



Title	GoD4Mum: A general practice-based quality improvement collaborative for diabetes prevention in women with previous gestational diabetes
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Title: Good4Mum: a general practice-based quality improvement collaborative for diabetes prevention in women with previous gestational diabetes

Article Type: Original Research

Keywords: diabetes prevention; gestational diabetes; primary care; quality improvement collaboratives; general practice.

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Abstract: Aims:

Gestational diabetes (GDM) and Type 2 diabetes pose tremendous health and economic burdens as worldwide incidence increases. Primary care-based systematic diabetes screening and prevention programs could be effective in women with previous GDM. Good4Mum aimed to determine whether a Quality Improvement Collaborative (QIC) would improve postpartum diabetes screening and prevention planning in women with previous GDM in general practice.

Methods:

Fifteen general practices within Victoria (Australia) participated in a 12-month QIC, which consisted of baseline and four quarterly audits, guideline-led workshops and Plan-Do-Study-Act feedback cycles after each audit. The primary outcome measures were the proportion of women on local GDM registers completing a diabetes screening test and a diabetes prevention planning consultation within the previous 15 months.

Results:

Diabetes screening increased with rates more than doubled from 26% to 61% and postpartum screening increased from 43% to 60%. Diabetes prevention planning consultations did not show the same level of increase (0% to 10%). The recording of body mass index improved (51% to 69%) but those with normal body mass index did not.

Conclusions:

Good4Mum supported increased diabetes screening and the monitoring of high risk women with previous GDM in general practice.

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Dear A/Professor Blackberry,

GooD4Mum: a general practice-based quality improvement collaborative for diabetes prevention in women with previous gestational diabetes

We would like to thank the reviewers for their time and expert feedback. We appreciate the interest in our paper and feel the observations have enhanced the manuscript's clarity. We have endeavoured to clarify the areas of weakness identified and revised the manuscript accordingly. We have taken the reviewer comments and responded to them individually in the response to review document.

My co-authors and I would be grateful for your consideration of our study as an original research paper in Primary Care Diabetes. The author for correspondence is at the address listed above, email Sharleen.oreilly@ucd.ie

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Sharleen O'Reilly', with a horizontal line underneath.

Sharleen O'Reilly, PhD, AdvAPD, RD

Dear A/Prof Blackberry,

We would like to thank the reviewers for their time and expert feedback. We appreciate the interest in our paper and feel the observations have enhanced the manuscript's clarity. We have endeavoured to clarify the areas of weakness identified and revised the manuscript accordingly. We have taken the reviewer comments and responded to them individually below.

Reviewer 1

General comments:

The authors have presented data from an analysis of Australian women with previous GDM and found that Good4Mum brought significant improvements in the postnatal diabetes screening and diabetes prevention planning consultation among women with GDM in general practice.

The analysis presented in this manuscript consists of two parts. First, the authors presented the influence of external factors on the planned activity over time. In the second part, the authors calculated the numbers and the rates of women for every measure included in this project at each stage. Though the aim of this paper is clearly elucidated and the topic is important, the study design and results are weak and did not support the conclusion.

Response:

Thank you for your comments. We appreciate that the quality improvement methodology through the use of Collaboratives is a quasi-experimental design and has inherent issues. The methodology is however well described in the literature and our study does meet the SQUIRE standards for the method. We have reframed our conclusions to better reflect the data.

We now state "**Conclusions:** *Good4Mum supported increased diabetes screening and the monitoring of high risk women with previous GDM in general practice.* "

Major comment 1

The study lacks a control group at the same period to check whether the Good4Mum can increase the rate of participation in the diabetes screening and in the monitor of BMI and other risk factors, due to the possible improvement in awareness over time.

Response:

Clinical guidelines for the follow-up of women who have had GDM exist in many countries but follow-up rates remain obstinately low.^{1,2} Awareness increasing over time is an unlikely explanation because screening rates have been low despite reminders sent to the women and their GPs from a National Gestational Diabetes Register.³

These guidelines represent the systematic review of randomised trials about **what** should be done but not **how**. e.g. NICE⁴. The Institute for Healthcare Improvement in Boston developed Collaboratives to improve the uptake of evidence. Collaboratives have been used in many countries. They were adapted by Prof Sir John Oldham in UK for use in primary care.⁵ He trained the Australian Government-funded Australian Primary Care Collaboratives team which has have been successful.^{6,7}

By using Collaboratives methodology we were following a decade of Australian Government policy on how to improve the uptake of evidence in primary care. Collaboratives do not include a control group and we acknowledge that this results in a quasi-experimental design.

We have amended the text to include this aspect:

“This quasi-experimental research project sought to apply QIC methods to the care of women with previous GDM...”

We have also provided more clarification in the methods on the activities:

“For women with previous GDM, this was engaging in annual diabetes screening and having a consultation where their lifestyle-related modifiable diabetes risk was assessed.”

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Major comment 2

Despite an increased rate of women screened for DM, the rate of participation in the diabetes prevention planning is not significant different. It is quite weak to believe that the increased screening of DM is attributable to diabetes prevention planning consultations.

Response:

The general practices viewed the screening as a separate activity to the diabetes prevention planning consultation, which is why we have treated them as such in our analysis. Diabetes screening requires a small amount of GP time (asking a woman to take a test request slip to the nearest phlebotomy service or doing the blood test then and there) while the other activity required a much larger amount of time. The prevention planning session was usually booked in as a separate consultation and/or it was delivered by practice nurses often on a separate day.

We have additional qualitative data that was collected as part of the study from practices but not reported in this paper due to space constraints. We have decided to include a component of this data to add context to the data already included.

The methods now includes:

“Qualitative interviews and focus groups were conducted in each practice upon completion of the QIC activity to explore barriers and enablers to the intervention.”

“The qualitative data was analysed thematically by an experienced qualitative researcher (SOR) and coded transcripts were checked by the participants for accuracy of interpretation.”

The results now includes:

“The qualitative data proposed several barriers to conducting the diabetes prevention planning consultation: 1) it was only emphasised in the final six months of Good4Mum and therefore had less time to become embedded within daily practice activity; 2) organising it within normal practice workflows was challenging; 3) women were reluctant to attend it for financial and time reasons; 4) limited lifestyle modification referral options existed; and 5) some GPs and practice nurses lacked confidence to engage in a lifestyle modification consultation.”

The discussion now includes:

“Diabetes screening and BMI monitoring in Good4Mum aligns well with previous QIC diabetes prevention initiatives [15] but providing a diabetes prevention planning consultation was the more challenging component of the project - it had low uptake by both practice staff and women and practice staff reported several barriers to engaging in the activity. In looking at the QIC activities as behaviours that need to be changed and using the Theoretical Domains Framework[25] to map them, the screening activity required minor environmental restructuring to ensure GPs knew which women needed screening alongside some education and training with modelling promoted via teleconferences. These were easier behaviours to change because staff already know they will get reimbursed for doing the blood test and that HbA1c is a useful diabetes indicator. The prevention planning activity was a new process for the practices and required substantial behaviour change. Within the theoretical domains framework it called for: cognitive and interpersonal skills (training practice nurses to perform the tasks and support women to engage in lifestyle change), belief about capability and consequences (both staff and woman), environmental restructuring (needed patient and staff resources plus space to conduct consultation), education and training, persuasion and enablement to influence practice nurses and GPs optimism that the prevention planning consultations was worthwhile. It may simply be that providing a diabetes planning consultation to all women with a history of GDM is not appropriate and that providing the consultation in a more targeted fashion would yield better results. This should be explored in further work.”

Major comment 3

Many major confounders in this study were not adjusted in the analysis, e.g. social economic status. Besides, it is still unrevealed whether the characters of the study population at each audit stage are different over time.

Response:

The reviewer points to an important difference between an epidemiological study or a controlled trial and improvement work. The population does change over time as more women are entered into the register and a higher proportion are recalled. Numerator and denominator are both changing.

For these reasons, the standard tool in improvement work is the *run chart* developed by the Institute of Healthcare Improvement¹. Its purpose is to help improvement teams formulate aims by

depicting how well processes are performing. It helps the practice teams determine when changes are true improvements by displaying a pattern of data that they can observe as they make changes. Run charts also indicate the direction of work on improvement and the value of particular changes.

For instance, if the run chart showed 100% follow up, there would be no need to look at SES or ethnicity affecting performance. If the run chart was obstinately at 80%, it might prompt thought about the demographic of the non-attenders.

In the absence of individual-level SES data, the best we could do is describe the area-level SES conditions where the practice is located which would not be useful for adjusting for SES. Supplementary Table 2 and Supplementary Table 3 provide a summary of outcomes by location and practice size – any analyses beyond these summaries is limited due to the sample size.

Reference

1. Run chart tool. Institute for Healthcare Improvement.
<http://www.ihl.org/resources/Pages/Tools/RunChart.aspx>

Major comment 4

The conclusion mainly stemmed from Table 2, but this table failed to give clear information, including: (a) it is better to point out which groups have statistical difference, if the difference assessed by ANOVA is significant; (b) the total number of women registered is far less than the numbers documented in text (N=481) and is also not consistent with the numbers showed in the supplementary table 2 and table 3, which are simply divided in different ways.

Response:

Thank you for this suggestion. There is an extra column added to Table 2 that highlights the pairwise differences.

The discrepancy described is between the total number of women (n=481) and the total number of practices that participated over the length of the study (n=14). The numbers presented in the Supplementary Table 2 and Supplementary Table 3 provide summary statistics of the outcome measures classified by location (rural v metro) and practice size (small, medium and large based upon the number of GPs in each practice). We considered this important to include to provide the readership with some context around these issues. Due to the small numbers, no attempt has been made to test for significance between groups and we believe the 95% CIs presented are sufficient.

Minor comments:

Some errors in text and tables need to be corrected. For example,location and size was explored descriptively (Supplementary Tables 2 and 3), rather than Supplementary Tables 1 and 2. (Line 173)

Response:

Thank you for highlighting these minor errors, we have edited the text accordingly.

Reviewer 2

Concluding statements:

How did it support diabetes prevention if diabetes prevention planning was little improved? Only 1 in 10 presented for diabetes prevention planning. Even if every one of them adopted the necessary interventions, it still leaves 90% of potentially vulnerable individuals not undertaking necessary prevention strategies.

Was it perhaps effective in detecting those with T2D or those with pre-diabetes rather than preventing diabetes?

Response:

Thank you for your feedback. We agree that our abstract conclusions needed to be framed better to reflect our findings.

We have now revised it to say *“GooD4Mum supported increased diabetes screening and the monitoring of high-risk women with previous GDM in general practice.”*

Our study was focused on delivering guideline-led diabetes prevention care, which detail regular diabetes screening and supporting women to achieve a healthy weight, diet and regular exercise through behaviour change (prevention planning) as the core activities that need to be completed to prevent diabetes. It is these activities that need to be enacted to deliver guideline-led care and what we focus on in this study. As a result, we are unable to make any conclusion as to its effectiveness in detecting women with T2DM or prediabetes versus preventing diabetes but it would be an important consideration in future research. We have edited the discussion limitations to include:

““Patient level data were not collected within GooD4Mum due to ethics approval restrictions, which limited our ability to explore the impact of factors such as age, blood glucose measurement values, education level or socioeconomic status as potential modifiers of engagement with the general practice and consequently the QIC activity.”

We provide additional information on the diabetes prevention planning session issues to Reviewer 1 above. We have added additional qualitative data to address this concern (see above).

Typographical errors:

Line 53

Line 127

Response:

These have been amended, thank you.

Results:

It would be interesting to know what the pickup rate for diabetes and prediabetes was in the screened population. Is this data available? Could it be included in this publication? This might inform, for example, the reasons for the low rates of diabetes prevention consultations.

Response:

As in a Collaborative, we do not have access the actual values for the diabetes screening tests. The data collection was focused on the rate of the screening rather than the biochemical result. We do not have ethical clearance to access this information.

We have added further detail on this as a limitation to the discussion section:

“Patient level data were not collected within GooD4Mum due to ethics approval restrictions, which limited our ability to explore the impact of factors such as age, blood glucose measurement values, education level or socioeconomic status as potential modifiers of engagement with the general practice and consequently the QIC activity.”

and additional information in the methods section:

“The standard of care provided to patients was aligned with guidelines and no personal or identified data was shared outside the general practice.”

We have additional qualitative data that was collected as part of the study from practices but not reported in this paper due to space constraints. We have decided to include a component of this data to add context to the data already included. We have detailed the exact text above in response to a Reviewer 1 query.

Discussion:

Some discussion re cost effectiveness would be interesting. Many people involved. (both practices and PHNs)- How resource intensive is this project- is it sustainable? Financial costs: Funding for the projects, and costs to the women in time and money.

Response:

We agree that this information would be useful. We have included the following additional information:

In the methods:

“Cost information was captured throughout the intervention from a QIC and intervention perspective. The cost data was collected from women and practices participating using cost diaries alongside recorded project expenses.”

“The cost data were analysed using a pathway approach and only cost descriptions could be provided.”

In the results:

“Total GooD4Mum intervention costs were estimated at \$AUD 52,923, comprising project coordination \$AUD 11,573, QIC Local Program Officers time cost \$AUD 1,919, GP and practice staff time cost \$AUD 14,172, materials development and production \$AUD 24,405 and website resources \$AUD 854. The average cost per practice was estimated at \$AUD 3,528 during the QIC project. However, more than one third of total costs were associated with the handbook and material development, which would not be required for future implementation. Excluding the research and development costs, it was anticipated to deliver the intervention to one general practice would cost \$AUD 2,166. Healthcare costs were collected from women with a GDM history in the participating general practices. However, the results were not representative due to a very small sample size (N=3 pre-intervention and N=10 post-intervention) and not reported as a result.”

In the discussion:

“Similarly GooD4Mum represented a modest investment to improve diabetes screening and risk monitoring amongst a high-risk population. Further research using a full economic evaluation is needed to assess the value for money of this type of intervention.”

Highlights

- GooD4Mum is a quality improvement study for diabetes prevention after gestational diabetes
- 15 general practices in Victoria, Australia participated in GooD4Mum collaborative study
- Diabetes screening rates doubled (30% to 60%) and 20% increase in BMI monitoring
- Improving screening and monitoring of women with previous gestational diabetes is feasible

GooD4Mum: a general practice-based quality improvement collaborative for diabetes prevention in women with previous gestational diabetes

RUNNING TITLE: Postpartum diabetes prevention in primary care

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2 **diabetes prevention in women with previous gestational diabetes**

3 **RUNNING TITLE:** Postpartum diabetes prevention in primary care

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38 **Good4Mum: a general practice-based quality improvement collaborative for**
39 **diabetes prevention in women with previous gestational diabetes**

40 **Abstract**

41 **Aims** Gestational diabetes (GDM) and Type 2 diabetes pose tremendous health and economic
42 burdens as worldwide incidence increases. Primary care-based systematic diabetes screening and
43 prevention programs could be effective in women with previous GDM. Good4Mum aimed to
44 determine whether a Quality Improvement Collaborative (QIC) would improve postpartum diabetes
45 screening and prevention planning in women with previous GDM in general practice.

46 **Methods** Fifteen general practices within Victoria (Australia) participated in a 12-month QIC,
47 consisting of baseline and four quarterly audits, guideline-led workshops and Plan-Do-Study-Act
48 feedback cycles after each audit. The primary outcome measures were the proportion of women on
49 local GDM registers completing a diabetes screening test and a diabetes prevention planning
50 consultation within the previous 15 months.

51 **Results** Diabetes screening increased with rates more than doubled from 26% to 61% and
52 postpartum screening increased from 43% to 60%. Diabetes prevention planning consultations did
53 not show the same level of increase (0% to 10%). The recording of body mass index improved overall
54 (51% to 69%) but the number of women with normal body mass index did not.

55 **Conclusions** Good4Mum supported ~~diabetes prevention in general practice through~~ increasing
56 diabetes screening and the monitoring of high risk women with previous GDM in general practice.

57

58

59

60 Abbreviations: gestational diabetes, GDM; glycated haemoglobin A1c, HbA1c; quality improvement
61 collaborative, QIC; general practitioner, GP; body mass index, BMI.

62

63 **Highlights**

- 64 • GooD4Mum is the first quality improvement collaborative study focused on increasing diabetes
65 screening and diabetes prevention planning consultations in general practice for women with
66 previous gestational diabetes.
- 67 • Using established collaborative methods in 15 general practices, we found diabetes screening
68 rates doubled and a 20% increase in body mass index monitoring.
- 69 • Though challenging, this study suggests that improving screening activity and monitoring of high
70 risk women with previous gestational diabetes in a primary care setting is feasible.
71

72

73 **Word count**

74 2827

75 Introduction

76 The prevalence of diabetes is growing worldwide [1] and a history of gestational diabetes (GDM)
77 confers increased risk of developing Type 2 diabetes [2]. The incidence of GDM in Australian women
78 is 6% [3] and is higher for some ethnic and socio-economic groups. For women who develop GDM,
79 their risk of developing Type 2 diabetes within 5-10 years is sevenfold higher than for women who
80 have not had GDM [2]. In 2011 Australia started a National Gestational Diabetes Register (Register)
81 to help women manage their diabetes risk by providing them with information booklets and regular
82 screening reminders [4]. Women with GDM typically have their 6-8 week postpartum check-up with
83 their general practitioner (GP) [5, 6]; although the Register provides screening reminders around this
84 time, postpartum screening rates do not appear to be increasing and remain low - around 30% over
85 three years [7, 8]. Significant barriers exist for mothers and general practitioners (GPs) around
86 diabetes screening and lifestyle change [5, 6, 9]. The main screening barriers are time pressures,
87 losing laboratory request forms, and arranging transport and childcare [6, 10], while those for
88 lifestyle modification are apathy towards change, time pressures and mixed messages [6]. Screening
89 appears to be the main stumbling block in supporting this population to reduce their risk of diabetes
90 as regular screening will help identify those at higher risk of developing diabetes and enable their
91 engagement in effective diabetes prevention lifestyle interventions [11] earlier.

92 Quality improvement Collaboratives (QIC) is a methodology developed by the Boston Institute for
93 Healthcare Improvement that can be applied to achieve system change within an organisation or its
94 teams [12]. QICs differ from randomised controlled trials because they aim to implement existing
95 evidence, usually a clinical guideline based on systematic review [13, 14], and they are concerned
96 with external and internal validity; randomised controlled trials are primarily focused on internal
97 validity [13]. QIC has shown measurable health care improvements in specific areas, for example
98 diabetes treatment and diabetes prevention in older adults [15]. This [quasi-experimental research](#)
99 project sought to apply QIC methods to the care of women with previous GDM based on prior

100 Australian QIC success [15] and the fact that the woman and GP identify general practice as the
101 desired location for care delivery [6]. The aim of this project was to determine whether a QIC based
102 in general practice would improve postpartum diabetes screening, weight monitoring and diabetes
103 prevention planning in women with previous GDM.

104 **Methods**

105 Context

106 Approximately 300,000 women give birth each year in Australia and at least 17,000 are diagnosed
107 with GDM [3]. The broad adoption of the WHO diagnostic criteria has increased GDM prevalence to
108 10% [16]. General practices in Australia receive support from Primary Health Networks, which are
109 government-funded and independent organisations. Almost a quarter of all general practices have
110 participated in a QIC project [15] and the Primary Health Networks provide QIC support through QIC
111 Local Program Officers.

112 The basic QIC constituents are: 1) convening an Expert Reference Panel to define the quality
113 improvement aim and measures, and approving the handbook; 2) identifying change principles and
114 ideas to address underlying causes of the evidence-to-practice gaps; 3) developing the intervention,
115 action periods and learning workshops to support the quality improvement process; and 4) using
116 small local tests of change through Plan-Do-Study-Act cycles. This QIC project was called GooD4Mum
117 and the Expert Reference Panel consisted of diabetes experts, general practice health professionals
118 (practice nurse, GP, dietitian), QIC experts and guideline developers. Victorian Primary Health
119 Networks agreed to participate in GooD4Mum and identified general practices with QIC experience
120 from their catchment areas they felt were suitable for recruitment. There was no funding attached
121 to GooD4Mum participation. Out of the 26 general practices identified and approached, 15
122 consented to participate (rural N=3, urban N=12). The reasons for declining were insufficient
123 capacity (N=6) and lack of staff interest (N=5).

124

125 Intervention

126 The GooD4Mum project team consisted of: a project manager, who is an implementation science
127 trained research dietitian; general practice leads, who ranged from practice managers to GPs to
128 practice nurses; QIC Local Program Officers; and the advisory group with key stakeholder
129 representation including women with previous GDM. Each participating general practice initially
130 identified a small GooD4Mum project team (typically a doctor and another staff member) to drive
131 the project activities and nominated a lead to engage with the project manager. The Primary Health
132 Networks nominated their QIC local program officers to engage with the project manager during
133 GooD4Mum. The project manager provided each QIC Local Program Officer and general practice
134 leads with one-to-one project training prior to the project starting. GooD4Mum registered with the
135 Royal Australian College of General Practitioners for Category A Continuous Professional
136 Development, which was important for GP participation. The QIC methods were unfamiliar to three
137 practices, these practices required additional support from the project manager and QIC Local
138 Program Officer.

139 GooD4Mum was divided into four three-monthly activity periods. During each activity period,
140 general practice teams used the Model of Improvement (three improvement questions and mini
141 quality improvement cycles using the Plan-Do-Study-Act approach). A minimum of one Plan-Do-
142 Study-Act cycle report was required for each activity period. Women with a previous or current GDM
143 diagnosis were identified through a combination of practice software and manual patient record
144 searches to form local general practice GDM registers, which were audited using the quality
145 improvement measures prior to each learning workshop. QIC Local Program Officers assisted general
146 practices with conducting audits, creating and maintaining local practice registers, reinforcing
147 learning workshop messages and providing guidance on completing Plan-Do-Study-Act cycles. The
148 project manager collected, analysed and fed-back quality improvement measures to general practices

149 and Primary Health Networks through emailed quarterly report cards. Similarly, Plan-Do-Study-Act
150 cycles were formally collated and shared among general practice teams at six monthly intervals.

151 General practice teams and QIC Local Program Officers attended four 90-minute online learning
152 workshops (webinars), facilitated by the project manager. The webinars provided interactive
153 learning on the change principles, quality improvement process and guidelines. The audit data from
154 each practice was shared during the webinar and a core component was sharing ideas and
155 collaborative problem solving. Webinars had a prescribed format (welcome, learning outcomes
156 outlined, reflection and discussion of audit data, learning topic with guest presenter/s, sharing ideas,
157 question time and review of learning outcomes, reminders) and the topics were progressive
158 (webinar one: creating and cleaning a local GDM register, webinar two: the practicalities of
159 postpartum screening, webinar three: lifestyle modification for diabetes prevention, webinar four:
160 sharing success through case studies). Each webinar recording was made accessible via the project
161 website for all participants; the website also hosted a discussion board, non-identified Plan-Do-
162 Study-Act reports and quarterly newsletters.

163 Study of Intervention

164 The approach chosen for assessing the impact of the intervention was assessing the guidelines and
165 determining what objective actions would reflect them being put into practice. For women with
166 previous GDM, this was engaging in [annual](#) diabetes screening and having a consultation where their
167 [lifestyle-related modifiable](#) diabetes risk ~~was~~ assessed. For diabetes screening, the issue of
168 whether the test type (arduous oral glucose tolerance test versus quicker fasting blood glucose or
169 Haemoglobin A1c (HbA1c) influenced observed outcomes was questioned but the Expert Reference
170 Panel deemed any change in screening activity would be sufficient evidence that the intervention
171 was driving the behaviour because of the previously low level of engagement of women in screening
172 over time [7, 8]. Also any changes in the first 3 months postpartum diabetes screening were specific
173 to changes in oral glucose tolerance testing, which would differentiate the effect of different

174 diabetes screening tests. For the diabetes prevention consultation, a specific project form was
175 required to be printed for each woman and this enabled general practices to differentiate
176 intervention consultations ~~with from~~ standard ones. Cost information was captured throughout the
177 intervention from a QIC and intervention perspective. The cost data was collected from women and
178 practices participating using cost diaries alongside recorded project expenses. Qualitative interviews
179 and focus groups were conducted in each practice upon completion of the QIC activity to explore
180 barriers and enablers to the intervention.

181 Measures

182 The outcome measures were decided by the Expert Reference Panel based on guidelines [17],
183 previously used QIC diabetes prevention measures and measures that were readily extractable from
184 clinical software within a busy clinical setting. All data were aggregated at the practice level and non-
185 identifiable. The general practice lead conducted the manual data extraction every three months.
186 Audit data were manually checked against patient records to ensure counts were accurate and
187 complete. The primary outcome measures were the proportions of women on individual general
188 practice audits: 1) who completed a diabetes-screening test; and 2) who engaged in a diabetes
189 prevention planning consultation within the previous 15 months. The 15-month timeframe was
190 chosen to allow for local variation in appointment scheduling and return of screening results.
191 Additional secondary outcome measures included oral glucose tolerance test screening rates by
192 three months postpartum and distribution of normal body mass index (BMI) within the practice
193 audit. BMI measurement was identified as a critical measure to identify high-risk women within the
194 register. The change in measures were calculated as average percentage change over time.

195 Analysis

196 Run charts were used to report the results of changes in measures over the 12 month intervention
197 (Supplementary Table 1 details each measure). Repeated-measure ANOVA was used to determine if

198 measures differed significantly between audits. A Greenhouse-Geisser correction was applied where
199 the assumption of sphericity was violated and post-hoc tests were corrected for multiple
200 comparisons using the Bonferroni method. The cost data were analysed using a pathway approach
201 and only cost descriptions could be provided. The qualitative data was analysed thematically by an
202 experienced qualitative researcher (SOR) and coded transcripts were checked by the participants for
203 accuracy of interpretation.

204 Ethical considerations

205 Good4Mum had ethical approval provided by Deakin University (HEAG-H 167_2014). The project
206 was managed and data were analysed by an external person to remove the influence of power
207 relationships. The standard of care provided to patients was aligned with guidelines and no personal
208 or identified data was shared outside the general practice. Each general practice consented to
209 inclusion and there were no funding incentives provided to participate.

210 **Results**

211 Fifteen general practices participated and fourteen completed the project work. One practice was
212 acquired by a larger provider during the project and subsequently withdrew, they were excluded
213 from the analysis as a result. The Expert Reference Panel determined that a three-monthly audit
214 frequency was appropriate due to the relatively low prevalence of GDM in general practice
215 populations and the period being sufficient to allow women time to engage in diabetes screening, or
216 attend an appointment for a diabetes prevention planning consultation, or both. The submission of
217 audits ranged from 100% to 93% each quarter and the number of women on registers with screening
218 within three months of delivery grew from 43% to 60%. Approximately 481 women with a history of
219 GDM were involved in the Good4Mum project. Thirty-eight Plan-Do-Study-Act cycles were reported
220 over the 12-month project and an average of three cycles were reported per general practice.

221 There was a general trend of improvement in variables measured over the duration of the project,
222 reflected in the main by shifts in screening practices and BMI monitoring (Table 1). The average
223 number of women per practice with a diagnosis of GDM was 26 (Table 2). At baseline, the average
224 level of screening occurring was 26%, rising to 61% at 12 months (P=0.002). BMI monitoring
225 increased from 51% at baseline to 69% at 12 months (P=0.003). The postpartum diabetes screening
226 and diabetes prevention action planning consultations rose over the course of the project (from 43%
227 to 60% for screening, P=0.066; from 1% to 10% for consultations, P=0.183). The impact of practice
228 location and size was explored descriptively (Supplementary Table [24](#) and [32](#)). The average rate of
229 conversion to Type 2 Diabetes was 6% (± 7 SD) over the 12 months but 2 general practices have
230 missing data for this variable.

231 The qualitative data proposed re-are several potential reasons barriers to conducting the diabetes
232 prevention planning for the low uptake of the consultation: 1) it was only emphasised in the final six
233 months of GooD4Mum and therefore had less time to become embedded within daily practice
234 activity; 2) organising it within normal practice workflows was challenging; 3) women were reluctant
235 to attend it for financial and time reasons; 4) limited lifestyle modification referral options existed;
236 and 5) some GPs and practice nurses lacked confidence to engage in a lifestyle modification
237 consultation-

238 The planned intervention activity was influenced by several external factors (Table 1). Briefly, during
239 the project's first quarter, glyated haemoglobin (HbA1c) became a government funded (Medicare)
240 screening test for high-risk individuals and women with a history of gestational diabetes were
241 eligible. At the time, HbA1c was not present in any GDM-specific guidelines and the expert reference
242 panel recommended that HbA1c screening was not recommended for first postpartum screening
243 test but suitable thereafter. Primary Health Networks were restructured by the Australian
244 government at the halfway point of the project, impacting the capacity of Local Program Officers to
245 be involved and the project manager assumed responsibility for this activity during the final part of

246 the project. The general practice software had initial limitations extracting data for some measures,
247 but this was resolved within the first 2 quarters. The lifestyle modification program used for diabetes
248 prevention in Victoria (State-funded and run by Diabetes Australia, Victoria) had a period of funding
249 uncertainty in quarter three. During that time, GPs were unable to refer their patients into the
250 program and alternative referral plans were developed. When the program was funded again in the
251 final quarter, these alternative plans were rescinded.

252 Total GooD4Mum intervention costs were estimated at \$AUD 52,923, comprising project
253 coordination \$AUD 11,573, QIC Local Program Officers time cost \$AUD 1,919, GP and practice staff
254 time cost \$AUD 14,172, materials development and production \$AUD 24,405 and website resources
255 \$AUD 854. The average cost per practice was estimated at \$AUD 3,528 during the QIC project.
256 However, more than one third of total costs were associated with the handbook and material
257 development, which would not be required for future implementation. Excluding the research and
258 development costs, it was anticipated to deliver the intervention to one general practice would cost
259 \$AUD 2,166. Healthcare costs were collected from women with a GDM history in the participating
260 general practices. However, the results were not representative due to a very small sample size (N=3
261 pre-intervention and N=10 post-intervention) and not reported as a result.

262 **Discussion**

263 The GooD4Mum QIC was able to demonstrate improved diabetes screening and BMI monitoring in
264 women with previous GDM – the rate of screening doubled and a twenty percent increase in BMI
265 monitoring occurred. Diabetes prevention QICs work by screening the practice population aged over
266 40 and largely identify people aged 50-69 [15] but the average age for GDM diagnosis is 30 years
267 [18], which means these women will generally be overlooked by diabetes prevention efforts and go
268 unnoticed in general practice. The creation and regular maintenance of a local GDM register enables
269 practices to promote awareness of this growing population and embed diabetes prevention within
270 routine care.

271 Although several studies have reported the outcomes of interventions to improve postpartum
272 screening rates or lifestyle modification programs to reduce T2DM risk in women with previous GDM
273 [19-22], only two screening reminder studies have been located in general practice [20, 23] and
274 none has addressed both outcomes together. Most have limited generalisability due to being
275 conducted in a single organisation and few used a multimodal approach, which is known to be a
276 critical aspect for supporting change in health behaviour [24]. Participating Good4Mum general
277 practices had varying levels of experience with QIC methods, had different practice sizes and were
278 located in urban and rural areas – all of which adds to the external validity of the findings.

279 QICs are multifaceted interventions that bring together many of the successful approaches identified
280 in systematic reviews for professional behaviour change (educational meetings, educational
281 outreach, local opinion leaders, audit and feedback, computerised reminders and tailored
282 interventions), which can yield changes in the order of 50% of participants [14]. Diabetes screening
283 and BMI monitoring in Good4Mum aligns well with previous QIC diabetes prevention initiatives [15]
284 but providing a diabetes prevention planning consultation was the more challenging component of
285 the project ~~and- it~~ had low uptake by both practice staff and women and practice staff reported
286 several barriers to engaging in the activity. In looking at the QIC activities as behaviours that need to
287 be changed and using the Theoretical Domains Framework[25] to map them, the screening activity
288 required minor environmental restructuring to ensure GPs knew which women needed screening
289 alongside some education and training with modelling promoted via teleconferences. These were
290 easier behaviours to change because staff already know they will get reimbursed for doing the blood
291 test and that HbA1c is a useful diabetes indicator. The prevention planning activity was a new
292 process for the practices and required substantial behaviour change. Within the theoretical domains
293 framework it called for: cognitive and interpersonal skills (training practice nurses to perform the
294 tasks and support women to engage in lifestyle change), belief about capability and consequences
295 (both staff and woman), environmental restructuring (needed patient and staff resources plus space
296 to conduct consultation), education and training, persuasion and enablement to influence practice

297 nurses and GPs optimism that the prevention planning consultations was worthwhile. ~~There are~~
298 ~~several potential reasons for the low uptake of the consultation: 1) it was only emphasised in the~~
299 ~~final six months of GooD4Mum and therefore had less time to become embedded within daily~~
300 ~~practice activity; 2) organising it within normal practice workflows was challenging; 3) women were~~
301 ~~reluctant to attend it for financial and time reasons; 4) limited lifestyle modification referral options~~
302 ~~existed; and 5) some GPs and practice nurses lacked confidence to engage in a lifestyle modification~~
303 ~~consultation [25].~~ It may simply be that providing a diabetes planning consultation to all women with
304 a history of GDM is not appropriate and that providing the consultation in a more targeted fashion
305 would yield better results. This should be explored in further work. Similarly GooD4Mum
306 represented a modest investment to improve diabetes screening and risk monitoring amongst a
307 high-risk population. Further research using a full economic evaluation is needed to assess the value
308 for money of this type of intervention.

309 Limitations

310 GooD4Mum was a small-scale, uncontrolled QIC conducted in a single State in Australia. While the
311 changes in the measures could be attributed to epiphenomena, we know that usual care during the
312 same timeframe was not producing change in diabetes screening [7, 8] or lifestyle modification rates
313 [21]. Similarly the changes in diabetes screening could be attributed solely to the availability of
314 HbA1c as a Medicare funded item and easier test to undertake, yet the change seen in postpartum
315 screening was only due to increased oral glucose tolerance testing, pointing to GooD4Mum
316 stimulating a increase in screening activity across the board. The 6-8 week postpartum screening
317 audit lacks complete data for audit one and two so a full picture cannot be seen for the whole
318 project, a clear limitation as this information would have provided a more nuanced picture of the
319 change in postpartum quality of care. Patient level data were not collected within GooD4Mum due
320 to ethics approval restrictions, which limited our ability to explore the impact of factors such as age,
321 blood glucose measurement values, education level or socioeconomic status as potential modifiers

322 of engagement with the general practice and consequently the QIC activity. The small sample size
323 limited the level of insight that could be gained from the QIC project. Only three Plan-Do-Study-Act
324 cycles were reported on average per practice, which is low for QIC projects and a possible limitation.
325 Staff turnover was the main reason for practices missing Plan-Do-Study-Act cycles and some
326 practices wrote up several Plan-Do-Study-Act activities within a single report, which reduced the
327 number of Plan-Do-Study-Act reports they submitted. It is possible that a cluster randomised
328 controlled trial approach with more refined measures would address the majority of the limitations
329 identified.

330 Conclusions

331 This QIC project demonstrates significant improvements in type 2 diabetes screening and BMI
332 monitoring but further improvements are possible, particularly around diabetes prevention planning
333 consultations. Future practice needs to build upon the learnings of this project and ensure that a
334 systems approach is taken to improve outcomes for women with previous GDM.

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340 Conflict of interest

341 The authors declare that they have no conflict of interest.

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359

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433

Table 1. Diabetes prevention collaborative for women with previous gestational diabetes in general practice and its evolution over time.

Aim	<ul style="list-style-type: none"> • 100% women with previous GDM within participating general practices to have a diabetes screening test within the past 15 months • 100% women with previous GDM within participating general practices to be provided with the opportunity to receive a consultation discussing a diabetes prevention action plan within the past 15 months 	
Timeline	Planned activity	External influences
Jul-Sep 2014	<ul style="list-style-type: none"> • Handbook preparation • Expert Reference Panel meeting – change principles and measures • Handbook finalised and endorsed by Expert Reference Panel, provided to all general practices • General practice recruitment to quality improvement collaborative 	
Oct-Dec 2014	<ul style="list-style-type: none"> • Audit 1 where the program manager and Local Program Officer supported practices to perform initial audit and form the baseline register of women with previous GDM • Learning workshop 1 occurred • Plan-Do-Study-Act cycle/s undertaken in general practice and records provided to program manager 	<ul style="list-style-type: none"> • Australian government announced HbA1c as a screening test under Medicare funding (Late Nov) • Handbook materials, audit support and education materials updated to reflect change and delivered to general practice • General practice audit software data extraction coding issue, negotiation with several software providers to resolve issue
Jan-Apr 2015	<ul style="list-style-type: none"> • Audit 2 performed with continued support • Learning workshop 2 occurred • Plan-Do-Study-Act cycle/s undertaken in general practice and records provided to program manager 	<ul style="list-style-type: none"> • General practice software patch rolled out to fix coding issue (Jan/Feb)
May-Aug 2015	<ul style="list-style-type: none"> • Audit 3 performed with continued support • Learning workshop 3 occurred • Plan-Do-Study-Act cycle/s undertaken in general practice and records provided to program manager 	<ul style="list-style-type: none"> • State-wide diabetes prevention program places freeze on new participants due to funding renegotiation, practices unable to refer women with previous GDM • American Diabetes Association and NICE revise guidelines to include HbA1c as screening test for women with previous gestational diabetes • Australian government restructure of Primary Health Networks reduces Local Program Officer capacity
Sep-Dec	<ul style="list-style-type: none"> • Audit 4 performed with continued 	<ul style="list-style-type: none"> • State-wide diabetes prevention

2015	support <ul style="list-style-type: none">• Learning workshop 4 occurred• Plan-Do-Study-Act cycle/s undertaken in general practice and records provided to program manager• Final audit performed	program refunded and new participants accepted
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Table 2. Summary of means and 95% confidence intervals from the general practices completing Good4Mum (N=14).

Outcome	Baseline	Audit 1	Audit 2	Audit 3	Audit 4	<u>Significant comparisons</u>
	Nov 2014	Feb 2015	May 2015	Aug 2015	Nov 2015	
Women registered (N)	26.7 (8.6, 44.8)	23.4 (6.3, 40.5)	29.6 (12.6, 46.6)	31.1 (14.5, 47.8)	34.4 (17.2, 51.5)	<u>Audit 1 v Audit 4;</u> <u>Audit 2 v Audit 4</u>
Women screened for diabetes (N)	9.1 (1.4, 16.9)	10.8 (2.3, 19.3)	14.9 (5.4, 24.4)	16.4 (6.0, 26.8)	20.0 (9.1, 30.9)	<u>Baseline v Audit 3;</u> <u>Baseline v Audit 4;</u> <u>Audit 1 v Audit 4</u>
Women screened for diabetes (%)	26.1 (11.6, 40.7)	32.9 (16.1, 49.7)	53.4 (38.9, 68.0)	54.2 (39.4, 69.0)	61.0 (48.6, 73.4)	<u>Baseline v Audit 5</u>
Women with BMI recorded (%)	50.7 (28.1, 73.3)	55.9 (34.7, 77.1)	65.6 (48.9, 82.2)	69.6 (55.1, 84.0)	68.8 (53.4, 84.2)	<u>Baseline v Audit 3;</u> <u>Baseline v Audit 4</u>
Women with normal BMI recorded (%)	19.1 (4.7, 33.4)	22.1 (9.4, 34.9)	31.3 (15.0, 47.6)	32.8 (16.5, 49.1)	33.2 (16.6, 49.9)	<u>No significant comparisons</u>
Women with diabetes prevention action planning consultation (%)	0.9 (-1.0, 2.7)	5.6 (-5.7, 16.8)	7.3 (-3.8, 18.4)	9.1 (-3.4, 21.7)	10.3 (-3.0, 23.5)	<u>No significant comparisons</u>
Women screened for diabetes within first three months postpartum (%)	Data incomplete	Data incomplete	42.3 (22.4, 64.2)	46.6 (23.8, 69.5)	59.9 (39.5, 80.3)	<u>No significant comparisons</u>

Supplementary Table 1. GooD4Mum quality improvement collaborative measures

Measure	Description
GDM Register	The number of women within the clinical database that are coded with a diagnosis matching the GDM definition
T2DM Screening	The number of women on the GDM Register who have had an OGTT/FPG measurement recorded within the previous 15 months
T2DM diagnosis	The number of women on the GDM Register who have had a diagnosis of T2DM recorded
T2DM Prevention Care	The number of women on the GDM Register who had the GooD4Mum diabetes prevention action plan printed out
Postpartum Follow Up of Gestational Diabetes	The number of women on the GDM Register who gave birth within the previous year <u>and</u> had an OGTT measurement recorded within 3 months of delivery
Body Mass Index (BMI) - Recorded	The number of women on the GDM Register with recorded weight <u>and</u> height OR BMI
Normal Body Mass Index (BMI)	The number of women on the GDM Register where BMI is < 25

Supplementary Table 2. Summary of means and 95% confidence intervals from the general practices completing Good4Mum divided into metropolitan and rural areas using Accessibility/Remoteness Index of Australia (ARIA).

	Metro (n=11)	Rural (n=3)
Total register (n, 95%CI)		
Audit 1	25.5 (4.1, 46.8)	31.3 (-57.9, 120.5)
Audit 2	25.9 (3.6, 48.2)	14.3 (-3.6, 32.3)
Audit 3	32.2 (10.3, 54.1)	20.0 (-10.2, 50.2)
Audit 4	32.8 (11.2, 54.4)	25.0 (-8.42, 58.4)
Audit 5	36.3 (14.2, 58.2)	27.3 (-10.3, 65.0)
Diabetes screened (% register, 95%CI)		
Audit 1	24.5 (8.8, 40.2)	32.3 (-58.5, 123.1)
Audit 2	28.1 (9.1, 47.1)	50.7 (-23.5, 124.9)
Audit 3	55.4 (38.0, 72.8)	46.3 (-19.1, 111.8)
Audit 4	53.7 (35.2, 72.3)	56.0 (0.1, 109.9)
Audit 5	61.0 (44.9, 77.1)	61.0 (35.8, 86.2)
Diabetes prevention consultation (% register, 95%CI)		
Audit 1	1.1 (-1.3, 3.5)	0 (0)
Audit 2	7.1 (-7.6, 21.8)	0 (0)
Audit 3	8.9 (-5.6, 23.5)	1.3 (-4.4, 7.1)
Audit 4	10.7 (-5.7, 27.1)	3.3 (-5.4, 12.1)
Audit 5	12.3 (-5.0, 30.0)	3.0 (-4.5, 10.5)

Supplementary Table 3. Summary of means and 95% confidence intervals from the general practices completing Good4Mum divided into practice size, using number of effective full-time general practitioners employed at baseline.

	Small practice (n=2)	Medium practice (n=4)	Large practice (n=8)
Total register (n, 95%CI)			
Audit 1	5.5 (-39.0, 50.0)	17.5 (-0.9, 35.9)	36.6 (4.5, 68.8)
Audit 2	6.5 (-50.7, 63.7)	16.8 (-0.8, 34.3)	31.0 (-0.3, 62.3)
Audit 3	7.0 (-31.1, 45.1)	22.0 (19.1, 24.9)	39.0 (8.6, 69.4)
Audit 4	8.0 (-42.8, 58.8)	22.0 (19.1, 24.9)	41.5 (12.3, 70.7)
Audit 5	9.5 (-60.4, 79.4)	26.5 (17.7, 35.3)	44.5 (14.6, 74.4)
Diabetes screened (% register, 95%CI)			
Audit 1	22.0 (-257.5, 301.5)	18.5 (-6.4, 43.4)	31.0 (6.3, 55.7)
Audit 2	41.0 (-480.0, 562.0)	19.5 (7.3, 46.3)	37.6 (13.6, 61.6)
Audit 3	75.0 (-242.7, 392.7)	48.0 (17.0, 79.0)	50.8 (28.9, 72.6)
Audit 4	66.5 (-143.2, 276.2)	36.0 (-5.1, 77.1)	60.3 (40.1, 80.5)
Audit 5	68.5 (-166.6, 303.6)	46.8 (12.0, 81.6)	66.3 (49.9, 82.7)
Diabetes prevention consultation (% register, 95%CI)			
Audit 1	0 (0)	3.0 (-6.6, 12.6)	0 (0)
Audit 2	36.5 (-427.3, 500.3)	1.3 (-2.7, 5.2)	0 (0)
Audit 3	36.5 (-427.3, 500.3)	3.5 (-3.4, 10.4)	1.9 (-1.4, 5.2)
Audit 4	41.5 (-485.8, 568.8)	3.5 (-3.4, 10.4)	3.9 (-0.1, 7.9)
Audit 5	43.5 (-509.2, 596.2)	3.5 (-3.4, 10.4)	5.4 (-1.0, 11.8)

SQUIRE 2.0 Reporting Checklist		
Section	Description	Location
Title	Indicate that the manuscript concerns an initiative to improve healthcare (broadly defined to include the quality, safety, effectiveness, patientcenteredness, timeliness, cost, efficiency, and equity of healthcare)	1-2
Abstract	a. Provide adequate information to aid in searching and indexing b. Summarize all key information from various sections of the text using the abstract format of the intended publication or a structured summary such as: background, local problem, methods, interventions, results, conclusions	31-47
Introduction	<i>Why did you start?</i>	
Problem description	Nature and significance of local problem	64-68
Available knowledge	Summary of what is currently known about the problem, including relevant previous studies	70-79
Rationale	Informal or formal frameworks, models, concepts, and/or theories used to explain the problem, any reasons or assumptions that were used to develop the intervention(s), and reasons why the intervention(s) was expected to work	80-88
Specific aims	Purpose of the project and of this report	89-90
Methods	<i>What did you do?</i>	
Context	Contextual elements considered important at the outset of introducing the intervention(s)	93-110
Intervention	a. Description of the intervention(s) in sufficient detail that others could reproduce it b. Specifics of the team involved in the work	113-149
Study of intervention	a. Approach chosen for assessing the impact of the intervention(s) b. Approach used to establish whether the observed outcomes were due to the intervention(s)	151-162
Measures	a. Measures chosen for studying processes and outcomes of the intervention(s), including rationale for choosing them, their operational definitions, and their validity and reliability b. Description of the approach to the ongoing assessment of contextual elements that contributed to the success, failure, efficiency, and cost c. Methods employed for assessing completeness and accuracy of data	164-175
Analysis	a. Qualitative and quantitative methods used to draw inferences from the data b. Methods for understanding variation within the data, including the effects of time as a variable	177-182
Ethical considerations	Ethical aspects of implementing and studying the intervention(s) and how they were addressed, including, but not limited to, formal ethics review and potential conflict(s) of interest	184-188
Results	<i>What did you find?</i>	
Results	a. Initial steps of the intervention(s) and their evolution over time (e.g., time-line diagram, flow chart, or table), including modifications made to the intervention during the project b. Details of the process measures and outcome c. Contextual elements that interacted with the intervention(s)	190-221

	<ul style="list-style-type: none"> d. Observed associations between outcomes, interventions, and relevant contextual elements e. Unintended consequences such as unexpected benefits, problems, failures, or costs associated with the intervention(s). f. Details about missing data 	
Discussion	<i>What does it mean?</i>	
Summary	<ul style="list-style-type: none"> a. Key findings, including relevance to the rationale and specific aims b. Particular strengths of the project 	223-231
Interpretation	<ul style="list-style-type: none"> a. Nature of the association between the intervention(s) and the outcomes b. Comparison of results with findings from other publications c. Impact of the project on people and systems d. Reasons for any differences between observed and anticipated outcomes, including the influence of context e. Costs and strategic trade-offs, including opportunity costs 	232-254
Limitations	<ul style="list-style-type: none"> a. Limits to the generalizability of the work b. Factors that might have limited internal validity such as confounding, bias, or imprecision in the design, methods, measurement, or analysis c. Efforts made to minimize and adjust for limitations 	256-273
Conclusions	<ul style="list-style-type: none"> a. Usefulness of the work b. Sustainability c. Potential for spread to other contexts d. Implications for practice and for further study in the field e. Suggested next steps 	275-281
Funding	Sources of funding that supported this work. Role, if any, of the funding organization in the design, implementation, interpretation, and reporting	283-286

Data Statement

[Click here to download Data Statement: dataprofile.xml](#)