

A systematic review and thematic synthesis of the barriers and facilitators to physical activity for women after gestational diabetes: a socio-ecological approach

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Abstract

Physical activity can reduce risk of type 2 diabetes (T2DM) after gestational diabetes. Understanding barriers and facilitators to physical activity, using a socio-ecological approach, could better direct multi-level interventions. The present review aimed to synthesise barriers and facilitators to physical activity, and to develop an understanding of where, across the socio-ecological model, these factors exist and/or are interrelated. Eligible studies included women with a history of gestational diabetes and a discussion around physical activity. A systematic search of MEDLINE, the Cochrane Library, Web of Science, CINAHL Complete and Scopus was conducted in October 2022. Barriers and facilitators to physical activity were thematically analysed and themes organised according to the socio-ecological model. Twenty-nine studies were included.

Barriers pertained to leisure time physical activity, while other types of activity including housework and transport were overlooked, despite being routine. Partner and family support were vital for engagement with activity, whether emotional support or provision of childcare. Most barriers and facilitators at the social and organisational levels were interrelated with those at the individual level. These findings suggest that multi-level physical activity interventions after gestational diabetes could be most effective.

Br J Diabetes 2023;**23**:2-13

Key words: physical activity, gestational diabetes, socio-ecological model, type 2 diabetes, barriers, facilitators, women's health, maternal health

Introduction

Gestational Diabetes Mellitus (GDM) occurs during pregnancy, and its prevalence has been steadily increasing, with the International Diabetes Federation (IDF) reporting a prevalence of 20.6% in the UK in 2021.¹ A GDM diagnosis increases the risk of several long-term complications, including increasing the risk of subsequent type 2 diabetes mellitus (T2DM) ten-fold.^{2,3} Preventing T2DM after GDM is a clinical priority.⁴

Lifestyle changes, including diet and physical activity (PA), can reduce risk of T2DM by up to 50%.⁵⁻⁷ This level of risk reduction can also be achieved after GDM.^{8,9} The National Institute for Health and Care Excellence (NICE) recommends promoting healthy lifestyle behaviours after a case of GDM.⁸ In the UK women with previous GDM can access the "Healthier You" National Diabetes Prevention Program. However, this program was designed for the general population, who may not face the unique barriers present for women with young families, such as other family commitments, lack of childcare and other responsibilities.^{9,10} This could in part explain why people who do engage with these lifestyle programs tend to be over the age of 65 years,¹¹ and why GDM patients' participation in prevention interventions is variable.¹² Overcoming engagement barriers to lifestyle changes in this population is important for lasting behaviour change and subsequent T2DM risk management.

The barriers to participation and engagement with PA after GDM may not be entirely within an individual's power to control. The Socio-Ecological Model (SEM) can be used to aid understanding of interrelationships between individuals and the factors associated with their surrounding environments, such as social, physical and policy factors.¹³ Viewing barriers and facilitators to PA with an SEM lens could therefore improve understanding of the cultural, social and other contextual factors that impact PA for women after GDM.^{14,15} Peng *et al.* used the SEM to explore barriers and facilitators to PA for young adult women and highlighted the wider socio-cultural influences on PA and the need for including multi-level strategies to target women's PA.¹⁶ For example, at wider levels, family support was 'crucial' to engaging with PA, while family commitments were the most significant barrier to PA for young adult women. It is therefore important to explore whether there are any differences or similarities in the wider barriers and facilitators to PA for women after GDM, to better tailor multi-level strategies aiming to improve PA after GDM.

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<https://doi.org/10.15277/bjd.2023.413>

The only review to look at barriers and facilitators to lifestyle changes postpartum was published in 2019 by Dennison *et al.*¹⁰ The barriers and facilitators to PA may differ in comparison to those of other lifestyle changes such as diet, since PA may be considered less important and time constraints may limit PA more.^{17,18} Buelo *et al.* explored PA-specific barriers and facilitators as part of a mixed methods review, where the qualitative component organised themes according to Dahlgren and Whitehead's determinants of health model.¹⁹ However, the Dahlgren-Whitehead model was designed to explore impacts on health, while the SEM highlights the interrelated systems surrounding and influencing individual behaviour, and therefore provides the structure for a deeper dive into the wider contexts affecting PA. The present review aimed to update these reviews, using a socio-ecological lens, to explore the barriers and facilitators to PA for women after GDM.

Methods

Five databases (MEDLINE, CINAHL, Scopus, Web of Science and Cochrane) and reference lists were searched in October 2022. Three main search themes (combined with 'AND') were constructed with the phenomenon of interest (physical activity and T2DM prevention as two separate themes) and sample (women with a history of GDM).²⁰ Within these themes, Mesh and search terms were combined with 'OR'. Terms were developed from other reviews of barriers and facilitators,¹⁸ and lifestyle interventions after GDM.^{19,21-24}

Table 1 summarises the inclusion criteria. The SPIDER tool was used to determine eligibility.²⁵ While studies did not exclusively explore PA postpartum, PA discussions had to be reported in the results, either as part of a lifestyle intervention or general attitudes for lifestyle changes. Title and abstracts were screened by the first author (EI), with a second round of screening at full-text level. A second reviewer (HH) independently processed a random 10% sample of papers at each stage. Disagreements were resolved by discussion. EI used the Critical Appraisal Skills Programmes (CASP) checklist for qualitative research as a quality assessment tool for the studies included in the present review, with a sample discussed with a second reviewer (HH).²⁶

A reflexive thematic analysis was employed, where multiple coders aided reflexivity in interpretations and sense-making from themes.²⁷ Open coding was used inductively, and data were extracted as reported results or participant quotes. Descriptive themes were then organised according to the SEM.¹⁴ Themes were grouped into respective levels depending on where they were actionable. This helped view barriers and facilitators through the lens of wider contexts and their influences on individual behaviour,¹³ and enabled identification of relationships between themes (inter-relationships) i.e. where themes appeared to act across more than one level. Nvivo 12 was utilised by the research team to aid the process of thematic analysis, as the team were all familiar with the software and were able to share the files so all authors could access and review the data and coding.

Results

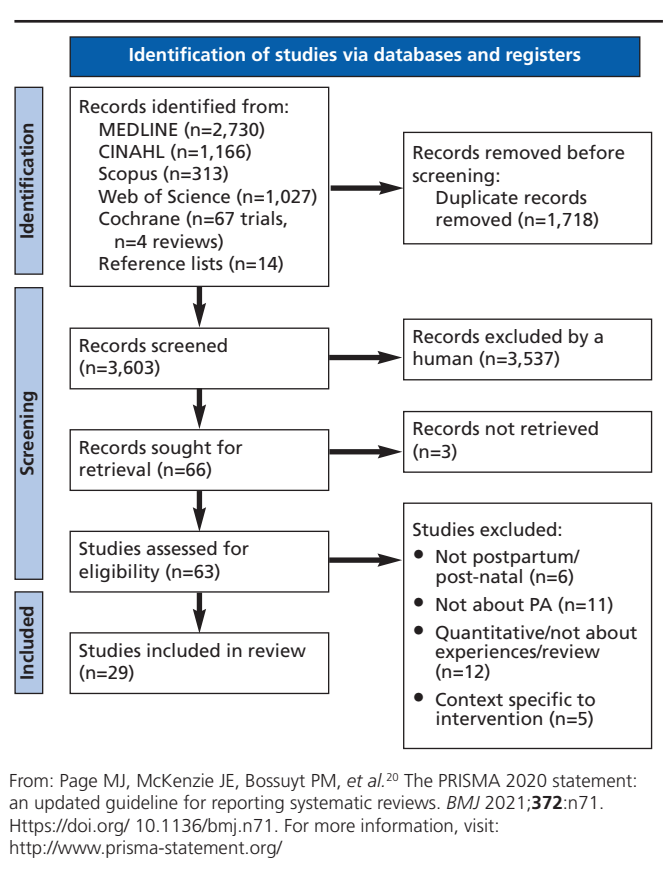
Twenty-nine studies were included (Figure 1).²⁰ At title and abstract stage, 3,603 records were screened and 63 progressed to full-text

Table 1 Summary of inclusion criteria for the present review

Inclusion criterion	Include	Exclude
Sample	Women with a history of GDM	Women with current/previous T1DM or T2DM or for GDM prevention (versus AFTER)
Phenomenon of interest	PA as a lifestyle change after GDM to prevent T2DM	Screening for T2DM, or specific dietary barriers
Design	Interview or focus groups	Surveys or questionnaires.
Evaluation	Experiences, attitudes, feelings, barriers and facilitators	-
Research type	Qualitative or mixed method	Quantitative

Each inclusion criterion was separated by the review questions being addressed.
GDM, Gestational Diabetes Mellitus; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus; PA, physical activity

Figure 1. PRISMA 2020 flow diagram for systematic reviews which include searches of databases.



screening. Articles were excluded if participants were pregnant (n=6), if the studies did not include PA (n=11), and if they were quantitative or review papers (n=12). Summary of included participant characteristics can be seen in Appendix 1 (online at www.bjd-abcd.com).

Since the reviews published by Dennison *et al.* and Buelo *et al.* in 2019,^{10,19} nine new published papers were identified. A summary of the study characteristics of all the papers considered in this review is presented in Table 2.²⁸⁻⁵⁶ All but four studies had a CASP

Table 2. Summary of included study characteristics

Author	Date	Title	Total #	Country	Study Aims	Study Design	Timing	Analysis	CASP
Bandyopadhyay <i>et al.</i> , ²⁸	2011	Lived experience of GDM among immigrant South Asian women in Australia	17	Australia	Explore understanding of T2DM risk, risk reduction, management strategies, and attitudes and behaviour after GDM	Interviews (face-to-face) in-depth	2 time points: following GDM diagnosis, 6 wks PP	Thematic analysis - commonalities + divergent + inter-relationship of themes	7
Boyd <i>et al.</i> , ²⁹	2020	Utility of the COM-B model in identifying facilitators and barriers to maintaining a healthy postnatal lifestyle following a diagnosis of GDM: a qualitative study	27	UK	Explored the use of COM-B framework to code and the socio-ecological model to contextualise participant responses to better inform intervention development	Semi-structured interviews	6 + 12 wks PP	Thematic analysis coded using the COM-B framework.	8
Dasgupta <i>et al.</i> , ³⁰	2013	Strategies to optimize participation in diabetes prevention programs following GDM: a focus group study	29	Canada	To identify factors that could enhance participation and engagement in a T2DM prevention program	Focus groups	Within 5 yrs of GDM	Qualitative content analysis	7
Dennison <i>et al.</i> , ³¹	2022	Post-GDM support would be really good for mothers": a qualitative interview study exploring how to support a healthy diet and PA after GDM	20	UK	Exploring views of women with history of GDM on possible interventions to support healthy diet and PA to reduce diabetes risk + own suggestions to identify promising interventions for future development	1-to-1 semi-structured interview + suggestion cards	12wks to 4yrs PP	Framework + participants' collective response to each suggestion card	9
Doran ³²	2008	GDM: perspectives on lifestyle changes during pregnancy and post-partum, PA and the prevention of future T2DM	8	Australia	Explore factors that hinder + support women to engage in PA PP to reduce risk of developing future T2DM	Results of GDM survey + subset of interviews	6 - 12 mo PP	Thematic analysis	6.5
Doran and Davis ³³	2010	GDM in Tonga: insights from healthcare professionals and women who experienced GDM	11	Australia	To gain contextual insights from Tongan healthcare professionals and women who had developed GDM	Semi-structured interviews (face-to-face)	GDM in previous 12 mo	Thematic analysis	6
Evans <i>et al.</i> , ³⁴	2010	Health behaviours of PP women with a history of GDM	16	Canada	Determine perceived health status and experiences in establishing and maintaining healthy lifestyle changes	Interviews (semi-structured)	Interview 4x PP (@ 6 wks, 3, 6 & 12 mo)	Descriptive interpretative analytic approach + concurrent mixed method (convergence of quantitative and qualitative data)	7.5
Gaudreau and Michaud ³⁵	2012	Cultural factors related to the maintenance of health behaviours in Algonquin women with a history of GDM	15	Canada	To understand cultural factors contributing to maintenance of health behaviours encouraged during GDM pregnancy	Observation (cultural immersion, detailed observations recorded into logbooks) + semi-structured interviews with key + general informants	GDM within 2-10 yrs	Analysed observations in 4 phases, vertical analysis of interviews, horizontal analysis of patterns and context, themes confirmed with informants	7.5
Graco <i>et al.</i> , ³⁶	2009	Participation in PA: perceptions of women with a previous history of GDM	10	Australia	Explore perceptions of PA among women with previous GDM, in context of T2DM prevention	Semi-structured interviews	Not reported	Modified grounded theory approach + thematic analysis.	8
Hjelm <i>et al.</i> , ³⁷	2012	GDM: prospective interview-study of the developing beliefs about health, illness and health care in migrant women	14	Sweden	Explore development over time of beliefs about health, illness and health care in migrant women with GDM + study influence on self-care and care seeking	Semi-structured interviews (face-to-face) [qualitative prospective exploratory study]	3 time points: wks 34-38 gestation+ 3, 14 mo PP	The sequential interpretation technique, interpreting word for word, was used.	9
Ingol <i>et al.</i> , ³⁸	2020	Perceived barriers to T2DM prevention for low-income women with a history of GDM: a qualitative secondary data analysis	12 FG (n= 5-7)	USA	Examine perceived barriers to adoption of lifestyle changes for T2DM prevention among a diverse group of low-income women with a history of GDM	Focus groups (semi-structured)	GDM in the past 10 yrs	Secondary data analysis (iterative content analysis to identify key themes)	7

continued...

Table 2. Summary of included study characteristics *continued*

Author	Date	Title	Total #	Country	Study Aims	Study Design	Timing	Analysis	CASP
Jones <i>et al.</i> , ³⁹	2012	Cardiometabolic risk, knowledge, risk perception, and self-efficacy among American Indian women with previous GDM	17	USA	Describe knowledge, perceptions and self-efficacy beliefs related to preventing cardiometabolic disease	Interviews (not specified) [mixed methods, cross-sectional, exploratory, descriptive]	History of GDM	Content analysis. Latent content interpreted in final step from 4 major categories into 1 overarching theme	7
Jones <i>et al.</i> , ⁴⁰	2015	Identifying PP intervention approaches to reduce cardiometabolic risk among American Indian women with prior GDM, Oklahoma, 2012-2013	26	USA	Elicit perspectives on cardiometabolic risk reduction behaviours to inform the development of a PP lifestyle modification intervention	Interviews (face-to-face, telephone) + focus groups	GDM within 10 yrs	Inductive content analysis to identify codes + overarching themes	7
Krompa <i>et al.</i> , ⁴¹	2020	PP lifestyle modifications for women with GDM: a qualitative study	16	France	Describe + analyse feelings and daily lifestyle changes, including PA, among women who experienced GDM + evaluate how GDM diagnosis was followed by lifestyle modifications during the PP period, to prevent T2DM	Semi-structured interview	6-12 mo PP	Thematic analysis (open coding) following theory of planned behaviour	6
Lie <i>et al.</i> , ⁴²	2013	Preventing T2DM after GDM: women's experiences and implications for diabetes prevention interventions	Phase 1:n=31 Phase 2:n=14	UK	Explore factors influencing post-natal health behaviours after GDM + elicit views about feasibility of lifestyle intervention to prevent T2DM 2 yrs after childbirth	Two phases semi-structured interviews: purposive sampling, then theoretical sampling 12-18mo later	Within 2 yrs of GDM	Framework + structured comparative analysis of textual data (directed content analysis)	8
Lim <i>et al.</i> , ⁴³	2017	Comparing a telephone- and a group-delivered diabetes prevention programme Characteristics of engaged and non-engaged PP mothers with a history of GDM	N=165 Group n= 136 Phone n=29	Australia	To explore the acceptability of a diabetes prevention programme and compare the characteristics associated with programme engagement	Semi-structured interviews (face-to-face and telephone)	Group (3mo + 6 mo PP) Phone (6 mo PP)	Thematically analysed using open coding, processed iteratively using spreadsheets + mind-maps Subthemes categorised based on the Health Action Process	8
Lindmark <i>et al.</i> , ⁴⁴	2010	Perception of healthy lifestyle information in women with GDM: a pilot study before and after delivery	10	Sweden	Investigate how women with GDM perceived information; explore opinions on healthcare provision up to 1yr after delivery; investigate perceptions about lifestyle 1yr after delivery.	Structured Interviews (face-to-face)	1yr after GDM	Text divided into meaning units, condensed then coded. Codes with similar meanings put into categories.	7.5
Muhwava <i>et al.</i> , ⁴⁵	2019	Experiences of lifestyle change among women with GDM: a behavioural diagnosis using the COM-B model in a low-income setting	35	South Africa	To explore women's lived experiences of GDM and the feasibility of sustained lifestyle modification after GDM in a low-income setting	Focus group + interviews	Had GDM 2014-2015	Qualitative content analysis + COM-B model (inductive + deductive)	8.5
Nicklas <i>et al.</i> , ⁴⁶	2011	Identifying PP intervention approaches to prevent T2DM in women with a history of GDM	25	USA	Identify barriers and facilitators to healthy lifestyle changes, and approaches to facilitate participation in interventions	Interviews (telephone) + focus groups	GDM within previous 7 yrs	Using grounded theory, open coding to identify themes. For the informant interviews, data analysis consisted of frequency distributions.	8.5
O'Dea <i>et al.</i> , ⁴⁷	2015	Can the onset of T2DM be delayed by a group-based lifestyle intervention in women with prediabetes following GDM? Findings from a randomized controlled mixed methods trial	17	Ireland	Evaluate a 12-week group-based lifestyle intervention programme for women with prediabetes following GDM (give context to quantitative findings)	Semi-structured interviews (face-to-face)	1-3 yrs after GDM	Thematically analysed using inductive approach	7.5

continued...

Table 2. Summary of included study characteristics *continued*

Author	Date	Title	Total #	Country	Study Aims	Study Design	Timing	Analysis	CASP
Pace <i>et al.</i> , ⁴⁸	2020	Preventing diabetes after pregnancy with GDM in a Cree community: an inductive thematic analysis	13	Canada	Aimed to understand the perspectives of Cree women with prior GDM living in northern Quebec	Semi-structured interviews	GDM in previous 5 yrs (2013–2019)	Inductive thematic analysis framework	7.5
Parsons <i>et al.</i> , ⁴⁹	2019	A qualitative study exploring women's health behaviours after a pregnancy with GDM to inform the development of a diabetes prevention strategy	50	UK	Inform interventions for women with GDM by exploring factors that influence health behaviours and preferences for lifestyle support	Focus groups + semi-structured interviews	Within 5 yrs of GDM	Framework (themes derived iteratively from data)	8.5
Razee <i>et al.</i> , ⁵⁰	2010	Beliefs, barriers, social support and environmental influences related to diabetes risk behaviours among women with a history of GDM	57	Australia	Explore beliefs, attitudes, social support, environmental influences etc. on diabetes risk behaviours; preferred forms of programme delivery to inform health promotion	Semi structured telephone interviews	GDM 6–36 mo	Coding data by general themes - open ended then checked against pre constructed codes, then developed into broad themes using constant comparison	8.5
Shang <i>et al.</i> , ⁵¹	2021	Chinese women's attitudes towards PP interventions to prevent T2DM after GDM: a semi-structured qualitative study	20	China	Explore Chinese women's perspectives, concerns and motivations towards participation in early PP interventions and/or research to prevent the development of T2DM after a GDM-affected pregnancy	Face-to-face semi-structured interviews + focus groups	Within 6 mo PP	Inductive thematic analysis	6.5
Sharma <i>et al.</i> , ⁵²	2021	Understanding mechanisms behind unwanted health behaviours in Nordic and South Asian women and how they affect their GDM follow-ups: a qualitative study	28	Norway	Aimed to advance the knowledge regarding the mechanisms behind suboptimal follow-up in the Nordic and South Asian women with previous GDM	Focus group interviews	GDM within 1–3 yrs	Thematic analysis, quotes to support inspired by Lipsky's theory of street-level bureaucracy focusing on mechanisms behind unwanted health behaviours	7
Svensson <i>et al.</i> , ⁵³	2017	What is the PP experience of Danish women following GDM? A qualitative exploration	5	Denmark	To examine the experience of transition from a GDM-affected pregnancy to PP	Semi-structured interviews (face-to-face)	3-5 mo after delivery	Qualitative content analysis (inductively) sorted into themes	8.5
Tang <i>et al.</i> , ⁵⁴	2015	Perspectives on prevention of T2DM after GDM: a qualitative study of Hispanic, African-American and White women	23	USA	Explore T2DM risk perception and motivators and barriers to preventive health behaviours, to inform intervention approaches	Semi-structured interviews (face-to-face)	Within 12 mo PP	Template analysis (health belief model) to code and organize themes	8
Tierney <i>et al.</i> , ⁵⁵	2015	Factors influencing lifestyle behaviours during and after a GDM pregnancy	13	Ireland	Examined the healthy lifestyle behaviours undertaken during and after a pregnancy complicated by GDM and the factors that influenced the likelihood of undertaking of such behaviours	Semi-structured telephone interviews	GDM in the previous 3–7 yrs	Thematic analysis driven by clinical + theoretical interests (semantic approach)	7.5
Zulfiqar <i>et al.</i> , ⁵⁷	2017	Barriers to a healthy lifestyle post GDM: an Australian qualitative study	23	Australia	Experiences, barriers and facilitators of women trying to follow the health advice they received during pregnancy to maintain a healthy lifestyle more than 3yrs after childbirth	Interviews (face-to-face)	3+ yrs after childbirth	Thematic analysis (inductive + deductive coding)	7.5

#, number; IMD / SES, Index Multiple Deprivation / Socio-Economic Status; yrs, years; MSc, Master's Degree; PG, postgraduate; IT, information technology; FG, Focus Groups; Uni, university level education; BSc, Bachelor's degree; HE Higher Education; T(#), Tertial; primip, primiparous; multip, multiparous; IMD; index multiple deprivation rank; PP, postpartum; mo, months; wks, weeks; GDM, gestational diabetes mellitus; T2DM, type 2 diabetes mellitus

Table 3. Visual representation of theme appearance across included papers

Author (date)	Intrapersonal					Social				Organisational					Community	
	Capability		Motivation			Influence fam	Socialising	Support		Access		Health care	Opportunity		Type ex	Support groups
	Capacity	Challenge	Knowledge & info	Monitoring	Weight focus			Fam	Partner	Cost	Safety		Child care	Time care		
Bandyopahdyay (2011)	X	X	X		X			X					X	X		
Boyd (2020)	X	X	X	X		X	X	X	X	X		X	X	X	X	
Dasgupta (2013)	X	X	X	X		X	X	X	X			X	X	X	X	
Dennison (2022)	X		X	X		X	X	X	X			X		X	X	
Doran (2008)		X	X		X	X	X	X	X	X		X	X	X	X	
Doran (2010)		X	X		X			X				X				
Evans (2010)	X	X	X		X			X		X		X	X			
Gaudreau (2012)			X		X		X	X	X			X		X		
Graco (2009)			X		X		X	X		X		X	X	X	X	
Hjelm (2012)		X	X			X						X	X	X	X	
Ingol (2020)			X				X	X	X	X		X	X	X	X	
Jones (2012)		X	X													
Jones (2015)	X	X	X		X	X		X		X			X		X	
Krompa (2020)	X	X	X		X	X		X					X	X		
Lie (2013)	X		X		X	X		X	X			X	X	X	X	
Lim (2017)			X			X		X					X	X	X	
Lindmark (2010)		X	X		X							X			X	
Muhwava (2019)	X		X		X	X				X	X	X	X	X	X	
Nicklas (2011)	X	X	X		X	X	X	X	X	X	X	X	X	X	X	
O'Dea (2015)	X	X	X		X			X				X	X			
Pace (2020)			X	X		X		X	X	X		X	X	X	X	
Parsons (2019)	X	X	X			X				X	X	X	X	X	X	
Razee (2010)	X		X										X	X	X	
Shang (2021)		X	X		X							X	X	X		
Sharma (2021)		X	X			X		X		X		X	X	X	X	
Svensson (2017)	X	X			X	X		X		X		X	X	X		
Tang (2015)			X		X	X						X	X	X	X	
Tierney (2015)			X			X						X	X	X	X	
Zulfiqar (2017)			X		X			X	X			X		X		

study quality rating greater than or including seven (n=25). The lowest quality rating of six was given to two separate studies.

Seven core themes were constructed from the data: two at the intrapersonal (capability and motivation), three at the social (influence of family, socialising while exercising, support) and four at the organisational level (access, opportunity, healthcare, type of exercise). Table 3 provides an overview of papers contributing to each theme. A summary of main themes and example quotes are displayed in Figures 2 and 3.

Intrapersonal

Capability referred to whether women felt able to engage with PA. Where PA felt achievable and women were confident, this was facilitative. Motivation related to the desire to engage with PA. While most women were aware of the benefits, they highlighted that this was not sufficient to overcome other barriers. One sub-theme to emerge under motivation was a weight focus, which in the short term was motivating but was debilitating for longer-term, sustainable engagement with PA.

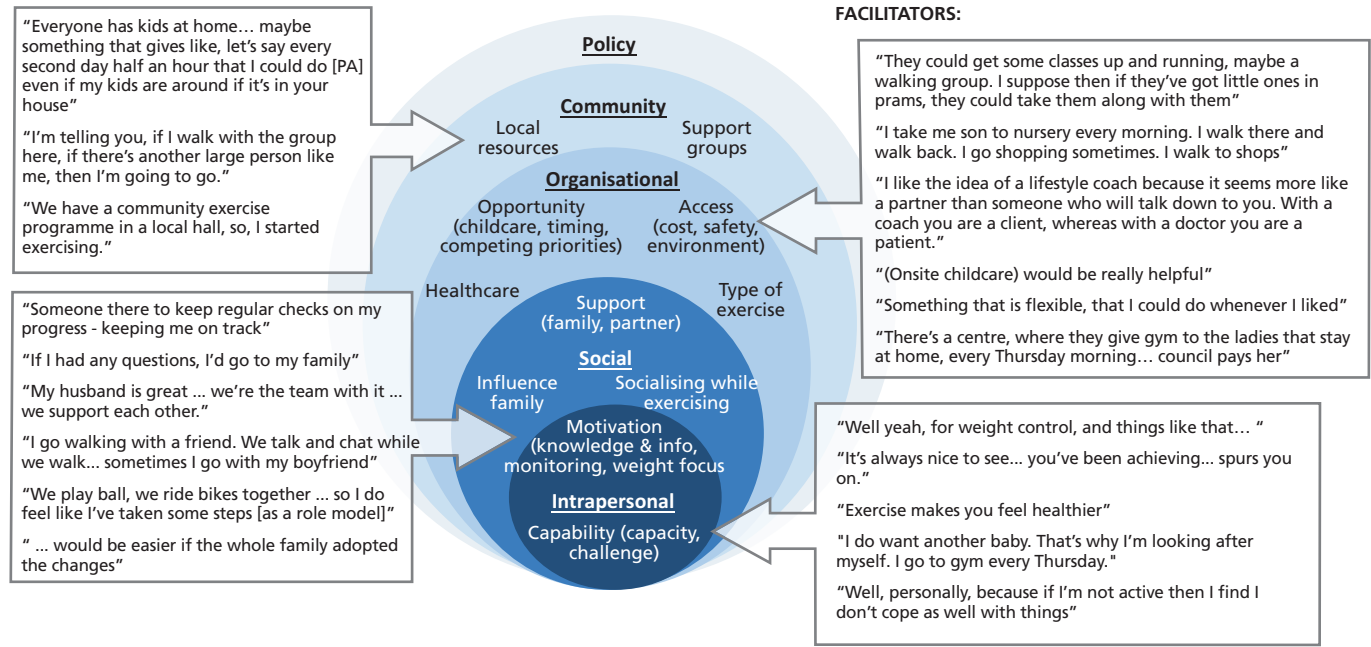
Social

Influence of family was wide-ranging and referred to any effects the family had on PA. For example, commitments and having children were barriers, while role modelling and being well enough to look after children facilitated PA. The presence of support from families, friends and partners was facilitative of PA, while lack of support was a barrier. Partner support was highlighted as vital for engagement with PA. Taking part in PA with other people was also a facilitator to activity.

Organisational

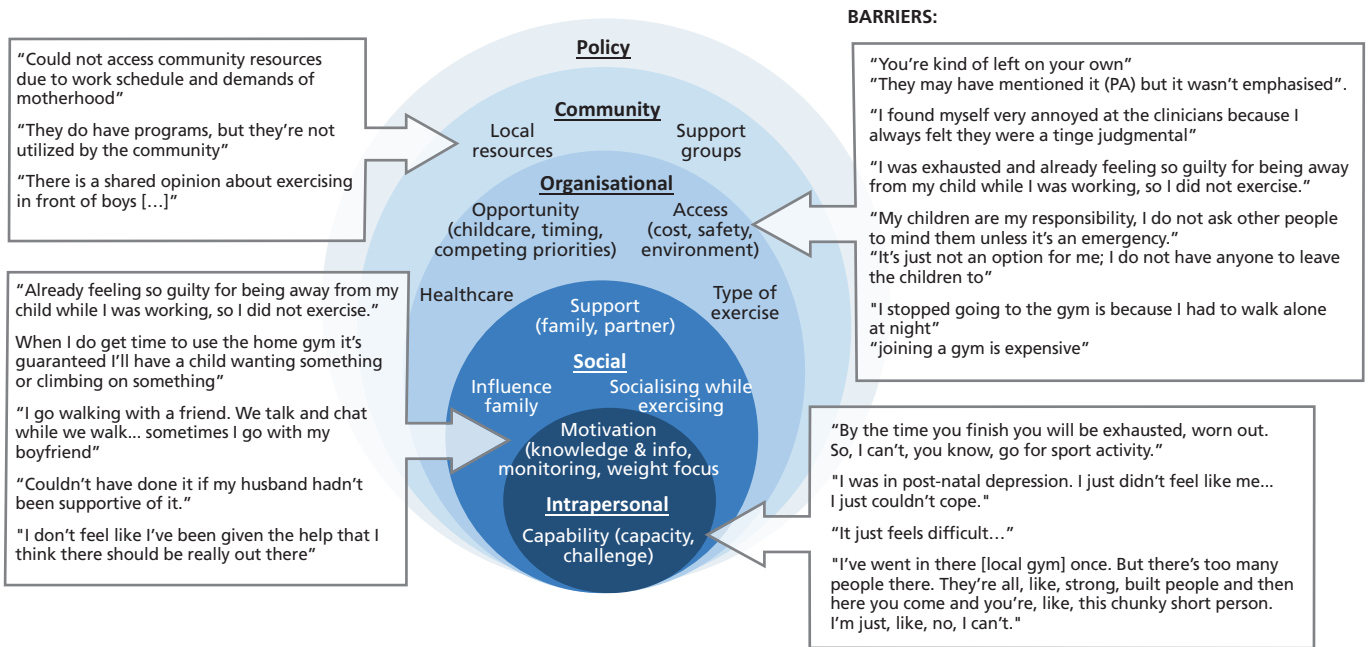
Availability of opportunities, either local resources or provision of activities, facilitated PA while barriers included cost of activities, safety, lack of childcare and other competing demands on time. Leisure PA was the focus, despite the emphasis of a general lack of time or inability to undertake leisure PA. However, participation in activities of daily living, such as domestic (chores, housework) or active travel (walking for transport), were acknowledged as easier to undertake and were prioritised.

Figure 2. Overview of the themes and subthemes appearing at each level, with some representative quotes of analogous facilitators at each level of an adapted SEM.



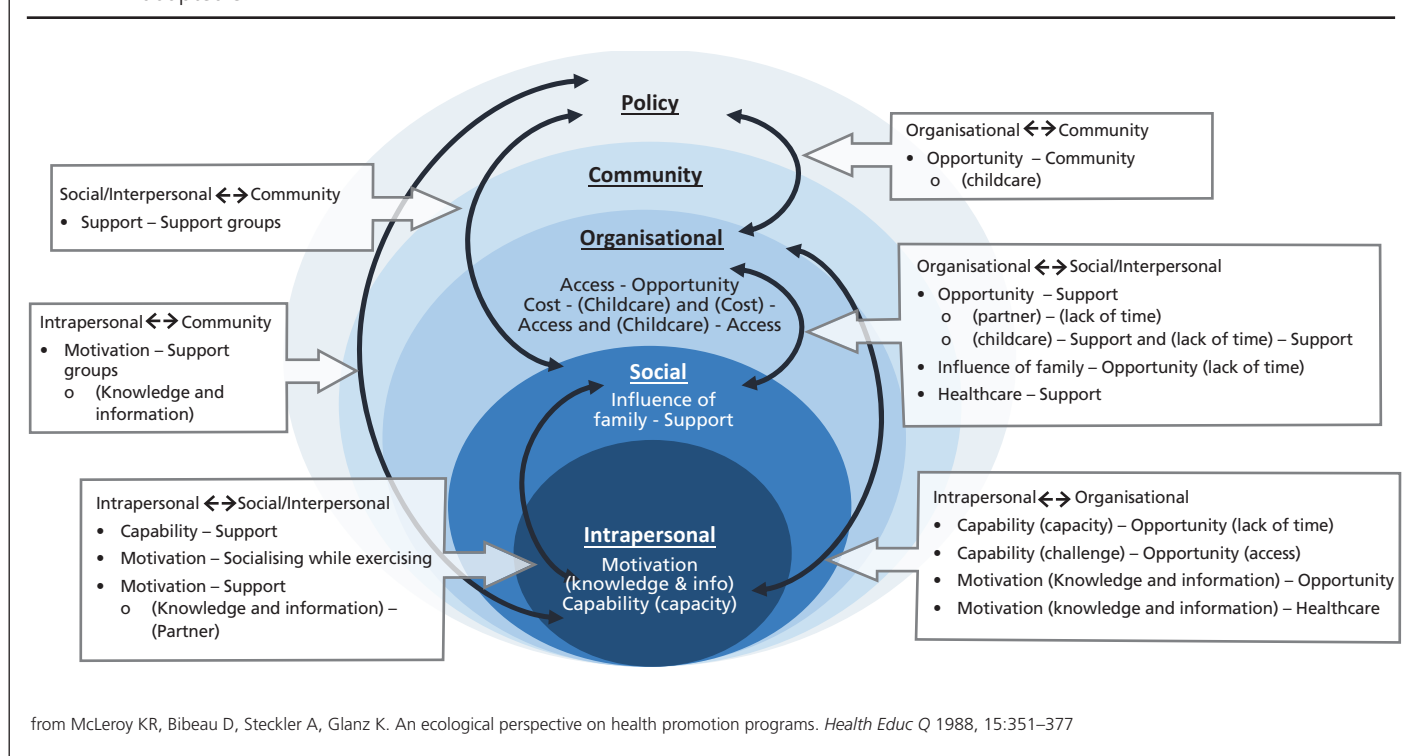
From McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. *Health Educ Q* 1988, 15:351-377.

Figure 3. Overview of the themes and subthemes appearing at each level, with some representative quotes of analogous barriers at each level of an adapted SEM.



From McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. *Health Educ Q* 1988, 15:351-377.

Figure 4. Visual display of the interrelationships identified through the thematic analysis of barriers and facilitators to PA in an adapted SEM



Community

Support groups, access to resources or sharing responsibilities within a community of people were helpful for creating opportunities for PA. Inhibitive social or cultural norms were barriers to PA.

Interrelationships between themes

Participant quotes and reported results demonstrated links between every level of the SEM. These interrelationships, highlighted through links between themes and sub-themes, are summarised in Figure 4.

Discussion

To the authors' knowledge, this is the first review of its kind to classify barriers and facilitators to PA for women with previous GDM according to the SEM. Barriers and facilitators to PA appeared on four levels of the SEM, in addition to interactions within and between these levels, resulting in a complex web of factors that need to be addressed, in combination, for increased PA engagement.

The focus of barriers in the present review was around leisure time purposeful exercise; active transport was identified as achievable and routine.²⁹ The American Diabetes Association recommends that for populations at high risk of T2DM, at least 150 minutes per week of PA should be undertaken.⁵⁷ Active travel could be one such domain of PA encouraged for women after GDM and is still linked to T2DM prevention.⁵⁸ Other domains of PA therefore need to be further explored and encouraged, as they may be a more realistic type of PA for women after GDM.

Barriers and facilitators at the social and organisational levels were linked with the interpersonal level, highlighting that behaviour may be compromised by wider barriers.¹⁵ Encouraging individual motivation is not sufficient in the presence of higher-level barriers, therefore targeting system-wide approaches, rather than solely individuals, could be more effective.⁵⁹ It is important to consider these wider factors and the subsequent impact on women's ability to undertake PA when planning future PA interventions after GDM. Findings in young adult women by Peng *et al.*, including accessibility to PA, familial commitments and the physical environment, overlapped with some of the findings in the present review.¹⁶ Defining women by their GDM diagnosis when women feel abandoned postpartum may not be helpful.³⁰ Further research is needed to explore how women after GDM define themselves postnatally, and how they may best be targeted or addressed in the context of PA.

At the individual level, themes capability and motivation align well with the COM-B model of behaviour change, which states that individual behaviour change is influenced by opportunity, motivation and capability.^{60,61} Within motivation, positioning PA as a method of weight loss was helpful in the short term, but was discouraging for maintaining PA in the long term.⁴⁵ Women with GDM, and general T2DM prevention advice, are recommended to manage their weight,^{62,63} which could be debilitating for women with unrealistic expectations for their body and weight postpartum.⁶⁴ Managing expectations and creating a long-term facilitative PA environment, emphasising broader benefits of PA besides weight loss, could aid longer-term PA uptake



Key messages

- Barriers to physical activity after gestational diabetes are wide-ranging and not always within an individual's power to change or control.
- Barriers were focused on leisure physical activity, whereas other domains of activity, such as active transport, were discussed from more achievable and manageable perspectives.
- Many barriers to physical activity are not specific to having previous gestational diabetes and overlap with postnatal barriers to activity.

and maintenance. Future interventions should therefore still consider individual tailoring and behaviour change theory, in conjunction with addressing wider barriers to PA.

Family commitments are a unique and specific barrier to women after GDM compared to the general population at risk of T2DM. Family-based interventions can increase PA in children,⁶⁵ which is important since children of women with GDM are at an increased risk of several metabolic disorders, including insulin resistance, T2DM, hypertension and obesity.⁶⁶ PA can help reduce risk of these metabolic disorders in both mothers and their children.⁶⁷ Therefore, family-based PA could have multiple benefits across generations. Family-based interventions may also overcome lack of childcare, which was the main organisational barrier identified in the present review. The lack of childcare is a widely cited and known barrier to PA, not just for women after GDM but also for postpartum women in general.⁶⁸ Further research is needed to establish how childcare could best be provided for maximum uptake and helpfulness to enable engaging with PA. The present review identified that childcare was heavily interrelated with the social level of the SEM. For example, childcare as a barrier was overcome with help from family or partner support,⁴⁰ and was not overcome when partners were busy or when women did not feel comfortable leaving their children with family for the sake of PA.^{45,47} Without partner buy-in, PA uptake and maintenance may not be possible for women after GDM. Therefore, PA interventions should consider targeting couples, including partners to 'tag team', in addition to other forms of childcare, to increase accessibility of PA for mothers. This is important, as interventions which have addressed childcare when trying to help women be active after GDM could be more successful at increasing PA.⁶⁹ Providing childcare opportunities in PA contexts is important, not only for women after GDM but at a wider, systems level for all (postnatal) women.

At the social level, support was one of the most quoted factors, posing a barrier when not present but a facilitator when present. Partner support and fostering positive PA environments for the whole family was highlighted as instrumental.^{31,47,70} When women did not feel supported, they were unable to en-

gage with PA, even if they wanted to. When women did feel supported, or when they had help from their partner or family, they reported more engagement with PA. Partner support specifically, in agreement with Peng *et al.* was essential in enabling PA.¹⁶ Support was also linked with the concept of non-physical community support.⁴⁵ Creating social 'community' and increasing access to PA within communities has been recommended for PA promotion.⁷¹ Community-based interventions could be cost-effective methods to increase PA,^{72,73} including for women with previous GDM.⁶⁹ Therefore, creating a supportive setting after GDM could partly be achieved by connecting women postpartum. Further research is needed to establish how and what community-based PA intervention could look like, and how it may be implemented for women after GDM.

Strengths and limitations

The SEM helped frame barriers and facilitators according to wider systems, providing more direction for designing multilevel interventions. To the authors' knowledge, it is also the first review of its kind to consider PA after GDM on a wider systems level. However, the contexts of included studies varied. Extracted results and conclusions could be specific to these contexts, or not generalisable. Additionally, the results synthesised can only shed light on the topic, and it is important that context-specific Patient and Public Involvement (PPI) and/or co-production be included when tailoring or developing interventions.

Conclusion

Women after GDM consistently face wider-level barriers that are not within their direct control to overcome. Reducing the onus on individual mothers by, for example, addressing organisational level barriers like childcare provision, may be important for long-term PA uptake and maintenance. Supplementing individually targeted interventions with wider multi-level population targets should be the focus for future interventions aiming to increase PA in women after GDM.

Conflict of interest None.

Funding This research was funded as part of a Graduate Teaching Assistant Scholarship provided by Sheffield Hallam University. The funder did not have any influence on or direct involvement in the research.

Acknowledgements Sheffield Hallam Librarians aided in the development of search terms and demonstration of database searches for the papers included in the present review.

Data availability Data sharing is not applicable to this article as no datasets were generated or analysed during the current study. All data used were obtained from published articles.

Other information This work was registered on Open Science Framework (<https://doi.org/10.17605/OSF.IO/PRG56>). For the purpose of open access, the author has applied a Creative Commons Attribution (CC BY) licence to any Author Accepted Manuscript version arising from this submission.

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ERRATUM

The use of HbA_{1c} for new diagnosis of diabetes in those with hyperglycaemia on admission to or attendance at hospital urgently requires research

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Br J Diabetes 2022;**22**:95-104 <https://doi.org/10.15277/bjd.2022.386>

In the printed issue of the article above, the affiliation for author Sandip Ghosh was missing. The correction has been made to the author box - see opposite - and the online version has been updated and can be viewed at <https://bjd-abcd.com/index.php/bjd/article/view/971>

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<https://doi.org/10.15277/bjd.2022.386>

Appendix 1. Participant characteristics

Author	Date	Total #	Age	Ethnicity split	Education level	Employment	IMD / SES	# of children / parity	# Pregnancies with GDM
Bandyopadhyay <i>et al.</i> , ²⁸	2011	17	23–33yrs (median 28 yrs)	Came from: India (n=8), Bangladesh (n=6), Sri Lanka (n=2) and Pakistan (n=1).	Yr 12 to MSc	Homemakers, student, employed in IT or public service	Not reported	Not reported	n=3 diagnosed with GDM during previous pregnancy
Boyd <i>et al.</i> , ²⁹	2020	27	Mean 33yrs Range 22–44yrs	White n=20 (74%) Asian n=3 (11%) Black African n=1 (4%) Arab n=3 (11%)	Degree n=18 (66.7%) Further education n=3 (11.1%) School >16yrs n=3 School ≤16yrs n=3	Employed n=23 Self-employed n=1 Not working n=3	Not reported	Pregnancies 1 n=11 (41%) 2 n=5 (19%) ≥3 n=1 (4%)	Not reported
Dasgupta <i>et al.</i> , ³⁰	2013	29	Mean 40.3yrs (SD 4.3)	Europid n=15 (63%)	n=29 completed high school (100%) n=15 completed Uni (63%)	Employed, n (%) 14 (58)	Not reported	Not reported	Median = 1 IQR = 1,2
Dennison <i>et al.</i> , ³¹	2022	20	26–35yrs, 60% 36–40yrs, 30% >41yrs 10%	White British or European, 70% Asian or Asian British, 30%	Secondary, 25% Uni (BSc), 30% PG, 45%	Full time 50% Part time 45% Home parent 5%	Not reported	# children 1, 30% 2, 45% >3, 25%	All pregnancies affected by GDM n=13 (65%)
Doran ³²	2008	8	Range 28–40 yrs	Not reported	Not reported	Not reported	Not reported	Parity 1 (n=5) 3 (n=2) 5 (n=1)	1 (n=6) 3 (n=2)
Doran and Davis ³³	2010	11	Mean 34yrs (24–40yrs)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Evans <i>et al.</i> , ³⁴	2010	16	Mean 33yrs, range 19–42	Not reported	High school n=4 Post-secondary n=12	Full-time n=6 Part-time n=6 Not employed 3	Not reported	Primip n=5 Multip n=11	Not reported
Gaudreau and Michaud ³⁵	2012	15	Mean 34yrs (range: 29–40 years)	2 Algonquin communities (Pikogan and Lac Simon)	50% not completed high school	Not reported	Not reported	# children; 4 (n=2) 5 (n=3) 6 (n=2)	Not reported
Graco <i>et al.</i> , ³⁶	2009	10	20–29yrs (n=3) 30–39yrs (n=4) 40+(n=3)	Country of birth Australia (n=7) Overseas (n=3)	Primary (n=0) Secondary (n=2) Diploma (n=4) Degree (n=4)	Part-time work (n=4) Full-time work (n=0) Full-time mother (n=6) Student (n=0)	Annual household income (\$) <23K (n=0) 23K–39K (n=1) 40K–59K (n=3) 60K+ (n=5)	# children; 1 (n=3); 2(n=5); 3 (n=2); 4 (n=0)	Not reported
Hjelm <i>et al.</i> , ³⁷	2012	14	28–44yrs (median 35yrs)	Born in Iraq (n=10), Iran (n=2) and from Lebanon (n=2) living in Sweden.	n=9 < 9 years education	Unemployed, housewives and dependent on social allowance (n=9)	Not reported	Not reported	Not reported
Ingol <i>et al.</i> , ³⁸	2020	12 FG (n=5–7)	Mean 32.9yrs (SD=1.24)	African-American, Hispanic, and Appalachian	Not reported	Not reported	Low-income	Mean # children, 2–3	Range 0–10 years from GDM diagnosis
Jones <i>et al.</i> , ³⁹	2012	17	Range 19–45yrs (35+, n=15)	Self-identified American Indian	High school n=1 > high school n=11 2-year college n=6 4-year college n=3 PG n=1	Employed n=18 Looking for work n=1 Homemaker n=1 Student n=2	Not reported	Not reported	1, n=17 2, n=3 3, n=2
Jones <i>et al.</i> , ⁴⁰	2015	26	32yrs (SD, 4.8)	Self-identified American Indian	< high school n=1 High school n=9 Some college n=6 Associate degree n=3, BSc+ n=7	Employed n=15 Looking for work n=1 Homemaker n=5 Student n=1 Unable to work n=1	Not reported	Mean # children 2.3 (SD, 0.7)	Not reported
Krompa <i>et al.</i> , ⁴¹	2020	16	Range 24–40yrs	France n=4, Algeria n=4, Mali n=1 Poland n=1, Cameroon n=1, Romania n=1 Not known n=4	Not reported	Employed n=12 None n=2 Not known n=4	Not reported	Primip n=6	Not reported

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Appendix 1. Participant characteristics *continued*

Author	Date	Total #	Age	Ethnicity split	Education level	Employment	IMD / SES	# of children / parity	# Pregnancies with GDM
Lie <i>et al.</i> , ⁴²	2013	Phase 1: 31 Phase 2: 14	Phase 1 range 20-42 (n=21 30-39) Phase 2 range 20-42	Phase 1 White n=30 Non-white n=1 Phase 2 White n=13 Non-white n=1	Phase 1 None n=1 GCSE n=9 A-level n=7 HE n=14 Phase 2 None n=0 GCSE n=4 A-level n=6 HE n=4	Phase 1 Not employed n=10 Employed n=21 Phase 2 Maternity leave n=10 Not employed n=4 Employed n=10	Phase 1 T1 most deprived n=8 T2 n=10 T3 least n=13 Phase 2 T1 n=4 T2 n=5 T3 n=5	Did not report	Phase 1 Primip n=15 Multip n=16 Phase 2 Primip n=4 Multip n=10
Lim <i>et al.</i> , ⁴³	2017	N=165 Group n= 136 Phone n=29	Mean (SD) Group: 34.1 (5.3) Phone: 34.8 (4.8)	Born in Australia Group: n=133 (47) Phone: n=18 (55)	Uni; Group: n=166 Phone: n=19	Not reported	Low-income Group: n=71 Phone: n=4	Parity Group: 1 n=127 2+ n=154 Phone: 1 n=11 2+ n=21	Not reported
Lindmark <i>et al.</i> , ⁴⁴	2010	10	30-40yrs	Not reported	All reached HE	Not reported	Not reported	Not reported	Not reported
Muhwava <i>et al.</i> , ⁴⁵	2019	35	Range 25-35+ 30-34yrs (n=15)	Black African and 'mixed ancestry'	Not reported	Employed 17% Unemployed 77% Student 6%	Not reported	Not reported	Not reported
Nicklas <i>et al.</i> , ⁴⁶	2011	25	Mean 35yrs (SD 5)	White n=13; African American n=5; Asian n=3 American Indian n=2; Refused n=2	Not reported	Not reported	Not reported	Mean # children 1.9 Mean age 3.7	Mean # GDM pregnancies, 1.4 (SD 0.6) Mean time since last GDM 1.7yrs (1.7 SD)
O'Dea <i>et al.</i> , ⁴⁷	2015	17	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Pace <i>et al.</i> , ⁴⁸	2020	13	30.5yrs (SD 7.5)	Cree	Not reported	Not reported	Not reported	Mean n=3 pregnancies	n=6 >1 GDM pregnancy
Parsons <i>et al.</i> , ⁴⁹	2019	50	Mean 37.7yrs (SD 6.3)	African/Caribbean/Black British n=25 White n=13 Asian/British n=9 Mixed n= 3	Not reported	Not reported	Median IMD 9,399 (range 1596 – 21202)	Parity mean 2.2 (SD 1.2) Primip 31%	Not reported
Razee <i>et al.</i> , ⁵⁰	2010	57	Mean Arabic 36yrs Cantonese/Mandarin 37yrs English 34yrs	Arabic n= 20 Cantonese/Mandarin n=20 English n=17	High school Arabic n=7 Cantonese/Mandarin n=17 English n=16	Not reported	Not reported	Mean # children (<5yrs) Arabic 4 (1.7) Cantonese/Mandarin 2 (1.4) English 1.9 (1.2)	Not reported
Shang <i>et al.</i> , ⁵¹	2021	20	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Sharma <i>et al.</i> , ⁵²	2021	28	Mean 35yrs	Nordic n=10 South Asia n=18 [Pakistani n=9 Sri Lankan n=6 Indian n=3]	Uni; Nordic n=7 South Asian n=8	Nordic n=9 South Asian n=9	Not reported	Primip Nordic n=4 South Asian n=7	GDM prior Nordic n=4 South Asian n=3
Svensson <i>et al.</i> , ⁵³	2017	5	Mean 33yrs (range 29-38)	Not reported	BSc n=2 Post-secondary n=2 In upper secondary n=1	Not reported	Not reported	Parity 1, n=2 2, n=2 4, n=1	1, n=3 2, n=3
Tang <i>et al.</i> , ⁵⁴	2015	23	Mean 33.1yrs (5.9 SD)	White n=7) Black n=8 Hispanic n=8	<high school n=2 High school n=2 Some college n=7 College graduates n=12	Not reported	Not reported	# children 1, n=15 2, n=4 3, n=4	Previous GDM n=1
Tierney <i>et al.</i> , ⁵⁵	2015	13	Mean 41.2yrs (range 31.2–49.6)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Zulfiqar <i>et al.</i> , ⁵⁷	2017	23	Mean 37 (SD 5) range 28-45	Australia born n=8 Overseas born n=15	Tertiary educated Australia n=8 Overseas n=13	Working mothers Australia n=6 Overseas n=10	Own house (%) Australia n=8 Overseas n=11	Mean # children Australia 3 range 2-4 Overseas 2 range 1-4	Not reported

#, number; IMD / SES, Index Multiple Deprivation / Socio-Economic Status; yrs, years; MSc, Master's Degree; PG, post graduate; IT, information technology; FG, Focus Groups; Uni, university level education; BSc, Bachelor's degree; HE Higher Education; T(#), Tertiary; primip, primiparous; multip, multiparous; IMD; index multiple deprivation rank.