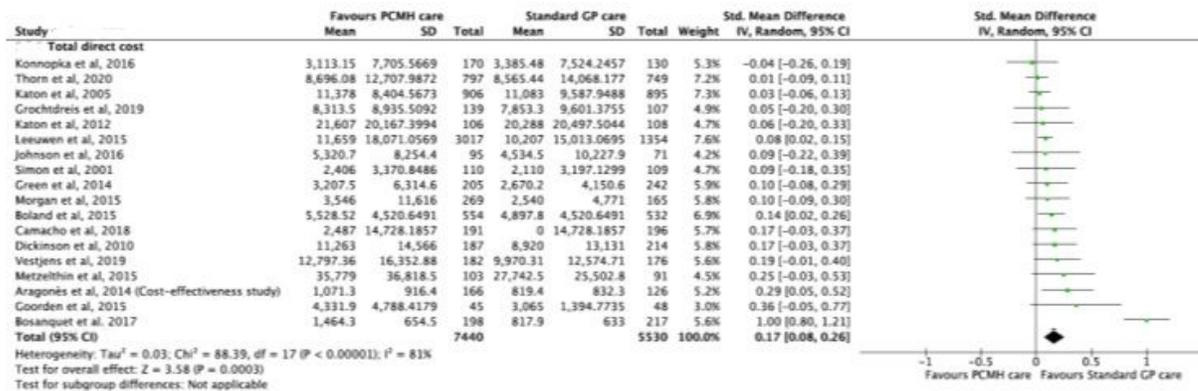


Figure 10

Forest plots of incremental cost of intervention between the PCMH care and Standard GP care.

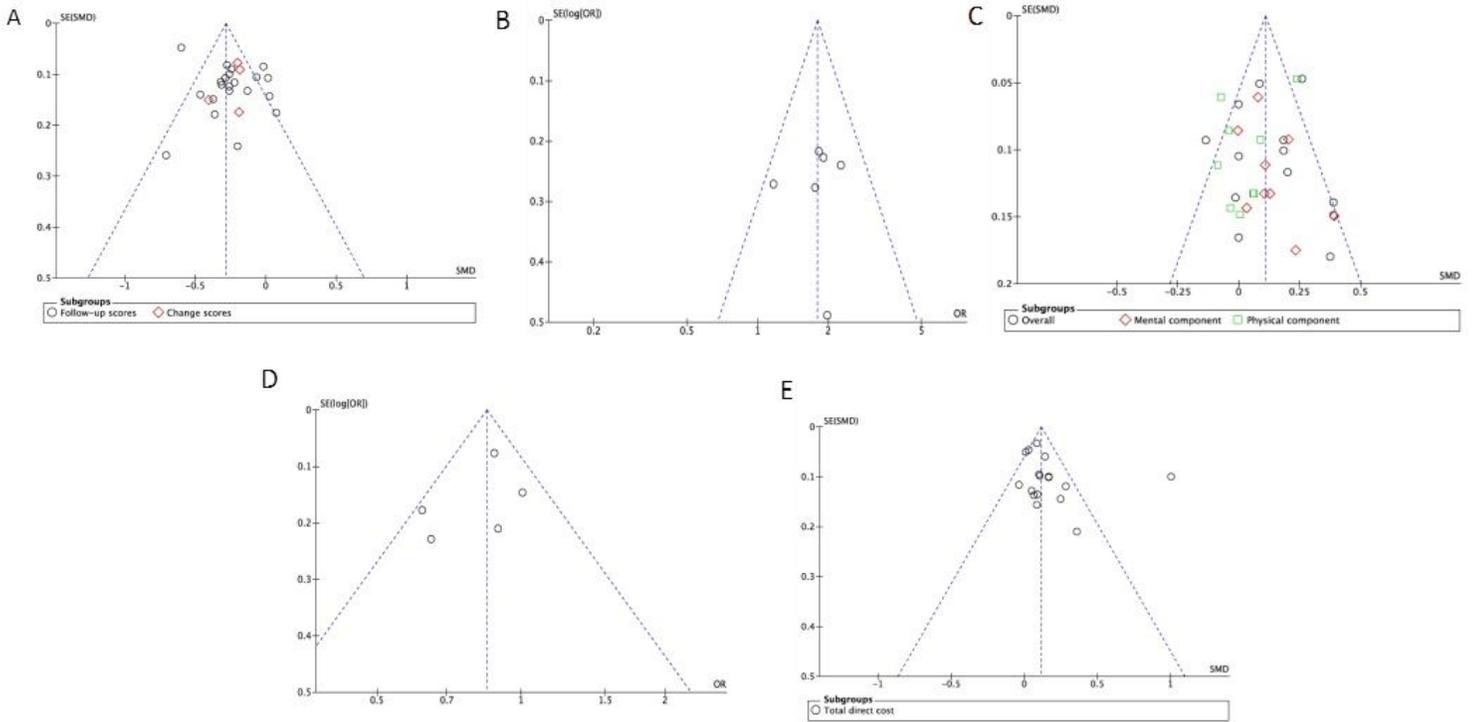


Figure 11

Funnel plots assessing asymmetry of depression, QoL, hospital admissions, and cost outcomes between the PCMH care and Standard GP care. A – Depression (SMD); B – Depression (OR); C – Quality of Life (SMD); D – Hospital admissions (OR); E – Direct costs

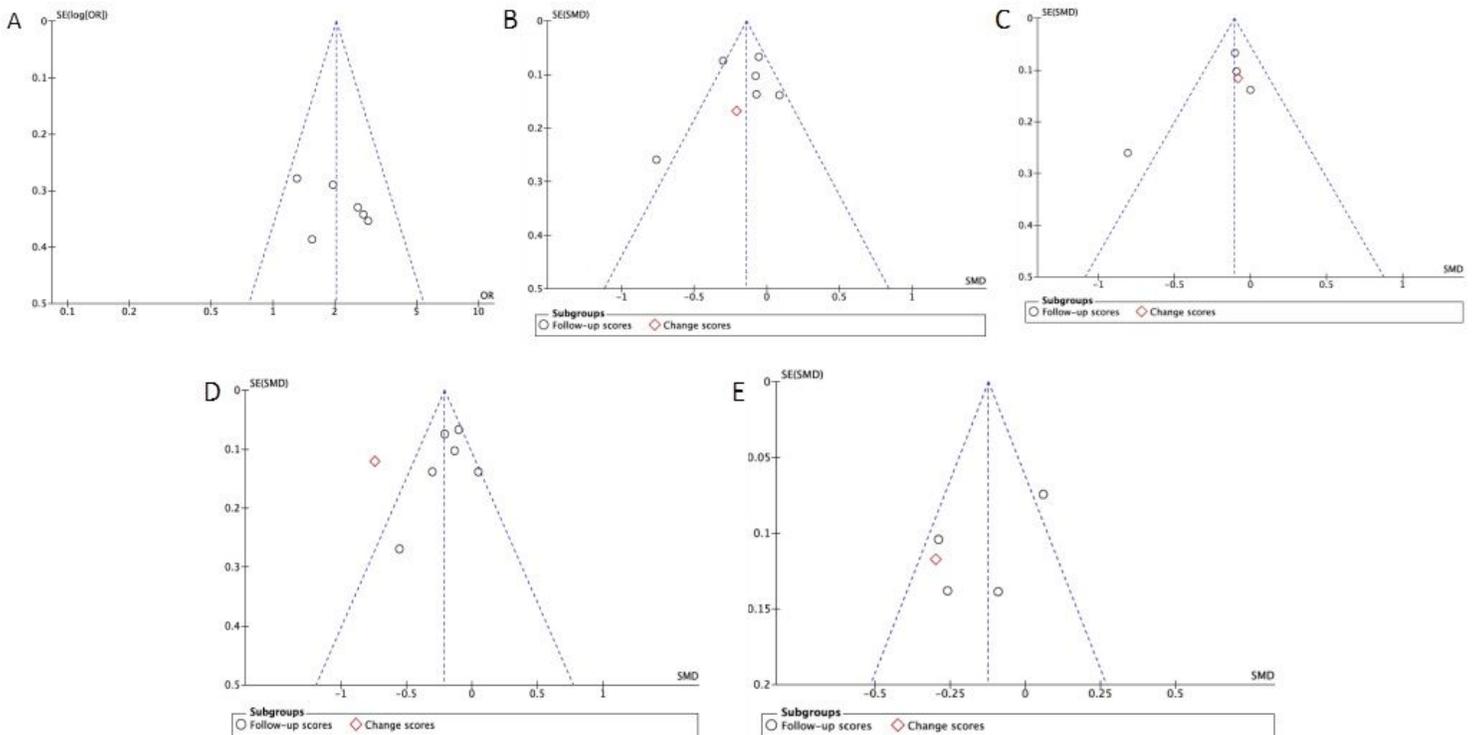


Figure 12

Funnel plots assessing asymmetry of clinical outcomes between the PCMH care and Standard GP care. A – Blood pressure (SMD); B – Systolic blood pressure (OR); C – Diastolic blood pressure (SMD); D – HbA1C (OR); E – LDL cholesterol

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [PRISMA2009checklist.doc](#)
- [Appendix8ROBINSI.docx](#)
- [Appendix57Qualityassessments.docx](#)
- [Appendix34Characteristicsofincludedstudies.docx](#)
- [Appendix2Reasonsforexclusion.docx](#)
- [Appendix1Searchterms.docx](#)