

# Evidence-based physical activity guidelines for pregnant women

Report for the Australian Government Department of Health  
March 2020

Prepared by:

Wendy J Brown<sup>1</sup> • Melanie Hayman<sup>2</sup> • Lene A H Haakstad<sup>3</sup> • Gregore I Mielke<sup>1</sup> • Gabriela P Mena<sup>1</sup> • Tayla Lamerton<sup>1</sup> • Anita Green<sup>1</sup> • Shelley E Keating<sup>1</sup> • Grace A O Gomes<sup>4</sup> • Jeff S Coombes<sup>1</sup>

<sup>1</sup>School of Human Movement and Nutrition Sciences, The University of Queensland; <sup>2</sup>School of Health, Medical and Applied Sciences, Central Queensland University; <sup>3</sup>Department of Sport Medicine, Norwegian School of Sport Science; <sup>4</sup>Gerontology Department, Federal University of São Carlos, Brazil.



## **Publication details:**

### **Evidence-based physical activity guidelines for pregnant women. Report for the Australian Government Department of Health, March 2020**

Print ISBN: 978-1-76007-418-0  
Online ISBN: 978-1-76007-419-7  
Publications approval number: DT000846

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## **Suggested citation:**

Brown WJ, Hayman M, Haakstad LAH, Mielke GI et al. Evidence-based physical activity guidelines for pregnant women. Report for the Australian Government Department of Health, March 2020. Canberra: Australian Government Department of Health.

This work was funded by the Australian Government Department of Health.

The authors declare they have no conflicts of interest relating to the preparation of this Report or its contents.

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# Executive Summary

As part of the suite of national physical activity and sedentary behaviour guidelines for Australians, the Australian Government, in 2018, commissioned a review and synthesis of the evidence to inform the development of practical and safe physical activity guidelines for pregnant Australian women (*'the guidelines'*).

The main purpose of these guidelines is to provide evidence-based best practice recommendations on physical activity/exercise<sup>a</sup> during pregnancy for Australian women and those who provide healthcare during pregnancy.<sup>b</sup>

The guidelines may be used to:

1. encourage women to achieve the levels of physical activity/exercise that are recommended for optimal health during pregnancy and in the postpartum period; and
2. provide health professionals with evidence-based guidance on optimal physical activity behaviours during pregnancy and in the postpartum period

A five-stage approach, which involved critical 'umbrella' reviews of the scientific evidence, and adaptation of recommendations included in recently published guidelines and position statements, was used to develop the Guidelines.

We identified 27 'critical elements' of evidence relating to the effects of physical activity/exercise during pregnancy on pregnant women and on fetal development and birth, the effects of physical activity/exercise during the postpartum period, and the effects of sedentary time and occupational physical activity on maternal and infant health outcomes.

Narrative reviews of the evidence (2012-2019) relating to each critical element were conducted and the quality of the evidence was rated using the GRADE system. A consensus process, based on the evidence reviews, expert judgements on issues relating to benefits and potential harms, and selected adoption or adaptation of the text used in seven recent guideline documents, was used to draft the proposed Guidelines. The strength of each recommendation in the Guidelines was assessed using National Health and Medical Research Council (NHMRC) guidance.

A three stage process was used to review and amend the proposed guidelines. This involved review by international experts, local clinicians and representatives of professional organisations and State or Territory government health departments.

The proposed Guidelines and Supporting Information are presented on pages 9-14 of this report.

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<sup>a</sup> The term 'physical activity/exercise' is used to conceptualise both physical activity (PA) (eg activities such as walking, cycling, swimming and jogging which are typically undertaken for leisure, transport, health, wellness or enjoyment) and exercise (ie more planned or structured activities, including sports [participation and training] and recreation activities, which may also have a focus on performance or competition).

<sup>b</sup> The term 'health professionals' is used in this report to describe medical practitioners, midwives, nurses, physiotherapists, exercise physiologists and others who are accredited to work in the health sector, who provide care and advice for women during pregnancy.

# Background

Data from the 2011–12 Australian Health Survey indicate that 47% of non-pregnant 18–45 year old women do sufficient physical activity (PA) to meet the minimum level recommended in our national physical activity guideline for moderate-vigorous physical activity (MVPA) (at least 150 minutes per week). In contrast, among pregnant women in the same age group, the prevalence of meeting the MVPA guideline is estimated to be 30%.<sup>1</sup> The lower level of PA during pregnancy may reflect a fear of harm to the developing fetus, and a lack of knowledge among both women and health professionals about the benefits and risks of PA for the mother and baby. While some women may return to pre-pregnancy PA levels following pregnancy, many face constraints to regular PA during the postpartum period and some never regain their pre-pregnancy activity levels.

Guidelines for physical activity or exercise during pregnancy are available in several countries<sup>2</sup>, and there are position statements in Australia from the Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG)<sup>3</sup> and Sports Medicine Australia (SMA).<sup>4</sup> The Australian Clinical Practice Guidelines on Pregnancy Care also provide recommendations on lifestyle considerations, including nutrition and physical activity.<sup>a</sup> However, as part of the suite of national physical activity and sedentary behaviour guidelines for Australians, the Australian Government has called for a comprehensive review and synthesis of the evidence to inform the development of practical and safe physical activity guidelines for pregnant Australian women. The tender requested that the review should follow the approach outlined in the 2016 NHMRC Standards for Guidelines (See Appendix 7)<sup>5</sup>, and that, if possible, the guidelines should consider advice on PA, sedentary behaviour and sleep requirements, so that the new guidelines conform to the 24-hour integrated approach that has recently been adopted for the development of guidelines for children in Australia.<sup>6</sup>

The main purpose of these guidelines is to provide evidence-based best practice recommendations on physical activity/exercise<sup>b</sup> during pregnancy for Australian women and those who provide healthcare during pregnancy.<sup>c</sup> The guidelines may be used to:

- encourage women to achieve the levels of physical activity/exercise that are recommended for optimal health during pregnancy and in the postpartum period; and
- provide health professionals with evidence-based guidance on optimal physical activity behaviours during pregnancy and in the postpartum period.

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<sup>a</sup> Under review at the time of writing

<sup>b</sup> The term 'physical activity/exercise' is used to conceptualise both physical activity (PA) (eg activities such as walking, cycling, swimming and jogging which are typically undertaken for leisure, transport, health, wellness or enjoyment) and exercise (ie more planned or structured activities, including sports [participation and training] and recreation activities, which may also have a focus on performance or competition).

<sup>c</sup> We have used the term 'health professionals' to describe medical practitioners, midwives, nurses, physiotherapists, exercise physiologists and others who are accredited to work in the health sector, who provide care and advice for women during pregnancy.

# Methods and Findings

The Guidelines were developed using an adaptation of the collaborative approach to adopting/adapting guidelines proposed by Okely et al. in 2017 for the Development of 24-Hour Movement Guidelines for the Early Years.<sup>7</sup> We used a five- stage approach which involved critical 'umbrella' reviews of the scientific evidence, and adaptation of recommendations included in recently published guidelines and position statements, as summarised below. A panel of University researchers ('the Consultant Group', see Appendix 1) located the sources, summarised the evidence, and developed draft guidelines, which were reviewed by panels of international experts, health professionals and national stakeholders (see Appendices 2 and 6).



Photo courtesy of Lene Haakstad

## Stage 1: Identification of key source documents

Literature searches were initially conducted in January 2019 to identify national guidelines and position statements from professional organisations, published since 2010. These searches located: national guidelines on Exercise during Pregnancy from Canada (2018)<sup>8</sup> and Switzerland (2018)<sup>9</sup>; recommendations and position statements developed by professional organisations [the American College of Obstetricians and Gynecologists (2015)<sup>10</sup> (ACOG), The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (2016)<sup>3</sup> (RANZCOG), and Sports Medicine Australia (2016)<sup>4</sup> (SMA)]. We also located the section on exercise during pregnancy in the 2018 report from the United States (US) Physical Activity Guidelines Committee<sup>11</sup>, a series of five papers from an International Olympic Committee expert group on Exercise during Pregnancy in Recreational and Elite Athletes (referred to here as the 'IOC series')<sup>12-16</sup> and an 'Update' of the evidence on exercise during pregnancy in the Wolters Kluwer *UpToDate*<sup>®</sup> resource for clinicians.<sup>17</sup>

Of these eight sources, four were identified as '*key source documents*' for the current review, because they included comprehensive reviews of the evidence, published in English since 2015 (to February 2019). They were:

- The American College of Obstetricians and Gynecologists' Committee on Obstetric Practice: Physical Activity and Exercise During Pregnancy and the Postpartum Period, 2015.<sup>10</sup>  
<https://www.acog.org/Clinical-Guidance-and-Publications/Committee-Opinions/Committee-on-Obstetric-Practice/Physical-Activity-and-Exercise-During-Pregnancy-and-the-Postpartum-Period?>

- The IOC Expert group meeting: Exercise and pregnancy in recreational and elite athletes: evidence summaries 1-5, 2015–2017.<sup>12-14,16</sup>
- Physical Activity Guidelines Advisory Committee: Scientific Report to the US Secretary of Health and Human Services, 2018.<sup>11</sup> Available from: <https://health.gov/paguidelines/second-edition/report/>
- Canadian guideline for physical activity throughout pregnancy, 2018.<sup>8</sup> Also available from: <https://csepguidelines.ca/en/guidelines-for-pregnancy/>

In addition, we referred to the *UpToDate*<sup>®</sup> publication (updated periodically during 2019) for additional information on selected topics.<sup>17</sup> Available from: <https://www.UpToDate.com/contents/exercise-during-pregnancy-and-the-postpartum-period#!>

## Stage 2: Selection and initial review of critical elements

Critical elements included in each of the key source documents were identified as those with sufficient evidence (at least one systematic review) for inclusion in our umbrella review. These elements were categorised as follows:

**Effects of physical activity/exercise during pregnancy on pregnant women:** cardiorespiratory fitness; gestational weight gain; gestational diabetes; gestational hypertension and pre-eclampsia; low back and pelvic girdle pain; urinary incontinence; mental health problems (including depression/depressive symptoms and anxiety); and sleep.

**Effects of physical activity/exercise during pregnancy on fetal development and birth:** developmental concerns; miscarriage and peri-natal mortality; gestational age and preterm birth; labour and birth; pelvic floor muscle injury; APGAR scores; and birthweight.

**Effects of physical activity/exercise during pregnancy and postpartum on postpartum issues:** weight retention/weight loss; breastfeeding; urinary incontinence; post-natal mental health problems (depression/depressive symptoms, anxiety, body image dissatisfaction); musculoskeletal complaints; infant neurodevelopment and longer term development of Non Communicable Diseases (NCDs) in the mother and child.

**Effects of sedentary time and occupational physical activity** on maternal and infant health outcomes.

Individual members of the consultant group (see Appendix 1) with specialist knowledge of the topic were assigned to review the evidence on one or more of these critical elements, and summarise this in narrative format. The consultants used information included in the source documents, and additional rapid evidence assessments (using search terms similar to those used by the developers of the Canadian Guidelines) to identify any additional systematic reviews (and important randomised controlled trials and cohort studies) that had been published since 2016, but were not included in the key source documents.

## Stage 3: Summarising and grading the evidence

Narrative reviews of the evidence on each critical element (based on the key source documents and supplementary publications) were checked by one or more additional reviewers, and evidence summaries were developed for each one. These were then combined into a single *Narrative Review* (See Appendix 3). The summary statements were transcribed into an *Evidence Summary Table* (see Appendix 4), with lists of the systematic reviews (SRs), meta-analyses (MAs), randomised controlled trials (RCTs) and umbrella reviews (URs) cited in the US and Canadian Guidelines, the US PAG report and the IOC series (see column 2 of the Table in Appendix 4). 'Supplementary' systematic and umbrella reviews, as well as important RCTs and cohort studies, published since 2016, and/or significant publications that appear to have been omitted from the key source documents, were also included.<sup>a</sup>

The Consultants collectively assessed the narrative reviews and evidence summaries to describe the quality of the evidence for each element, using the criteria described by Balshem et al, 2011.<sup>18</sup> ['High' indicates that there is good evidence from high quality randomised controlled trials (RCTs), (and that we are therefore confident about the associations between physical activity and the health outcome); 'Moderate' indicates that there is lower quality RCT or good cohort study evidence (and that we are moderately confident about the associations); 'Low' indicates that there is a limited number of studies, or poorer quality studies, (and that our confidence in the findings is therefore limited); and 'Very Low' indicates that there is insufficient evidence to draw firm conclusions].

To arrive at these ratings, sources of the evidence were initially identified as (i) RCTs (where the rating starts at HIGH quality) or (ii) cohort studies and non-RCTs (where the rating starts at LOW quality). The quality of the evidence for each element was then discussed, and a decision made on whether to downgrade or upgrade the quality rating. (For this we used the original authors' summaries, and our own interpretations of risk of bias, imprecision, inconsistency and indirectness in the studies included in the review documents).<sup>19-21</sup>

Quality ratings for each element were arrived at through consensus during a series of seven Consultant meetings. These ratings are shown in the right hand column of the Evidence Summary Table (See Appendix 4).

Of the 27 elements examined (see *Evidence Summary Table*, Appendix 4), only three were assigned a quality rating of 'high' (gestational weight gain and prevention of urinary incontinence, both during and following pregnancy). This grading reflects consistent evidence from systematic reviews which included high quality RCTs and cohort studies. The majority of the elements were assigned a quality rating of 'moderate', based on numerous systematic reviews and meta-analyses, of data from both RCTs and cohort studies, many of which included low quality RCTs. For the remaining elements, the evidence was rated as 'low' or 'very low', reflecting a limited amount, or low quality underlying evidence. Importantly, we found no evidence of adverse outcomes in any of the reviews, most of which included data from women with normal pregnancies.

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<sup>a</sup> If a study with a different design was the only source of information in any of the key source documents, or if we located a recently published RCT, these references were included. For example, as the only evidence used in the IOC series to support their recommendations on sleep was a case control study, it is listed in the table.

## Stage 4: Developing the Guidelines and supporting information

Of the eight sources identified in Stage 1, all except the IOC series included specific recommendations or statements about physical activity/exercise during pregnancy and the postpartum period. Initial review of these documents found a range of individual recommendations /statements. These were summarised into three categories: general recommendations; the 'dose' (duration, frequency, intensity, and type) of physical activity/exercise; and aspects of medical and health care, as shown in the table in Appendix 5.

The Consultants used a consensus process, based on their evidence reviews, their expert judgements on issues relating to benefits and potential harms, and selected adoption or adaptation of the text used in the seven guideline documents,<sup>3,4,8-11,17</sup> to draft the proposed new Australian recommendations.

Each of the recommendations was initially assigned an overall grade from A to D, based on the 2009 National Health and Medical Research Council (NHMRC) Levels of Evidence and Grades of Recommendations for Developers of Guidelines.<sup>21</sup> (See middle column of Table 1). In line with current NHMRC guidance,<sup>5</sup> these categories were then merged, using the approach described in the Department of Health's Clinical Practice Guidelines for Pregnancy Care (2020),<sup>a</sup> to denote how well the body of evidence can be trusted to guide practice. (See right hand column of Table 1).

**Table 1 Description of categories used to grade the guidelines.**

Recommendation category	Description (initial review)		Description (final review)
Evidence-based recommendation	A	Body of evidence can be trusted to guide practice.	<i>Evidence based recommendation (EBR):</i> body of evidence can be trusted to guide practice.
	B	Body of evidence can be trusted to guide practice in most situations.	
	C	Body of evidence provides some support for recommendation(s) but care should be taken in its application.	<i>Qualified evidence based recommendation (QEBR):</i> body of evidence can be trusted to guide practice in most situations.
	D	The body of evidence is weak and the recommendation must be applied with caution.	
Consensus-based recommendation		Recommendation based on clinical opinion and expertise as insufficient evidence available.	Recommendations formulated in the absence of quality evidence (where a systematic review was conducted as part of the search strategy).
Pre 2016 Good Practice Note Post 2016 Practice Points (PP)		Practical advice and information based on clinical opinion and expertise.	Area is beyond the scope of the systematic literature review and advice was developed by the committee.

Based on material provided by the National Health and Medical Research Council<sup>b</sup>

<sup>a</sup> Department of Health (2020). Clinical Practice Guidelines: Pregnancy Care. Canberra: Australian Government Department of Health. (In development at the time of writing this report).

<sup>b</sup> see <https://www.nhmrc.gov.au/guidelinesforguidelines>

The eight source documents were then reviewed to select information for inclusion as *Supporting Information*. This was designed to aid interpretation, practical implementation and uptake of the Guidelines, without reference to the full Narrative Review and Evidence Summary Table. The supporting information includes brief advice on types of activity, judging the intensity of activities/exercise, advice for the postpartum period, and safety precautions (activities/exercises to avoid; warning signs to stop physical activity/exercise; absolute and relative contraindications).

## Stage 5: Review of the draft Guidelines

**Initial review:** The draft Guidelines (Version 1), with recommended evidence categories and supporting information, were sent to the 11 member International Advisory Group (see Appendix 2), with an invitation to complete a short on-line survey, in September 2019. The survey asked about the appropriateness, clarity of the wording, and evidence rating of each of the draft Guidelines, and invited comments and suggestions for changes (to the Guidelines, the quality ratings and the supporting content; see Appendix 6). Eight experts completed the short survey and two offered qualitative feedback by email.

Suggestions from this group included emphasising the need to 'build up' to recommended amounts of physical activity/exercise, especially after the birth, when women should work towards the Guidelines, even if they were previously active. They also raised concerns about returning to high intensity activity before the six week postpartum check, and suggested that there should be emphasis on the correct technique for pelvic floor exercises. These reviewers also asked for more facts on breastfeeding, on interpretations of intensity, and on resistance training (including a note on heavy lifting), to be included in the supporting information. There was agreement that previously active women should not necessarily be medically screened before being advised to follow the Guidelines (except of course when there were contraindications). One reviewer suggested that the information in the attachments should be included in the guideline statements, and another thought the evidence on sitting time during pregnancy should be graded as a 'D' rather than a 'C'. Importantly, this group asked whether the Guidelines were written for health professionals or for pregnant women. One reviewer noted that physical activity/exercise can be for pleasure and enjoyment (not solely for health) and another requested we should emphasise that ANY activity is good. In general, the expert reviewers were supportive of the overall content of the Guidelines:

All the suggested changes were considered at a meeting of the Consultants in October 2019. The Guidelines and supporting content were then modified to produce 'Guidelines Version 2', designed to be applicable to both pregnant women and their health care providers. (See Appendix 6 for details of the actual Guidelines and a summary of the feedback and revisions made at each stage).

**Second review:** The revised Guidelines (Version 2), evidence ratings and supporting information were then reviewed during a 'round table' meeting of a small group of informed medical practitioners in December 2019 (see Appendix 2). Most of the discussion relating to the actual guidelines focussed on Guideline #5, with debate about the use of the term 'complications'. It was agreed that we should use the word 'contraindications' (to physical activity/exercise) instead. There was discussion about whether 'only women with contraindications' should seek advice from a health professional, when in reality, a health professional might be required to identify any contraindication. These reviewers also suggested that we should use the term 'obstetric health professionals' which they thought provided a better description of the health professionals who provide care during pregnancy.

These experts were most helpful in identifying specific improvements that could be made to the supporting material to aid understanding and readability, as well as interpretation of the information provided. For example, they requested that we change the postpartum period to 'six to eight weeks' after the birth, and to change some of the wording used in the section on Safety Precautions. Overall, the feedback from this group was positive, as evidenced by:

*Agree that this is a monumental task, and clinical engagement is really critical. Thank you for inviting us to provide feedback. Hopefully the quality of the underpinning data will improve over time, so we can make firmer and more considered recommendations in the future.*

Suggestions from this group were considered by the Consultants, and where appropriate, changes were made to produce 'Guidelines Version 3' (see Appendix 6 for summary of feedback and changes).

**Third review:** The revised Guidelines (Version 3), with revised supporting information, were then sent to selected national stakeholders (see Appendix 2), with an invitation to complete the short on-line survey which was completed by the International Advisers in the initial review (December 2019). Responses were received from 16 individuals or groups, who were representatives of professional organisations (eg Australian College of Midwives, The Royal Australian College of General Practitioners, Sports Medicine Australia and Exercise and Sports Science Australia), and State or Territory government health departments. Fifteen people provided individual or group responses to the survey and one provided responses to the questions without using the survey.

Many of the issues raised by this group were ones that had already been considered in the two previous rounds of review, including safety concerns, adaptations and modifications, and progression towards meeting guidelines. This group also raised several examples of vocabulary which might not be understood by all pregnant women, especially those from disadvantaged backgrounds, who 'do not have the health literacy to interpret the full meaning of some of these guidelines.' Suggested changes were to remove complicated words like 'anatomical and physiological' and to change the terms 'delivery' (to 'birth') and 'premature labour' (to 'preterm labour'). This group also suggested that the term 'obstetric' health professionals was not inclusive of all who provide 'maternity' care, and that pregnant women who are over 35 should not be singled out in the preamble.

One reviewer suggested that our first proposed Guideline did not contain advice and should therefore be an introductory statement. This group also suggested that, as far as possible, the information should be contained *in* the Guidelines and not in the attachments, which most lay readers would not look at. Given that we were asked to develop these Guidelines for both lay women and health professionals, it was difficult to restrict the Guidelines to simple messages, without using supporting information.

One reviewer suggested that there should be development of additional communication resources (print and web based) to provide clear definitions, instructions and illustrations, especially for pelvic floor exercises. As was the case with the first two stages of feedback, the wording of the final guideline was widely debated. One group suggested that this be split into two; with one part about provision of information and support and a second about contraindications.

Once again, the overall tenor of the feedback was positive:

*The proposed guidelines appear consistent with international guidelines and those from other organisations within Australia. The wording is clear and evidence grades appear appropriate. The 'supporting information' to aid interpretation will be important and I look forward to seeing the final product when released.*

All the changes were considered by the Consultants, with a focus on making the Guidelines more understandable for all women, while maintaining the evidence-based information for health professionals. These changes were reviewed by two Professors of Midwifery in June 2020, to check that the language and terminology was appropriate for the pregnancy care setting. A summary of the changes made to the Guidelines at each stage is included in Appendix 6, and the final version of the Guidelines and Supplementary Information is provided on pages 9–14.



# The Proposed Guidelines

(This is the final version, following reviews as described in the previous section and in Appendix 6)

## Preamble: Who are the Guidelines for?

The Guidelines are applicable to all Australian women<sup>a</sup> and the health professionals who provide care during pregnancy.

**Previously inactive** women are encouraged to participate in physical activity during pregnancy; they are advised to start slowly and gradually progress towards meeting the Australian Physical Activity and Sedentary Behaviour Guidelines for Adults<sup>1</sup> (PA and SB Guidelines).

**Previously active** women are encouraged to continue with their activities in accordance with the PA and SB Guidelines. Those with a regular physical activity/exercise program can continue, but may need to modify their activities as pregnancy progresses.

Provided they have a pregnancy without contraindications (also known as 'complications'), **previously highly active** women, including athletes who are already exceeding the amount of physical activity described in the Guidelines, may continue with their physical activity/exercise program, but should modify their activities as their pregnancy progresses, with advice from an informed health professional. The series published by the International Olympic Committee Expert Group (IOC)<sup>12-16</sup> provides useful reference materials, and updates can be found in the Wolters Kluwer *UpToDate*<sup>®</sup> resource for clinicians.<sup>17</sup>

**Women who are overweight or obese** are encouraged to meet the Australian Physical Activity and Sedentary Behaviour Guidelines. If they were previously inactive, they are advised to start slowly and gradually progress towards meeting the PA and SB Guidelines.

**Women who are 35 years or older** are also encouraged to meet the Australian Physical Activity and Sedentary Behaviour Guidelines, with advice from an informed health professional. If they were previously inactive, they are advised to start slowly and gradually progress towards meeting the PA and SB Guidelines.

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<sup>a</sup> regardless of gender identity, cultural or language background, geographic location or socio-economic status. In developing these guidelines, evidence related to physical activity/exercise and people with diverse sex characteristics who may become pregnant, has not been examined.

# The Guidelines<sup>a</sup>

Guidelines	Notes and evidence grade
<p>Physical activity/exercise during pregnancy and the postpartum<sup>i</sup> period is safe, has health benefits for the woman and her unborn child, and reduces the risks of some pregnancy related complications.</p>	<p><sup>i</sup> defined by health professionals as six-eight weeks following the birth.  <i>Evidence-based recommendation.</i><sup>b</sup></p>
<p>#1. All women without contraindications<sup>ii</sup> should be encouraged to meet the Australian Physical Activity and Sedentary Behaviour Guidelines<sup>23</sup> (see below) before, during and after pregnancy.<sup>iii</sup></p>	<p><sup>ii</sup> a full list of contraindications, and  <sup>iii</sup> further information on progression, types and intensity of activities, is provided in the Supporting Information.  <i>Evidence based recommendation.</i><sup>b</sup></p>
<p>#2. Modifications to physical activity/exercise may be required to accommodate the physical changes that occur as the pregnancy progresses.<sup>iv</sup> If there are any concerns (including warning signs and contraindications<sup>v</sup>), women are advised to seek advice from a qualified health professional.</p>	<p><sup>iv</sup> examples include modifying supine exercises (lying flat on the back) and some yoga poses after 28 weeks. See Supporting Information.  <sup>v</sup> a list of warning signs and contraindications is provided in the Supporting Information.  <i>Consensus-based recommendation.</i><sup>c</sup></p>
<p>#3. All pregnant women are advised to do pelvic floor exercises<sup>vi</sup> during and after pregnancy.</p>	<p><sup>vi</sup> if unsure, seek advice on how to do these correctly.  <i>Evidence-based recommendation.</i><sup>b</sup></p>
<p>#4. Health professionals should support women to take an active role in shared decision-making about their physical activity/exercise during and after pregnancy. All health professionals who provide care during pregnancy should be familiar with contraindications, signs and symptoms which suggest that physical activity/exercise should be modified or avoided.<sup>vii</sup></p>	<p><sup>vii</sup> an update of the scientific evidence on physical activity/exercise and pregnancy is available in the Guidelines report.  <i>Consensus-based recommendation.</i><sup>c</sup></p>

## Australian Physical Activity and Sedentary Behaviour Guidelines for Adults<sup>23</sup>

- Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some, and gradually build up to the recommended amount.
- Be active on most, preferably all, days every week.
- Accumulate 150 to 300 minutes (2½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1¼ to 2½ hours) of vigorous physical activity, or an equivalent combination of both moderate and vigorous activities, each week.
- Do muscle strengthening activities on at least 2 days each week.
- Minimise the amount of time spent in prolonged sitting.
- Break up long periods of sitting as often as possible.

<sup>a</sup> The Guidelines are intended to be read in conjunction with the Supporting Information on pages 11–14.

<sup>b</sup> Body of evidence can be trusted to guide practice.

<sup>c</sup> Formulated in the absence of quality evidence.

# Supporting Information

This information is designed to aid interpretation, practical implementation and uptake of the Guidelines.<sup>a</sup>

## Types of activity

Pregnant women who do not have medical or obstetric contraindications (sometimes known as 'pregnancy conditions' or 'complications', see pages 13-14) are encouraged to (1) do both aerobic and muscle strengthening exercises and (2) learn how to do pelvic floor exercises correctly. Most activities present minimal risk to the woman and the fetus/unborn child, but some modifications to specific exercises will be required to accommodate the physical (anatomical and physiological) changes which occur as pregnancy progresses. For example, after 28 weeks, activities/exercises normally done in the supine position should be modified by tilting the upper body to 45 degrees or completing the activities/exercises while lying on the side. Some yoga poses and post-activity/exercise stretching may also have to be modified later in pregnancy because of the hormonal effects on joint laxity.

**Aerobic activities**, which include brisk walking, cycling (stationary bike later in pregnancy), swimming, dancing, exercise classes, etc will maintain or improve cardiorespiratory fitness and endurance, and help to avoid excess gestational weight gain. In line with the Australian guidelines,<sup>21</sup> the aim for previously inactive women is to start slowly and gradually increase the amount of activity to accumulate 150 to 300 minutes/week of at least moderate intensity (see page 12) activity/exercise that uses large muscle groups. Women who were active prior to pregnancy can continue with their usual activities for as long as they feel comfortable. They are advised to check with a health professional if they would like to continue with vigorous intensity or high impact sports and exercise.

**Strengthening activities**, which include functional and postural exercises, will maintain or improve musculoskeletal health (including core strength and endurance, flexibility and body composition) and may help to reduce the severity of musculoskeletal discomfort (eg low back and pelvic girdle pain) as pregnancy progresses. Women are advised to follow the Australian guideline,<sup>22</sup> which suggests muscle strengthening activities on at least two days each week, using body weight, light weights or resistance bands. While resistance training is recommended, heavy lifting and intense repetitive isometric exercises are not, as information about safety is limited.

**Pelvic floor exercises** help to strengthen and improve the tone of the pelvic floor muscles and other tissues which provide perineal support for the pelvic structures. All women are encouraged to learn correct technique and practice prior to and during pregnancy, then re-commence pelvic floor exercises as soon as possible after the birth.

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<sup>a</sup> For more information, please see references 3, 4, 8, 9, 10, 11, 12, 14 and 17.

## Judging the intensity of activities/exercise

Current physical activity guidelines recommend both moderate and vigorous intensity activities. In exercise physiology, intensity is commonly defined using ranges of percentage of maximal heart rate ( $HR_{max} = 220 - \text{age}$ ). However, as heart rate responses to physical activity/exercise change during pregnancy, physical activity guidelines recommend that pregnant women use a rating of perceived exertion to judge the intensity of their activities.<sup>9-11</sup> Our rating (right) is based on information provided in the Position Statement on Physical Activity and Exercise Intensity Terminology.<sup>24</sup> On our scale (right), where 1 is sedentary (not moving), and 10 is maximal effort, activities in the range 3-7 are considered safe and are recommended for health benefits in pregnant women. (For reference, MET values of 3.33 and 6.66 are often used to represent the energy expenditure of moderate and vigorous intensity physical activity in epidemiological studies).<sup>22</sup> Intensity may also be judged using the 'talk test'; in moderate intensity activities women should be able to carry on a conversation, while in vigorous activities they would find this difficult.<sup>17</sup>

### *Rating of Perceived Exertion for Physical Activities*

<b>1</b>	<b>Sedentary</b>
<b>2</b>	<b>Light</b>
<b>3</b>	
<b>4</b>	<b>Moderate</b>
<b>5</b>	
<b>6</b>	<b>Vigorous</b>
<b>7</b>	
<b>8</b>	<b>High intensity</b>
<b>9</b>	
<b>10</b>	

## Postpartum physical activity/exercise

In consideration of resuming pre-pregnancy physical activity/exercise habits, clinicians define the postpartum period as six to eight weeks after the birth, because many of the physical (anatomical and physiological) changes that occur during pregnancy will persist for this length of time. The timing of return to activity/exercise following childbirth is highly variable. It reflects the type of birth, recovery from perineal damage, medical or surgical procedures, blood loss (degree of anaemia), and habitual pre-pregnancy physical activity/exercise levels. If there are any concerns, seek advice at the first post-natal visit (usually after six weeks). Pelvic floor exercises (several times each day) should be commenced as soon as is comfortable following the birth, and continued for life. Physical activity/exercise does not negatively impact breastfeeding as long as nutrient and fluid intakes are adequate, and there is adequate support for the breasts.<sup>4,9,10,14,17</sup>

## Safety precautions

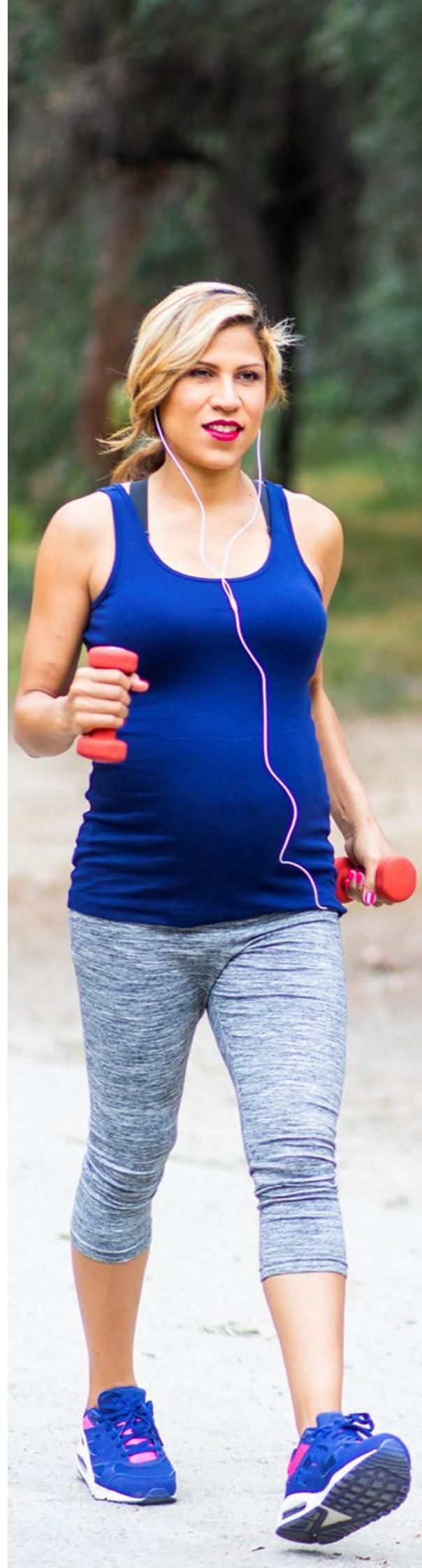
Although there is no systematic review level evidence, international physical activity guidelines and expert opinions<sup>3, 4, 8-10, 12, 16, 17</sup> suggest that pregnant women should:

- Avoid dehydration and inadequate nutrition. Stay well hydrated and try to ensure energy intake is in line with recommended gestational weight gain.
- Avoid heat stress/hyperthermia, especially in the first trimester. Although it is unlikely that normal physical activity/exercise would cause core body temperature to reach levels that may be harmful to fetal development<sup>17</sup>, PA/exercise levels should be adjusted in excessively hot weather, especially when there is high humidity. Activity/exercise should preferably be done in a cool environment.
- Avoid long periods of motionless posture (standing still, or lying in a supine position), especially if this causes light headedness or dizziness. Avoid physical activity/exercise at high altitude (above 2000m) unless acclimatised and trained to do this prior to pregnancy. Regular high-altitude high intensity athletes should seek advice or supervision from an appropriately qualified health professional.
- Always wear appropriate shoes for the activity, non-restrictive clothing and a supportive bra. When it is hot, wear loose clothing made from 'breathable' fabric.

**Pregnant women are also advised to avoid activities that involve:**

- Significant changes in pressure (eg sky diving, scuba diving)
- Risk of contact/collision
- Risk of falling (ie activities that require high levels of balance, coordination and agility)
- Heavy lifting

Women who are healthy and already active do not need to seek medical clearance for physical activity/exercise during pregnancy, but those who are considering high volumes of exercise training (high intensity, prolonged duration, etc) should seek advice and guidance from a health professional who is knowledgeable about the effects of high level training on maternal and fetal outcomes.



## **Warning signs to stop physical activity/exercise**

International physical activity guidelines and expert opinions<sup>3,4,8-10,12,16,17</sup> suggest that pregnant women who experience any of the following symptoms during physical activity/exercise should stop, and seek advice from their health professional before continuing with a physical activity/exercise program:

- Chest pain
- Persistent excessive shortness of breath – that does not resolve with rest
- Severe headache
- Persistent dizziness / feeling faint – that does not resolve with rest
- Regular painful uterine contractions
- Vaginal bleeding
- Persistent loss of fluid from the vagina – indicating possible ruptured membranes

## **Absolute Contraindications**

International physical activity guidelines and expert opinions<sup>3,4,8-10,12,16,17</sup> concur that pregnant women who have any of the following are advised not to exercise until individually tailored advice has been sought:

- Incompetent cervix
- Ruptured membranes, preterm labour
- Persistent second or third trimester bleeding
- Placenta previa
- Pre-eclampsia
- Evidence of intrauterine growth restriction
- Multiple gestation (triplets or higher number)
- Poorly controlled Type 1 diabetes, hypertension or thyroid disease
- Other serious cardiovascular, respiratory or systemic disorder

## **Relative Contraindications**

International physical activity guidelines and expert opinions<sup>3,4,8-10,12,16,17</sup> also concur that pregnant women with a history of, or who develop, the following conditions during pregnancy should discuss starting or continuing physical activity/exercise with their health professional:

- History of spontaneous miscarriage, preterm labour or fetal growth restriction
- Mild/moderate cardiovascular or chronic respiratory disease
- Pregnancy induced hypertension
- Poorly controlled seizure disorder
- Type 1 diabetes
- Symptomatic anaemia
- Malnutrition, significantly underweight or eating disorder
- Twin pregnancy after the 28th week
- Other significant medical conditions

# Discussion

The main purpose of these Guidelines is to provide evidence-based recommendations on physical activity/exercise during pregnancy for Australian women and those who provide healthcare during pregnancy, including health professionals, as well as coaches, trainers and fitness and recreation professionals who may be asked for advice about physical activity/exercise during pregnancy.

The proposed Guidelines build on recently published international guidelines,<sup>8-11</sup> and on the advice offered by Australian professional organisations (RANZCOG<sup>3</sup> and SMA<sup>4</sup>). They will also complement the lifestyle considerations section of the Australian *Clinical Practice Guidelines: Pregnancy Care*<sup>a</sup>

**The main differences between these new Guidelines and others (see Appendix 5) are that:**

- The new Guidelines explicitly refer to the Australian Physical Activity and Sedentary Behaviour Guidelines for Adults.<sup>22</sup> These include recommendations on moderate-vigorous intensity physical activity, muscle strengthening activities, and on reducing and breaking up time spent in prolonged sitting.
- In addition to the muscle strengthening activities included in the Australian PA and SB Guidelines, we have included a specific recommendation that advises all pregnant women to do pelvic floor exercises during and following pregnancy. A similar recommendation is made in the Canadian Guidelines<sup>8</sup> and the SMA position statement.<sup>4</sup>
- We have included a recommendation on the role of health professionals, as was done in the ACOG,<sup>10</sup> RANZCOG<sup>3</sup> and SMA<sup>4</sup> statements. However, we have changed the emphasis to reflect contemporary practice which suggests that women should be actively involved in shared decision-making about their physical activity/exercise during and after pregnancy. Our final guideline emphasises the need for all health professionals who provide care during pregnancy to be familiar with contraindications, signs and symptoms which suggest that physical activity/exercise should be modified or avoided.

The final guideline was the focus of extensive debate during the review process. In the earlier stages of development we had recommended that women who are healthy and already active do not need to seek medical clearance to participate in physical activity/exercise during pregnancy. This statement is now in the supporting information, where we note that women who are considering high volumes of exercise training (high intensity, prolonged duration, etc) should seek advice and guidance from a health professional who is knowledgeable about the effects of high level training on maternal and fetal outcomes. It is highly likely that most women, including athletes and sports women, will modify their activities as pregnancy progresses, in line with advice from qualified health professionals (Guideline #2). As there will be cases when it is unsafe for women to exercise during pregnancy, the second part of our final guideline suggests that all health professionals should be familiar with indications for both not commencing, and for ceasing, activity.

Overall, in our reviews, we found no evidence of adverse outcomes of physical activity/exercise during pregnancy. On balance, for women who participated in the hundreds of RCTs and cohort studies which were summarised in the reviews which informed the development of our Guidelines, the health benefits of

<sup>a</sup> Department of Health (2020). Clinical Practice Guidelines: Pregnancy Care. Canberra: Australian Government Department of Health. (In development at the time of writing this report).

participation in leisure time or transport physical activity/exercise before, during and after pregnancy were confirmed. Further research on occupational PA, including lifting heavy loads, as well as on prolonged periods of sitting or standing at work is required.<sup>15</sup>

A gradual return to recommended levels of physical activity is considered to be safe after the six week postnatal check. For women who wish to return to training and competitive sport, depending on the individual case, more intense activities can be gradually resumed, building from moderate to vigorous physical activity over a period of about three months. However, the postpartum period is a challenging time for most new mothers, who may be juggling family and work commitments, as well as caring for a new baby and taking care of their own health.

## Introductory statement

The initial statement in the Guidelines is intended to assure women with healthy pregnancies physical activity/exercise is safe and beneficial and may reduce the risk of some complications. It is similar to statements made in all our source documents. Our evidence review confirmed benefits for women *during pregnancy* in terms of cardiorespiratory fitness, gestational weight gain, gestational diabetes, low back and pelvic girdle pain, urinary incontinence (UI) and mental health problems. We also found benefits relating to gestational age and preterm birth, mode of delivery and birthweight, and for reduced risk of UI and depression postpartum.

Whatever level of physical activity/exercise women wish to do, it is likely that the amount (volume, intensity etc) will decrease as pregnancy progresses, because activities become more uncomfortable in the later stages of pregnancy. More large scale dose-response studies, which assess types and volumes of PA, before and during early and late pregnancy, and in the postpartum period, are required to clarify long term health outcomes.<sup>15</sup>

## Guideline One

We found no evidence to suggest that women who do not have contraindications (listed in the Supporting Information) should not participate in physical activity/exercise in line with the current Australian Physical Activity and Sedentary Behaviour Guidelines for Adults.<sup>22</sup> In relation to the 'activity' component of these Guidelines (most days, 150 to 300 minutes at moderate intensity, or 75–150 minutes at vigorous intensity, or any equivalent combination),<sup>22</sup> similar recommendations are offered in the Canadian<sup>8</sup> and Swiss<sup>9</sup> guidelines, and in the SMA statement.<sup>4</sup> The first guideline closely mirrors the guidance offered in the US Physical Activity Guidelines (PAG) report, which suggests a minimum of 150 minutes (aerobic and muscle strengthening activities) 'spread throughout the week'.<sup>11</sup> Previously inactive women, whether pregnant or not, are advised to start slowly and increase amounts of physical activity/exercise gradually.

The single systematic review of the effects of vigorous intensity physical activity/exercise (which included 10 cohort studies and 5 RCTs) concluded that vigorous exercise appears to be safe in the third trimester of pregnancy, but that further research on vigorous physical activity/exercise in the earlier stages of pregnancy is required.<sup>25</sup> It is extremely difficult to conduct research to assess the maximal safe levels of physical activity/exercise during pregnancy. There was therefore little evidence on which to base any recommendation about the typically high intensity or prolonged physical activity/exercise training that is characteristic of athletes and sportswomen. Restrictions on vigorous activity (based on keeping the heart rate [HR] below 140 bpm, and restricting exercise to 15 minute bouts) have now been removed from most

guidelines worldwide, but athletes are advised to consult with informed health professionals and to review training loads throughout pregnancy on an individual basis. Those who provide advice for athletes and sportswomen are advised to read the series of reviews by the IOC expert committee<sup>12-14,16</sup>, or the clinical *UpToDate*<sup>®</sup> webpages.<sup>17</sup>

Whilst vigorous intensity activity is now considered safe for most women, most guidelines now recommend moderate intensity physical activity/exercise during pregnancy, and advise that intensity should be based on ratings of perceived exertion. We have recommended using perceived exertion of 3-7 (on a scale of 1-10), or using the talk test, to indicate moderate to vigorous intensity activity.

Physical activity choices during pregnancy should reflect individual preferences and pre-pregnancy activities. However, given that only about one quarter of non-pregnant women aged 18-45 report any muscle strengthening activities, and that this proportion is likely to be lower during pregnancy, this life-stage may be a good time to emphasise the importance of the 'twice weekly muscle strengthening activities' recommendation in the Australian PA and SB guidelines for adults.<sup>22</sup>

Although research on muscle strengthening during pregnancy in the general population is in its infancy, and evidence on the types of resistance training that are now commonly included in gym-based programs (eg Body Pump, F45) is scarce, we found no evidence to suggest that pregnant women should not use light weights or resistance bands to improve muscle strength and endurance. The *UpToDate*<sup>®</sup> document does however suggest that physical activities/exercises that involve marked straining (such as heavy lifting) should be avoided.<sup>17</sup> Given that there is some evidence in the occupational activity literature of adverse associations between repeated heavy lifting and indicators of poor fetal and maternal health outcomes<sup>26</sup>, we suggest that heavy lifting and intense repetitive isometric exercises should not be recommended during pregnancy. The *UpToDate*<sup>®</sup> information<sup>17</sup> and IOC series<sup>16</sup> also suggest that contracting the pelvic floor muscles before and during heavy lifting may counteract the impact of increased intra-abdominal pressure on the pelvic floor.

Research on the effects of sedentary behaviour during pregnancy is also emerging, and we found mixed evidence of associations between sitting and indicators of maternal and fetal health outcomes. However, while we have no reason to suspect that the adverse effects of prolonged sitting would be different in pregnant and non-pregnant women, it is likely that the circulatory effects (eg venous pooling) may be exacerbated during pregnancy. In general population samples, daily sitting for greater than eight hours is associated with increased risks of several NCDs, but these risks are attenuated by moderate-high levels of physical activity.<sup>27</sup> There are however metabolic and circulatory benefits when prolonged periods of sitting are interrupted by short periods of light activity.<sup>28</sup> Given that many women continue to work late into pregnancy, pregnant women are advised to minimise amounts of prolonged sitting and to break up long periods of sitting as often as possible, as advised in the Australian PA and SB guidelines for adults.<sup>22</sup> To date, the Swiss guidelines are the only others to have included a recommendation on sitting time ("make breaks/interrupt long seated periods").<sup>9</sup>

## Guideline Two

The second guideline acknowledges that, as pregnancy progresses, anatomical and physiological / metabolic changes mean that modifications to some activities/exercises are required. This is in line with recommendations made in the ACOG statement<sup>10</sup> and in the Swiss guidelines.<sup>9</sup> The Canadian Guidelines<sup>8</sup> suggest that yoga and/or gentle stretching may be beneficial during pregnancy, and the Swiss guidelines<sup>9</sup> also suggest that 'adjusted' stretching can be beneficial for health and well-being. Others suggest that flexibility exercises should be individualised to reduce susceptibility to joint injury.<sup>17</sup> However, both the IOC and UpToDate<sup>®</sup> series raise the issue of exercise in the supine position, and potential compromises to venous return of blood from exercising lower limb muscles. Notwithstanding, a recent Canadian review found there was insufficient evidence to ascertain whether maternal exercise in the supine position is safe or should be avoided during pregnancy.<sup>29</sup> This guideline is therefore based on clinical expertise, and highlights the difficulties of conducting research in which adaptations are *not* made. In terms of modifications to preferred types of activity, it is common sense to avoid physical activity/exercises with high risk of falls or blunt trauma.

## Guideline Three

To date only the Canadian Guidelines<sup>8</sup> and the SMA statement<sup>4</sup> have included a specific recommendation on pelvic floor muscle (PFM) exercises. Given the prevalence of urinary incontinence during pregnancy (30–50%), its impact on quality of life and exercise participation,<sup>30,31</sup> and the strong possibility that the condition will persist into older age, we included a specific recommendation that all women should do PFM strengthening exercises during and following pregnancy. The evidence on PFM strengthening and *prevention* of UI is based on good quality RCTs which show that starting PFM exercises before the birth reduces the risk of postpartum UI. For *treatment* of UI, supervised PFM exercise has greater effects. As no trials have continued 'for life' our advice on continuing these exercises for life is based on clinical judgement that this can do no harm and may well prove to be beneficial in later life.

## Guideline Four

The overall aim of the final guideline is to encourage joint decision making between women and their health professionals on issues relating to physical activity/exercise during pregnancy.

Some previous guidelines suggest that women should be screened before exercising during pregnancy. For example, the ACOG statement suggests that *a thorough clinical evaluation should be conducted*,<sup>10</sup> and the RANZCOG statement<sup>3</sup> advises that *potential contraindications should be identified*,<sup>3</sup> before recommending an exercise program. As indicated above, our view is that healthy women should not be *required* to seek clearance from a health professional if they choose to be physically active during pregnancy, especially if they were active prior to pregnancy, and as long as they have no contraindications and remain asymptomatic. However, women who are considering exercise and training at levels above those recommended in the PA guidelines should consult a pregnancy care professional with relevant knowledge and expertise, for screening and ongoing review. In this report we summarise all the general precautions included in previous guidelines and statements, and we are developing a pre-exercise screening tool for those who wish to continue exercise training during pregnancy. The aim of the screening tool is to help identify any contraindications, signs or symptoms that indicate that physical activity/exercise is not recommended. The ACOG statement<sup>10</sup> suggests that bed-rest is only rarely indicated and that in most cases walking should be allowed. Recommendations on when to stop and seek

medical guidance are provided in this report (pages 13-14) and may also be found in the series of five papers from the IOC, to guide both elite and recreational athletes during and following pregnancy.<sup>12-16</sup> Regular updates of the evidence are provided in the *UpToDate*<sup>®</sup> resource for clinicians.<sup>17</sup>

## Methodological constraints

In developing these Guidelines we used a staged approach in which we first identified key source documents, then extracted systematic review level information on the evidence relating to 27 *critical elements* of physical activity/exercise during and following pregnancy. Our critical review of all the evidence informed our *Narrative Review* and *Evidence Summary Table*. The majority of the reviews included information on the effects of physical activity/exercise on the pregnant woman's health and on birthweight, reflecting difficulties of doing research that focuses on the developing fetus.

Interpretation of the systematic review evidence relating to some of the critical elements (including gestational hypertension, gestational diabetes and post-natal depression) was not straightforward. For example, although several of our key sources used the same systematic reviews to shape the evidence on a specific topic, their conclusions did not always agree with each other. When we re-reviewed the contributing systematic reviews, we found limitations and sources of bias in the studies which were included in them. In some cases we also found recently published studies which had not been included in the source documents, which created uncertainty in some summary evidence statements and the quality ratings assigned to them.

Throughout this body of literature we identified several common methodological limitations, especially in the RCTs included in earlier reviews. For example, inclusion of heterogeneous volunteer samples of pregnant women in RCTs introduced biases in terms of health, wealth and education. Inclusion of primiparous and multiparous women, healthy weight and overweight/obese women, and women with and without risk factors (eg hypertension, hyperglycaemia), in the same trial, without sufficient sample size for sub-sample analyses, also created challenges to interpretation of the evidence. Moreover, many of the effects of physical activity/exercise during pregnancy described here are not independent of each other (eg women who develop GDM are more likely than other women to have large babies, which then impacts on birthweight and mode of delivery). Few of the studies we reviewed considered these synergistic effects when considering multiple outcomes.

In many cases the effects of physical activity alone could not be deduced in lifestyle interventions with multiple components, such as activity/exercise and diet (which are important for weight related outcomes). In some reviews the effects of supervised and unsupervised interventions were not considered separately, and in many studies the effects of bias due to drop out (high attrition) and of variable or poor compliance with intervention instructions were not considered. In some studies, data were collected in three different trimesters (from different participants), even though effects may vary at different stages of pregnancy. For example, the developing embryo may potentially be more susceptible to changes in maternal physiological and metabolic parameters during the first trimester of pregnancy.

## Public health implications

A recent analysis of National Health Survey data by the Australian Institute of Health and Welfare has shown that the median weekly duration of physical activity for fitness, recreation, sport or transport, in non-pregnant women, is 149 minutes, compared with 90 minutes in pregnant women.<sup>1</sup> Most of the difference is accounted for by lower levels of vigorous intensity PA, but there appear to be some

reductions in moderate intensity activity as pregnancy progresses. Amounts of walking for transport are similar in pregnant and non-pregnant women, presumably because many women continue their paid work until just before the birth and most transport-related walking occurs during the daily commute. Amounts of recreational walking are only slightly lower in pregnant than in non-pregnant women. Notwithstanding, overseas studies have shown significant declines in physical activity during pregnancy in Brazilian<sup>32</sup> and in Danish<sup>33</sup> women.

In recent years the global obesity epidemic has focussed attention on rates of weight gain during young adulthood, and there is evidence to suggest weight gained during pregnancy may signal the transition from 'normal weight' to overweight or obesity.<sup>34,35</sup> High rates of weight gain at this life stage may be associated with weight gain during pregnancy that is not subsequently lost.<sup>36</sup> Our review confirmed that physical activity prior to and during pregnancy will help to ensure that overall weight gain is in line with recommendations. This is important because excess weight gain increases the risk of gestational diabetes, and GDM is associated with a seven fold increase in risk of developing type 2 diabetes after pregnancy.<sup>37</sup> Weight gain at this life stage is also strongly linked with the development of UI, independent of parity.<sup>38</sup>

Although it seems intuitive to suggest that sleep is extremely important during pregnancy, research in the area of physical activity and sleep during pregnancy is in its infancy. Most research is based on the hypothesis that physical activity may improve sleep, which may, in turn, improve health outcomes.<sup>39</sup> To date however, results of studies in pregnant women have shown mixed results, with positive, negative or null associations. The findings reflect the subjective measures of both physical activity/exercise and various sleep indices, as well as huge variability in sleep patterns and quality at different stages of pregnancy. Potential bidirectional associations between sleep and physical activity/exercise are also problematic, particularly in cross-sectional studies. In the absence of systematic review level evidence on the combined effects of physical activity/exercise and sleep at different stages of pregnancy, and the wide heterogeneity of results in studies to date, we were not able to draw any conclusions about the relationships between sleep, physical activity and health outcomes during pregnancy. More high quality research is clearly required.

In line with advice from the NHMRC, the Guidelines proposed here were subjected to a series of reviews by international experts, local clinicians and national stakeholders. (See Appendix 2). Collectively, the Consultants and Reviewers represented expected users of the Guidelines, including consumers, service providers, researchers, and representatives of government and non-government agencies, and professional organisations.

## **Conclusions**

These Guidelines provide evidence based best practice recommendations on physical activity/exercise during pregnancy for Australian women and those who provide healthcare during pregnancy. They may be used to correct misconceptions about physical activity/exercise during pregnancy and to improve the quality of information provided to women by health and exercise professionals.<sup>16,39,40</sup> Given women's increased engagement with the healthcare system during and following pregnancy, this life stage is an opportune time for implementation of health promotion and disease prevention strategies which will improve the health of mothers and their babies.<sup>41-43</sup> If more women are encouraged to commence or continue being active during and following pregnancy, they may be more likely to continue with life-long activity, which has countless health, social and economic benefits for themselves, their children and the health system.

## **Next Steps**

The recommendations made in this report are based on scientific evidence which was available up to November 2019. This should be reviewed within five years. If the new World Health Organisation public health guidelines for physical activity and sedentary behaviour (due for release in October 2020) are markedly different from the Australian Guidelines (which are included in the first 'pregnancy' guideline), there may be a case for inserting the new WHO guidelines into Guideline #1.

Once approved by the Department of Health, these Guidelines should be made widely available, free of charge, to end-users, and be easy to find using online searches of the Department's website. Ideally, their release should be accompanied by communication resources and supporting materials with clear definitions, information and illustrations.

# APPENDICES



# APPENDIX 1:

## The Consultant Group

Name	Position	Qualifications
Professor Wendy Brown (Lead Consultant)	Professor The University of Queensland	BSc (Hons) Grad Dip (Physical & Health Ed) MSc (Human Biology) PhD (Exercise Physiology) FACSM, FASMF
Dr Melanie Hayman	Senior Lecturer Central Queensland University	BHealthMed Sci MEdPractice PhD (Exercise and Pregnancy)
A/Prof Lene Haakstad	A/Professor Norwegian School of Sports Sciences Oslo, Norway	BSc MSc (Sports Medicine) PhD (Exercise, Women's Health)
Dr Gregore I. Mielke	Research Fellow, The University of Queensland	BA MSc (Epidemiology) PhD (Epidemiology)
Dr Gabriela P. Mena	PhD Scholar The University of Queensland	MD (Medicine) MPH (Public Health) PhD candidate
Ms Tayla Lamerton	PhD Scholar The University of Queensland	BA (Hons) MA (Psychology) PhD candidate
Dr Anita Green	Chair, Brisbane North Primary Health Network Senior Lecturer The University of Queensland	MBBS MSpMed (Sports Medicine) FRACGP, FASMF.
Dr Shelley Keating	NHMRC Early Career Research Fellow The University of Queensland	BExSciRehab (Hon-1) MExSpSci (ClinExSci) PhD (Clin Exercise Physiology)
A/Prof. Grace Gomes	Assistant Professor Federal University of Sao Carlos Brazil	BSc Grad Dip (Physical & Health Ed) MSc (Epidemiology) PhD (Human Movement)
Professor Jeff Coombes	Professor The University of Queensland	BEd (Hons) BAppSci MEd PhD (Exercise Physiology) FACSM, FESSA

### *Declaration of Conflict of Interest*

None of the Consultants has any conflict of interest to declare in association with the creation of these Guidelines.

# APPENDIX 2:

# Membership of the Review Panels

## 2.1 International Advisory Group

Name	Position	Research area
Professor Raul Artal	Professor and Chair Emeritus Department of Obstetrics/ Gynecology and Women's Health: Saint Louis University, USA	Obstetrics and Gynaecology
Professor Kari Bo	Professor Norwegian School of Sports Sciences Oslo, Norway	Physiotherapy
Professor Amanda Daley	Professor School of Sport Exercise and Health Sciences University of Loughborough, UK	Behavioural Medicine
Professor Loretta diPietro	Professor George Washington University, USA	Exercise physiology and public health
Professor Kelly Evenson	Professor University of North Carolina, USA	Epidemiology and public health
Professor Sonja Kahlmeier	Professor Swiss Distance University of Applied Science, Switzerland	Physical activity and public health
Professor Bengt Kaiser	Professor University of Lausanne Switzerland	Medicine, exercise physiology and public health
Professor Tarja Kinnunen	University of Tampere, Finland	Nutrition, public health, lifestyle during pregnancy
Professor Michelle Mottola	Professor University of Western Ontario, Canada	Exercise physiology
Dr Katrine Owe	Researcher Norwegian Institute of Public Health	Epidemiology and public health
Professor Mireille van Poppel	Professor University of Graz, Austria	Public and occupational health

## 2.2 Clinical Reviewers

Name	Position	Expertise
Dr Meg Cairns <sup>a</sup>	Clinical adviser to Brisbane North Primary Health Network, Metro North Hospital and Health Service, and Queensland Health	General practice and pregnancy care
Prof. Leonie Callaway <sup>a</sup>	Head, Royal Brisbane Clinical School, and Senior Specialist in Obstetric and Internal Medicine at the Royal Brisbane and Women's Hospital	Obstetric physician
Dr Sharon Stay <sup>a</sup>	Sports Physician Northside Sports Medicine, Brisbane	Care of professional and senior athletes
Prof. Deborah Davis <sup>b</sup>	Clinical Chair and Professor of Midwifery, University of Canberra and ACT Health	Midwifery and pregnancy care
Prof. Maralyn Foureur <sup>b</sup>	Clinical Chair of Nursing and Midwifery Research, University of Newcastle and Hunter New England Local Health District	Midwifery practice and research

## 2.3 National Stakeholders

The 16 respondents to the third consultation were from representatives of three professional organisations, and from the health and maternal services offices in several States and Territories. Some respondents to the survey were anonymous. Those who disclosed their identity were from:

- The Royal Australian College of General Practitioners Antenatal/Postnatal Special Interest Group
- The Australian College of Midwives
- Exercise and Sports Science Australia
- Clinical Excellence Queensland, Office of the Deputy Director-General, Queensland Health
- NSW Ministry of Health
- Public Health Services, Department of Health, Tasmania
- Maternity Services and WA Health (West Australian government)
- Maternity Services, Northern Territory Government

<sup>a</sup> Participated in 'round table' discussion in December 2019.

<sup>b</sup> Participated in on-line review in July 2020.

# APPENDIX 3:

## Narrative review of the evidence

### Methods

The methods are described on pages 2–7 of the main report. In brief, eight source documents (counting the IOC series as one source) were identified.<sup>3,4,8–14,16,17</sup> The four sources which included comprehensive reviews<sup>8,10–14,16,17</sup> were searched to identify *critical elements* of physical activity/exercise during pregnancy. Twenty-seven elements were identified and each was categorised into one of five categories, as follows:

- Effects of physical activity/exercise during pregnancy on the pregnant woman;
- Effects of physical activity/exercise during pregnancy on fetal development and birth;
- Effects of physical activity/exercise during pregnancy and postpartum (6 months) on postpartum issues;
- Effects of sedentary time on maternal and infant health outcomes;
- Effects of occupational physical activity on maternal and infant health outcomes

Narrative reviews of the evidence on each critical element (based on the source documents, and supplementary searches to identify missing or recently published papers) were prepared and critically reviewed. The Consultants prepared a summary statement, and collectively assigned grades to summarise the quality of the evidence, for each critical element.

## **3.1 Effects of physical activity/exercise during pregnancy on the pregnant woman**

### **Cardiorespiratory fitness**

In line with the findings of the 2015 US ACOG report<sup>1</sup> (which included a 2006 Cochrane review<sup>44</sup>), nine<sup>45-53</sup> of the eleven RCTs published in the last 20 years have reported positive results in terms of improving what was then referred to as 'physical fitness,' with physical activity/exercise interventions during pregnancy.<sup>45-55</sup> The quality of many trials was suboptimal (with small sample sizes, inadequate descriptions of interventions, measures and statistics, and poor reporting of adherence and compliance). Few studies were conducted with overweight/obese women, younger/older mothers, previously inactive or well-trained women, or elite athletes.

**We conclude that regular physical activity/exercise during pregnancy maintains or improves cardiorespiratory fitness, and grade the quality of the evidence as 'moderate' (downgraded RCT evidence).**

### **Gestational weight gain**

A recently published systematic review and meta-analysis of individual participant data (IPD) from 36 trials ( $n = 12\,526$ ), showed that women randomized to physical activity/exercise had a slightly lower average gestational weight gain (-0.70 kg) than women in the control groups.<sup>56</sup> This is in accordance with the conclusions of the ACOG<sup>10</sup> and Canadian<sup>8</sup> guidelines reports, and four other reviews,<sup>57-60</sup> which also found differences of around 1kg less weight gain in active/exercising women, and reduced risks of weight gain above the Institute of Medicine (IOM) recommendations.<sup>61</sup> Similar evidence was found in overweight or obese populations,<sup>62,63</sup> but further studies in different subpopulations are warranted. The recent umbrella review from authors of the US PAG Advisory Committee's Chapter on Exercise in Pregnancy also concluded that moderate intensity physical activity reduced the risk of excessive gestational weight gain.<sup>64</sup>

**We conclude that physical activity/exercise prior to and during pregnancy is associated with lower weight gain and improves compliance with weight gain in accordance with IOM guidelines. The quality rating is 'high' (ie there is good RCT evidence to support this statement).**

### **Gestational diabetes mellitus**

Recent systematic reviews have reported that regular physical activity/exercise (>120 minutes/week) before and during pregnancy, especially in early pregnancy and among overweight/obese pregnant women, has a protective effect on the development of gestational diabetes.<sup>57,65-69</sup> However, a recent systematic review found that five out of seven

RCTs reported no effect of combined physical activity/exercise and diet interventions on the prevention of gestational diabetes in high-risk populations (four out of seven included overweight and obese women).<sup>70</sup> The combination of physical activity/exercise and nutritional interventions, variations in the 'dose' of physical activity/exercise (from generic physical activity advice to 'supervised exercise training') and considerable methodological heterogeneity (from low to very high quality) make interpretation of this evidence challenging. Despite the inconsistency of findings, the recent US PAG umbrella review concluded that there was strong evidence of an inverse association between physical activity/exercise and the development of GDM.<sup>11,64</sup>

Three systematic reviews have reported that physical activity/exercise ( $\geq 60\text{--}120 \text{ min/weekly}$ ) may lead to small improvements in blood glucose among women diagnosed with gestational diabetes.<sup>71\text{--}73</sup>

**We conclude that regular physical activity/exercise before and during pregnancy (and especially in early pregnancy) may have a protective effect on the development of gestational diabetes and may assist with regulation of blood glucose in women diagnosed with gestational diabetes. Given the high heterogeneity of study designs, quality and findings, we rate the quality of the evidence as moderate (downgraded RCTs).**

## Gestational hypertension and pre-eclampsia

Since the publication of the US ACOG Guidelines<sup>1</sup> (which relied on evidence from only two small trials), three systematic reviews have concluded that regular aerobic exercise reduces the risks of gestational hypertension.<sup>65,74,75</sup> All three found significantly reduced risk of hypertensive disorders among women who did moderate-intensity leisure activities during pregnancy (compared with those who were inactive). However, the i-WIP collaborative group reported no effect of physical activity on hypertensive disorders (OR = 0.74; 95% CI: 0.42 to 1.33) when individual data from seven studies with 2,565 women were pooled.<sup>56</sup> When these individual data were supplemented with study-level data from an additional 13 studies that did not contribute IPD, there was an inverse relationship between physical activity and hypertension (OR = 0.68; 95% CI: 0.49 to 0.93; N=5,125). Relationships were similar across different age, race/ethnicity, and BMI subgroups.<sup>56</sup> In their recent overview of this evidence, DiPietro et al concluded that the dose-response relationship between physical activity and gestational hypertension was limited.<sup>64</sup>

Pre-eclampsia is characterised by high blood pressure, high levels of protein in the urine (proteinuria) and swelling in the hands and feet. If left untreated it can lead to serious complications for both the mother and baby. Results of two meta-analyses (of cohort and case-control studies) have indicated the importance of physical activity prior to and in early pregnancy, for reducing the risk of pre-eclampsia.<sup>76,77</sup> In contrast, other systematic reviews and meta-analyses have reported no differences in the incidence of pre-eclampsia in physical activity/exercise and control groups<sup>57,68,75,77</sup> even if physical activity is prior to<sup>57</sup> or in early pregnancy.<sup>58,68</sup> The authors of the 2019 US Physical Activity Guidelines umbrella review<sup>64</sup>, the IOC review of exercise in athletes<sup>12</sup> and the US PAG recommendations<sup>11</sup> all found inconsistent or limited evidence of any inverse relationship between physical activity and pre-eclampsia.

The few RCTs included in these systematic reviews have small sample sizes and variable methodological quality, which make it difficult to draw firm conclusions. Hence, the evidence remains somewhat mixed.

**We conclude that there is limited evidence that regular physical activity/exercise is associated with reduced risk of gestational hypertension, and that physical activity/exercise may lower maternal arterial pressure. The effects of physical activity/exercise on pre-eclampsia are unclear. We grade the quality of this evidence as moderate (downgraded RCTs).**

## Low back pain and pelvic girdle pain

A 2015 Cochrane review of 34 RCTs (n=5121) (which was included in the US ACOG Guidelines) concluded that there is weak evidence that physical activity/exercise may reduce pregnancy related low back pain and pelvic girdle pain.<sup>78</sup> This is in accordance with other reviews which show that physical activity/exercise does not decrease the odds of low back pain (LBP), pelvic girdle pain (PGP) or lumbo-pelvic pain (LPP),<sup>59,79</sup> but may have a small protective effect on low back pain.<sup>80,81</sup> The review and meta-analysis conducted for the Canadian Guidelines also found very low to moderate quality evidence from 13 RCTs to show that prenatal exercise did not reduce the odds of suffering from LBP, PGP or LBPP during pregnancy. However, women who exercised during pregnancy had lower pain severity than those who did not (Standardised Mean Difference -1.03; 95% CI: -1.58, -0.48).<sup>82</sup>

There is wide heterogeneity in the quality of the studies included in these systematic reviews, and the evidence on the benefits of water exercise appears to be anecdotal. Physical activity/exercise may, however, decrease the severity of these conditions, and may improve functional disability and reduce sick leave in working women.<sup>59,78,82</sup>

**We conclude that there is little evidence to show that physical activity/exercise (on land or in water) prevents pregnancy related low back and pelvic girdle pain but may help to reduce the severity of these musculoskeletal symptoms. We rate the quality of this evidence as moderate (downgraded RCTs).**

## Urinary incontinence

The US ACOG Guidelines<sup>10</sup> did not include any evidence on urinary incontinence (UI), but suggested that exercises for pelvic floor muscles should be initiated in the immediate postpartum period. The Canadian Guidelines<sup>8</sup> included one recent systematic review.<sup>83</sup> This review, as well as a 2017 Cochrane review (38 trials; n=9892)<sup>84</sup> and two other systematic reviews,<sup>59,85</sup> have concluded that regular pelvic floor muscle exercise/training during pregnancy has a clinically relevant effect on prevention of urinary incontinence (UI), and lowers the risk of reporting UI in late pregnancy, especially when supervised exercise is conducted.

In contrast, it is unclear whether pelvic floor muscle training during pregnancy is effective for the treatment of urinary incontinence in pregnant women.<sup>83,84</sup> High quality RCTs have shown

that close follow-up and more intense exercise may be necessary to reduce and treat urinary incontinence in incontinent women.<sup>86</sup> It is possible that pelvic floor muscle training, as a therapeutic approach, would show greater effects if targeted to high-risk pregnant women (eg multiparous, overweight/obese or women of advanced maternal age).<sup>83,84</sup>

**We conclude that doing regular pelvic floor exercises during pregnancy has a clinically relevant effect on prevention of UI and reduces the risk of UI in late pregnancy, especially when exercise is supervised. The quality of the evidence is graded as high. It is however unclear whether pelvic floor exercise during pregnancy is effective for treatment of urinary incontinence during pregnancy and we rate the quality of this evidence as moderate (downgraded RCTs).**

## Depression and depressive symptoms

The review conducted for the Canadian Guidelines reported that physical activity/exercise during pregnancy was associated with a very small reduction in the severity of prenatal depressive symptoms (based on 21 low-moderate quality RCTs) and 45% lower odds of developing prenatal depression (eight RCTs).<sup>87</sup> Moderate effect sizes were seen when physical activity/exercise was in line with current guidelines, but the overall quality of many of the included studies was low, with significant heterogeneity and risk of bias. An earlier systematic review reported that there was some evidence that physical activity/exercise may be effective in treating depression during pregnancy, but this was based on six low-moderate quality RCTs which showed significant heterogeneity in their results.<sup>88</sup> A smaller systematic review (of data from six RCTs, N=375) showed that yoga (especially integrated yoga) may help to decrease prenatal depression symptoms.<sup>89</sup> The most recent review<sup>64</sup>, based on the evidence presented in the 2018 US PAG Advisory Committee report<sup>11</sup> concluded that there was limited evidence of an inverse relationship between physical activity and the risk of antenatal depressive symptoms.

**We conclude that there is limited evidence to show that physical activity/exercise during pregnancy is associated with reduced risk or severity of depressive symptoms during pregnancy, and we rate the quality of the evidence as moderate.**

## Anxiety

The review conducted for the Canadian Guidelines<sup>87</sup> concluded that physical activity/exercise during pregnancy was not associated with a reduction in anxiety symptoms during pregnancy (two RCTs) and the umbrella review by authors of the US guidelines reported very limited evidence on this association.<sup>64</sup> The Canadian review noted that one study of yoga showed positive effects.<sup>87</sup> This is in line with an earlier RCT (96 women in the 20<sup>th</sup> week of gestation) which showed that anxiety symptoms during pregnancy decreased with yoga, but not with other forms of activity/exercise during pregnancy.<sup>90</sup>

**We conclude that physical activity/exercise during pregnancy does not reduce the risk of anxiety during pregnancy. The evidence quality rating is low (limited number of downgraded RCTs).**

## Sleep

Although it is well known that sleep is often disturbed during pregnancy, and that these disturbances may impact on health outcomes, research on the effects of physical activity on sleep during pregnancy is limited.<sup>91</sup> To date, no systematic review of this literature has been conducted.

Studies of the effects of physical activity during pregnancy on sleep onset latency,<sup>92-95</sup> sleep efficiency,<sup>91,93,94</sup> sleep quality,<sup>91,93,95-100</sup> sleep disturbances (sleep awakenings,<sup>94,101</sup> insomnia<sup>101,102</sup>), wake after sleep onset,<sup>91,94</sup> and sleep duration /total sleep time,<sup>92-94,96,99,100,103</sup> have shown mixed results. These include positive associations (more physical activity/exercise, better sleep), no associations, and negative associations (more physical activity/exercise, worse sleep). This probably reflects the (often retrospective) mix of subjective and objective measures of both physical activity/exercise and sleep indices, the timing of the physical activity/exercise interventions (morning/evening), the stage of pregnancy and the limited follow-up periods.

**With high heterogeneity of study designs, measures, interventions and quality, it is not possible to draw any conclusions about the effects of physical activity on sleep during pregnancy, or on the joint effects of physical activity and sleep on health outcomes at this time. The quality of the evidence is low.**

## Body image dissatisfaction

One systematic review (of three cohort studies and one quasi-experimental study) has investigated relationships between physical activity/exercise and body image dissatisfaction among pregnant women.<sup>104</sup> It concluded that women who exercised had slightly better body image satisfaction.

**We conclude that there is limited research on physical activity/exercise and body image dissatisfaction among pregnant women, and that the quality of the evidence is low.**

## 3.2 Effects of physical activity/exercise during pregnancy on fetal development and birth

### Developmental concerns

There has been some disquiet about the potential effects of physical activity/exercise in the first trimester of pregnancy on early development of the fetus, especially in relation to congenital abnormalities.<sup>13,17</sup> However, the review conducted for the Canadian Guidelines found that very low quality evidence from 14 studies indicated no increase in the odds of congenital abnormalities<sup>105</sup>, and concluded that no cohort or case control studies have shown increased risk of developmental abnormalities in the fetuses of women who exercise in early pregnancy. The authors noted that most studies were conducted after 12 weeks gestation when the risk of de novo (new) abnormalities is low.

Concerns have been raised about the potential effects of physical activity/exercise related hyperthermia. Although the Canadian review found a small (0.26°C) but significant increase in maternal temperature during and immediately following exercise<sup>105</sup>, a recent *UpToDate®* review stated that it is unlikely that body core temperature would reach teratogenic levels (levels that may be harmful for fetal development) during normal exercise.<sup>17</sup> The author notes, however, that strenuous exercise in a hot environment (eg running a marathon on a hot day, hot yoga or hot Pilates) may cause unsafe hyperthermia. Importantly, thermoregulation seems to improve during pregnancy.<sup>12,13</sup>

Concerns have also been raised about changes in fetal heart rate (HR), but these may reflect healthy physiological responses to changes in uterine artery blood flow, consequent to the redistribution of the mother's blood flow to the working muscles during physical activity/exercise. The *UpToDate®* review<sup>17</sup> suggests that the normal fetus compensates for transient changes in utero-placental blood flow during maternal exercise and is not at risk of harm. A recent meta-analysis also concluded that there were no detrimental effects of vigorous intensity exercise during the third trimester on fetal heart rate responses or on markers which may reflect outcomes of reduced blood flow, such as incidence of small for gestational age (SGA), low birthweight (LBW) and prematurity.<sup>25</sup>

Given the challenges of conducting RCTs during early pregnancy (when many women do not know they are pregnant), most of the evidence is from cohort and case control trials, with wide heterogeneity of measures and outcomes. Few if any adverse effects have been reported. For further information about fetal HR responses to maternal physical activity/exercise please see Bø et al (2016).<sup>13</sup>

**We conclude that there is no evidence of detrimental effects of physical activity/exercise on fetal development. The quality rating for this statement is low.**

## Miscarriage and perinatal mortality

Although earlier research had identified the potential for increased risk of miscarriage with intense physical activity/exercise in very early pregnancy (at around the time of implantation)<sup>13</sup>, a 2019 systematic review (23 studies, N=7125) and meta-analysis found no increased risks of miscarriage (or perinatal mortality) in pregnant women who exercised compared with those who did not.<sup>106</sup> The authors identified serious risk of bias in many of the included studies, and noted that the studies generally included moderate intensity exercise with a maximum duration of 60 minutes, so the effects of longer duration exercise/activity are unknown.

Data underpinning the potential risks of miscarriage are largely from one very large 2007 Danish cohort study<sup>107</sup> in which 92,671 women (and 100,422 pregnancies) were tracked between 1996 and 2002. There was a stepwise increase in risk of miscarriage with increasing physical activity/exercise; the largest risk estimate was observed in women with miscarriages in 11–14 weeks who exercised more than 419 minutes/week (HR = 3.7, 95% CI: 2.9–4.7) and in those who reported high impact exercise for 75–269 minutes/week (HR = 1.8, 95% CI: 1.0–3.6). (Both estimates are compared with women who did no exercise). As there are potential bias and validity problems in this study, the findings should be interpreted with caution.<sup>107</sup>

A recent review of the effects of vigorous exercise in the third trimester of pregnancy concluded that there was no increased risk of perinatal mortality as a result of vigorous training.<sup>25</sup> The number of studies was however small and exercise was in the later stages of pregnancy.<sup>25</sup>

**We conclude that physical activity/exercise during pregnancy is not associated with increased risk of miscarriage or perinatal mortality. The quality of this evidence is low.**

## Gestational age and preterm birth

The US ACOG<sup>10</sup> and Canadian<sup>8</sup> guidelines each included one meta-analysis<sup>105,108</sup> and reported no significant associations between physical activity/exercise during pregnancy and gestational age or preterm birth. The US PAG report also found no differences between active and inactive pregnant women in the risk of preterm birth or gestational age of infant at delivery.<sup>11</sup> Only one of the five meta-analyses included in that report found a slightly decreased risk of preterm birth among more physically active women<sup>57</sup>; the others reported no differences in preterm birth or gestational age among women with different levels of physical activity/exercise during pregnancy. The US PAG authors noted that one older (2007) meta-analysis of occupational physical activity found that long periods of standing and heavy lifting were associated with elevated risk of preterm birth.<sup>109</sup> However, in that study, the pooled RR for preterm birth from eight studies that compared work for at least 40 hours per week with shorter hours was 1.31 (95% CI: 1.16 to 1.47); this estimate was attenuated (RR = 1.20 (0.98 to 1.47) when only data from the five studies judged to have higher methodological quality were included.

Several additional meta-analyses and systematic reviews have reported on the effects of physical activity/exercise on gestational age and duration of pregnancy.<sup>25,110–112</sup> In 2016,

Sanabria-Martinez et al pooled data from thirteen RCTs, and reported no differences between the intervention and control groups for gestational age at birth.<sup>110</sup> In contrast, two systematic reviews (published in 2016 and 2017)<sup>111,112</sup> concluded that leisure time physical activity/exercise (but not transport PA) during pregnancy may protect against preterm birth. Most of the included studies were rated as high quality.<sup>111</sup> Moreover, a recent SR and MA (10 cohort studies and 5 RCTs) of vigorous intensity physical activity/exercise also reported a very small reduced risk of preterm birth and a small increase in gestational age (0.21 weeks) in mothers who engaged in vigorous physical activity/exercise.<sup>25</sup> This small increase is unlikely to be clinically meaningful.

**We conclude that physical activity/exercise does not have any meaningful impact on gestational age and may have very small protective effects on preterm birth. We rate the quality of the evidence as moderate.**

## Labour and birth

Contrary to concerns that strenuous physical activity/exercise may increase the tone of the pelvic floor muscles and lead to prolonged labour<sup>13</sup>, the US ACOG Guidelines<sup>10</sup> report found no differences between exercisers and controls in overall duration of labour, and the IOC review<sup>13</sup> concluded that physical activity/exercise does not increase the duration of the first or second stage of labour.

Two systematic reviews and meta-analyses (which included 10 and 16 RCTs)<sup>113,114</sup> which were published prior to the review of the effects of exercise on labour and birth outcomes conducted for the Canadian Guidelines<sup>115</sup> found higher rates of normal vaginal delivery<sup>113</sup>, and lower rates of caesarean delivery<sup>113,114</sup>, in women who exercised in the second and third trimesters. The International Weight Management in Pregnancy Collaborative Group<sup>56</sup> examined Individualised Personal Data from 11,410 women in 32 studies; they also reported a significant reduction in the odds of caesarean section (CS) in interventions (physical activity and diet) compared with 'routine care'.<sup>56</sup> A similar trend was seen when data from 'physical activity only' interventions were included, but the numbers were small.

The review conducted for the Canadian Guidelines also reported decreased odds of CS, using data from 66 RCTs that included both exercise and co-intervention and exercise only interventions. There were no differences when exercise-only interventions were compared with controls.<sup>115</sup> This group also reported that exercise-only interventions reduced the odds of instrumental delivery (OR = 0.76; 95% CI: 0.63 - 0.92; N = 3819 women in 20 RCTs). The physical activity component of most of these interventions was moderate intensity structured exercise or resistance training and the quality of most of the trials was low, with methodological and clinical heterogeneity.

Information included in the 2018 US PAG review also suggests that women who are more physically active during pregnancy are less likely than women who are less active to have a CS. In that report, two meta-analyses reported statistically significant reductions in the risk of CS among women assigned to intervention arms that included aerobic activity and/or resistance training during pregnancy<sup>74,116</sup>, while two Cochrane reviews<sup>58,117</sup> reported non-significant

reductions. The only meta-analysis that found a non-significant increase in risk of CS included only two studies.<sup>118</sup>

**Pelvic floor injury:** There are few research studies on the effects of physical activity/exercise on pelvic floor injury during labour. The most common injury (seen in 10-20% of primiparous women) is to the levator ani muscles (LAM). According to the IOC review<sup>13</sup>, the pubococcygeus muscle is the LAM most affected by vaginal birth, as it stretches to more than three times its normal length during delivery of the fetal head, sometimes with avulsion injuries, or LAM defects. The incidence of LAM defect increases to 50% when deliveries involve forceps delivery, large fetal head circumference, high fetal weight and prolonged second stage of labour. There have been no studies of the effects of physical activity/exercise on LAM defects. Anal sphincter tear can also occur during labour, and may result in later anal incontinence. Secondary data analyses from one RCT suggest no effect of an exercise intervention on this injury, which occurs more often in complicated births.<sup>13</sup>

**We conclude that physical activity/exercise during pregnancy protects against unplanned caesarean section, and may reduce the risk of instrumental delivery, but does not impact on duration of labour. There is no consensus on the effects of physical activity/exercise on injury during labour. The quality of the evidence is moderate.**

## APGAR scores

The review conducted for the Canadian Guidelines found no association between prenatal exercise and APGAR scores at 1 minute (18 studies, N=2720), and a very small (probably clinically insignificant) association between prenatal exercise and APGAR score at five minutes (16 RCTs, N=1,548; OR 0.07, 95% CI 0.00, 0.14).<sup>105</sup> The evidence was rated as low quality due to serious risk of bias, inconsistency and indirectness. Sensitivity and subgroup analyses showed that the exercise-only interventions did not impact APGAR scores at one minute or five minutes. The four meta-analyses included in the US PAG report<sup>67,68,117,118</sup> also found no significant difference between APGAR scores (mean values, and <7 at five minutes) of babies born to women who were active and inactive during pregnancy.

**We conclude that physical activity/exercise during pregnancy is not associated with APGAR scores. This statement is graded as moderate (downgraded RCTs).**

## Birthweight

Numerous systematic reviews and meta-analyses have examined associations between leisure time physical activity during pregnancy and birthweight.<sup>57,67,68,105</sup> Most show no or very small effects on birthweight. For example in three meta-analyses which were included in the US PAG report, differences in birthweight between active and inactive mothers were between -1.05g (95% CI: -1.49 to -0.62)<sup>57</sup> and -60g (95% CI: -120 to -10).<sup>117</sup> At least five additional meta-analyses of RCT data have shown non-significant difference in birthweight.<sup>67,68,74,116,118</sup> None of the reported associations are likely to be clinically significant.

However, the comprehensive review (of 135 studies) conducted for the Canadian Guidelines<sup>105</sup> found 'high quality evidence' from exercise only randomised controlled trials (RCTs) of a 39% reduction in the odds of having a baby >4000 g in women who exercised, compared with women who did not ('macrosomia' OR = 0.61; 95% CI: 0.41 to 0.92; N=3670 in 15 RCTs). The odds of active women having a growth-restricted, preterm or low birthweight baby were not significant.<sup>105</sup>

The overall quality of the RCTs included in these meta-analyses is low, reflecting small sample sizes, mixed interventions, and poor reporting of methodological details, confounders, adherence and compliance. Notwithstanding, the evidence is consistent in showing no effects of exercise during pregnancy on the likelihood of low birthweight.

**We conclude that there is consistent evidence (from cohort studies and RCTs) that physical activity/exercise does not have a clinically relevant effect on birthweight. Physical activity/exercise may however reduce the risk of macrosomia and large for gestational age infants. The quality rating is moderate (good cohort studies and downgraded RCTs).**

### 3.3 Effects of physical activity/exercise during pregnancy and postpartum (6 months) on postpartum issues

#### Weight retention/Weight loss

Several systematic reviews and meta-analyses (including those included in the ACOG Guidelines<sup>58,62</sup> and the one conducted for the Canadian Guidelines<sup>60</sup>) have examined the effects of physical activity/exercise on postpartum weight retention (PPWR). Most of the included studies focus on lifestyle interventions (ie diet and physical activity)<sup>63,119,120</sup>, and there is consensus across the reviews that lifestyle interventions are more effective than physical activity alone for preventing PPWR.<sup>60,62,63,119-122</sup> Very few high quality RCTs have assessed whether physical activity/exercise *alone* affects PPWR, but several reviews have concluded that women randomised to physical activity/exercise interventions retain less weight (about 1 kg less)<sup>60,62</sup>, and that the risk of excess gestational weight gain is reduced by 32%.<sup>60</sup>

Interpreting this evidence is difficult, because there is marked heterogeneity in the interventions (combined lifestyle interventions, habitual or acute physical activity, supervised or unsupervised physical activity/exercise) in the type and 'dose' (frequency, intensity, duration) of physical activity/exercise, in adherence and compliance, and in the target groups (eg overweight and obese women, women with gestational diabetes). Results are confounded by initial weight and the amount of weight gained during pregnancy, and it is difficult to control for the effects of dietary intake and breastfeeding.

In contrast with the earlier reviews, the recent US PAG report found five systematic reviews and meta-analyses (which included only six studies of physical activity/exercise alone) and found no significant difference in weight loss in women who did physical activity/exercise and controls.<sup>121,123-126</sup> Because of the low number of studies, the authors did not assign a quality rating to this relationship.

**We conclude that the effects of postpartum physical activity/exercise on PPWR and weight loss are confounded by multiple factors which make it difficult to assess whether physical activity/exercise alone impacts on PPWR or weight loss in the postpartum period. The quality of the evidence is moderate.**

## Breastfeeding

No studies have examined the effects of physical activity *during pregnancy* on breastfeeding outcomes, and there is little information about the effects of physical activity/exercise *after* pregnancy on lactation and breastfeeding duration. We found two randomized controlled trials of physical activity/exercise in lactating women. The earlier study (1994) reported that physical activity/exercise did not affect maternal prolactin or the volume or composition of the breast milk.<sup>127</sup> The other found that a 12-week postpartum physical activity/exercise program improved cardiorespiratory fitness, without any adverse effects on lactation-hormone levels (prolactin, oestradiol, cortisol, TSH, fT<sub>3</sub> and fT<sub>4</sub>).<sup>128</sup>

**We conclude that there is no evidence to show that physical activity/exercise affects either the quality or quantity of breast milk. Reflecting the lack of evidence, the quality rating is very low.**

## Urinary incontinence

**Prevention**—A 2012 Cochrane review, updated in 2017, concluded that continent women who initiate pelvic floor muscle training (PFMT) during pregnancy are 30% less likely to develop urinary incontinence (UI) up to 6 months following birth than women who do not engage in PFMT.<sup>84,129</sup> Other systematic reviews, including the one conducted for the Canadian Guidelines, agree that PFMT is an effective prevention strategy for reducing the risk of developing UI, especially when PFMT is supervised, follows strength training principles including near maximal contractions, and lasts at least eight weeks.<sup>83,86,129</sup> At this stage, there is insufficient high quality evidence to show that pelvic floor exercises before the birth reduces the risk into the late postnatal period (ie >6 months postpartum), although it is reasonable to assume that to experience long term benefits, any physical activity/exercise program must be continued long term.

**We conclude that PFMT during and following pregnancy is effective in reducing risk of UI postpartum. The quality of this evidence is high.**

**Treatment**—There is mixed evidence on whether incontinent women who initiate pelvic floor exercises during pregnancy can lower the risk of persistent UI in the postnatal period.<sup>83,84</sup>

However, the outcomes of the three RCTs with incontinent women, included in both the 2012 and 2017 Cochrane reviews, seem to favour women who engaged in PFMT, although these relationships were not statistically significant.<sup>84</sup> The reviews show high heterogeneity in terms of PFMT programs and adherence, and are limited by inclusion of both prevention and treatment studies. Effects appear to be stronger if PFMT is supervised.<sup>84,129</sup>

**We conclude that intensive supervised PFMT is recommended as a conservative strategy for treatment of postnatal UI. The quality of this evidence is moderate (downgraded RCTs).**

## Depression and depressive symptoms

There have been at least six systematic reviews and meta-analyses of the evidence on physical activity/exercise during pregnancy and in the postpartum period on postpartum depression and depressive symptoms since 2017. Some reviews included only RCT level evidence<sup>130-133</sup> while others included both RCT and cohort studies.<sup>87,134</sup> Overall, most of these reviews, found positive effects of physical activity/exercise relative to control groups, for both prevention and treatment of depression and depressive symptoms, and greater improvements in symptomatology in women with previous depressive symptoms.<sup>131,132</sup> In contrast, the review conducted for the Canadian Guidelines, which considered the findings of seven RCTs, concluded that physical activity/exercise *during pregnancy* does not affect postpartum depression or the severity of depressive symptoms following pregnancy.<sup>87</sup> The quality of the evidence was rated as 'very low'. Recent results from the PAMELA RCT (not included in the earlier reviews) concur that physical activity/exercise *during pregnancy* does not influence postpartum depression.<sup>135</sup>

Based on the findings of an earlier (2013) review of 10 cohort and seven intervention trials<sup>136</sup>, and on the reviews by McCurdy et al<sup>131</sup> and Poyatos-Leon et al<sup>132</sup> (also considered by the IOC reviewers), the US PAG report concluded that physical activity/exercise *during the postpartum period* was more likely to prevent postpartum depression than physical activity/exercise prior to this and that the benefits are more pronounced in women with greater depressive symptomatology.

DiPietro et al (2019)<sup>64</sup> also concluded that postpartum aerobic exercise interventions significantly reduced depressive symptoms, in women with diagnosed postpartum depression, but note that the effects were greater when there were co-interventions (eg social support or dietary change) than with physical activity/exercise alone.

Interpretation of this body of evidence is problematic because of differences in study designs (cohort studies and randomised controlled trials), the selection of participants (eg women with and without depression/depressive symptoms, or a mixture of both), intervention type (physical activity/exercise alone or in combination with other lifestyle changes) and timing (during or following pregnancy). Different interventions were used (eg individual or in a group; supervised or not) and the range of physical activity/exercise types included walking, aerobics, Pilates, yoga and stretching. There is also likely to have been a high level of confounding due to medication use, or to social support in many group-based interventions.

**We conclude that post-natal physical activity/exercise improves mild-to-moderate depressive symptoms and increases the likelihood that mild-to-moderate depression will resolve in the postpartum period. The quality of this evidence is rated as moderate.**

## Anxiety

Only one systematic review has examined the association between physical activity/exercise during pregnancy and the risk of post-natal anxiety.<sup>87</sup> It included data from two RCTs (N=1299) and concluded that physical activity/exercise during pregnancy does not reduce the risk of anxiety during the postpartum period.<sup>87</sup>

**We conclude that prenatal physical activity/exercise is not associated with post-natal anxiety, and the quality of this evidence is very low.**

## Musculoskeletal complaints

Although several RCTs have investigated the effects of physical activity/exercise on low back pain, pelvic girdle pain and diastasis recti (visible separation of the abdominal muscles), the effects of physical activity/exercise in terms of both prevention and treatment are unclear. The IOC review concluded that the evidence on treatment of these problems was mixed, reflecting heterogeneity in design, intervention strategies (mostly clinical treatment trials), measures and quality of the research in this area.<sup>14</sup> The review conducted for the Canadian Guidelines found that physical activity/exercise initiated during pregnancy did not reduce the risk of musculoskeletal complaints postpartum.<sup>82</sup> (For information on pelvic floor muscle injury see 'Labour and birth' above).

**We conclude that physical activity/exercise initiated during pregnancy does not appear to reduce the risk of musculoskeletal complaints postpartum. The quality of the evidence is low.**

## Infant neurodevelopment

One systematic review has assessed the association between physical activity/exercise during pregnancy and offspring neurodevelopment (1–8 years).<sup>137</sup> This review included five cohort studies and one RCT. Based on the cohort studies (only one with a large sample), it was concluded that physical activity during pregnancy was associated with better short-term neurodevelopment (<12 months), but no long-term associations were found. Associations between physical activity/exercise and neurodevelopment might be confounded by socioeconomic conditions, and residual confounding is likely. The single RCT examined the effects of moderate intensity physical activity/exercise between weeks 20 and 36 weeks of pregnancy on infant development at 20 months; overall, no effects were found.<sup>137</sup> Longer term follow-up of infants of mothers who exercised during pregnancy, with inclusion of all potential confounders, is required.

**We conclude that physical activity/exercise during pregnancy is not associated with infant neurodevelopment. The quality of this evidence is very low.**

### **Longer term development of non-communicable diseases in the mother and child**

It is difficult to assess the effects of physical activity/exercise during pregnancy on long term development of NCDs because of the confounding effects of chronic or continuing inactivity and other risk factors on NCD risk.

Postpartum weight retention (PPWR) has been associated with an increased risk of several adverse outcomes, including obesity and complications in future pregnancies.<sup>138-142</sup> As obesity increases, so does the risk of many serious health conditions, including cardiovascular diseases, type 2 diabetes, mental health problems and some cancers. Therefore, researchers have suggested that the postpartum period may provide an important opportunity to intervene and promote weight control for the prevention of NCDs.<sup>123</sup> Several systematic reviews have examined the effects of mothers' physical activity/exercise during pregnancy on the later development of these NCDs in their offspring, but few associations have been documented.<sup>143-145</sup> Longer term follow up of both mothers and their offspring (after exposure to exercise during pregnancy) is needed, to document any associations with fat and lean mass, and the development of NCDs.

**We conclude that there is limited evidence on effects of physical activity/exercise during pregnancy on the long-term development of NCDs in mothers or their offspring. This statement is graded as moderate.**

## **3.4 Effects of sedentary time on maternal and infant health outcomes**

Research on the effects of sedentary behaviour (conceptualised here as sitting time, ST) during pregnancy is in its infancy. The first systematic review was published in 2017<sup>146</sup> and updated in 2018.<sup>147</sup> These reviews included 14 cross-sectional studies, 22 cohort studies, four case-control studies and four RCTs. The quality of these studies is very mixed, but the results show associations between high ST and a range of biological (eg C-reactive protein and LDL-cholesterol) and anthropometric (newborn abdominal circumference, macrosomia) measures, and with incident gestational diabetes mellitus (GDM).<sup>146,147</sup> A major limitation is that none of the included studies assessed the potential confounding effects of physical activity/exercise or BMI.

A 2019 review<sup>148</sup> reported associations between prolonged sitting time during pregnancy and higher fasting glucose, and between TV time and development of GDM, but found no associations between ST and GDM, gestational hypertension, gestational age at birth or birthweight. One additional cohort study and one RCT have shown associations between ST

and several adverse health outcomes, including neonatal body fat<sup>149</sup>, and postnatal depression.<sup>150</sup>

As the metabolic and cardiovascular effects of prolonged sitting are likely to be similar to those seen in non-pregnant women, and because there is increased potential for cardiovascular and metabolic risk (ie venous pooling in later pregnancy as blood pressure falls, development of gestational diabetes, etc), it may be as important to avoid and/or break-up long periods of sitting during pregnancy, as recommended in the Australian Physical Activity and Sedentary Behaviour Guidelines.<sup>23</sup>

**Although this evidence base is rapidly increasing, given the heterogeneity of study designs, measures, quality and findings, it is difficult to draw conclusions about the effects of high ST during pregnancy on pregnancy-related outcomes at this time. The evidence quality is graded as low.**

### **3.5 Effects of occupational physical activity on maternal and infant health outcomes**

A 2013 meta-analysis of the effects of occupational PA<sup>108</sup> found small or null effects of occupational physical activity on preterm birth.<sup>108</sup> In contrast, as mentioned in the US ACOG Guidelines report<sup>10</sup>, and in the IOC review<sup>14</sup>, several studies have shown inconsistent associations between occupational exertion and preterm birth, low birthweight, pre-eclampsia and gestational hypertension. The IOC review found that several cohort studies showed increased risk of miscarriage with increasing *occupational* activity which involved lifting or crouching.<sup>14</sup> Moreover, data from a single Danish cohort study of more than 62,000 women show a dose-response relationship between lifting heavy loads (eg >20kg/more than 10 times per day) and increased risk of preterm birth.<sup>151</sup>

**We conclude that there is mixed evidence on associations between occupational physical activity and fetal/ maternal health outcomes. The quality of the evidence is low (inconsistent findings from cohort studies).**

# APPENDIX 4

## Evidence Summary Table



## 4.1 Effect of physical activity/exercise during pregnancy on the pregnant woman

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<b>Cardiorespiratory Fitness</b> Regular PA/exercise during pregnancy maintains or improves cardiorespiratory fitness.	<b>US ACOG Guidelines:</b> Kramer et al. 2006 <sup>44</sup> (SR) De Oliveria Melo et al. 2012 <sup>45</sup> (RCT) Price et al. 2012 <sup>46</sup> (RCT) <b>IOC Series:</b> Kramer et al. 2006 <sup>44</sup> (SR) Ruchat et al. 2012 <sup>47</sup> (RCT)		Required exercise dose for different populations (overweight/obese, younger/older mothers, previously inactive, well-trained or elite athletes) remains to be determined.	Moderate
<b>Gestational Weight Gain</b> PA/exercise prior to and during pregnancy is associated with lower weight gain (about 1kg less) and improves compliance with weight gain in accordance with IOM Guidelines.	<b>US ACOG Guidelines:</b> Muktabhant et al. 2015 <sup>58</sup> (SR) Choi et al. 2013 <sup>62</sup> (SR) <b>Canadian Guidelines:</b> Ruchat et al. 2018 <sup>60</sup> (SR) <b>US PAG Recommendations:</b> da Silva et al. 2017 <sup>57</sup> (SR) Muktabhant et al. 2015 <sup>58</sup> (SR) <b>IOC Series:</b> Perales et al. 2016 <sup>59</sup> (SR)	i-WIP Collaborative Group. 2017 <sup>56</sup> (SR) Farpour-Lambert et al. 2018 <sup>63</sup> (UR) DiPietro et al. 2019 <sup>64</sup> (UR)	Focus of most reviews is on either prevention of excess weight gain, or gaining weight as recommended. No evidence of different results in overweight or obese populations.	High
<b>Gestational Diabetes Mellitus</b> Regular PA/exercise before and during pregnancy (and especially in early pregnancy) may have a protective effect on the development of gestational diabetes and may assist with regulation of blood glucose in diagnosed gestational diabetes.	<b>US ACOG Guidelines:</b> Garcia-Patterson et al. 2001 <sup>152</sup> (RCT) Jovanovic-Peterson et al. 1989 <sup>153</sup> (RCT) <b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>65</sup> (MA) Aune et al. 2016 <sup>69</sup> (MA) <b>US PAG Recommendations:</b> da Silva et al. 2017 <sup>57</sup> (MA) Yu et al. 2017 <sup>67</sup> (MA) Zheng et al. 2017 <sup>68</sup> (SR) Aune et al. 2016 <sup>69</sup> (MA) Di Mascio et al. 2016 <sup>74</sup> (MA) Song et al. 2016 <sup>154</sup> (MA) Madhuvrata et al. 2015 <sup>155</sup> (MA) Russo et al. 2015 <sup>156</sup> (MA) Sanabria-Martinez et al. 2015 <sup>157</sup> (MA) Han et al. 2012 <sup>118</sup> (SR)	Di Biase et al. 2019 <sup>70</sup> (SR) DiPietro et al. 2019 <sup>64</sup> (UR) Martis et al. 2018 <sup>73</sup> (SR) Brown et al. 2017 <sup>71</sup> (SR) Shepherd et al. 2017 <sup>66</sup> (SR) Harrison et al. 2016 <sup>72</sup> (SR)	Prior to 2018 evidence suggested protective effects, especially for exercise before and in early pregnancy. Newer reviews suggest dose-response relationships are unclear. Results confounded by methodological heterogeneity.	Moderate

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
	<p>Yin et al. 2014<sup>158</sup> (MA)  Oostdam et al. 2011<sup>159</sup> (MA)  Tobias et al. 2011<sup>160</sup> (MA)</p> <p><b>IOC Series:</b>  da Silva et al. 2017<sup>57</sup> (MA)  Yu et al. 2017<sup>67</sup> (MA)  Zheng et al. 2017<sup>68</sup> (SR)  Di Mascio et al. 2016<sup>74</sup> (MA)  Russo et al. 2015<sup>56</sup> (MA)  Han et al. 2012<sup>118</sup> (SR)</p>			
<p><b>Gestational hypertension and pre-eclampsia</b>  There is limited evidence that regular PA/exercise is associated with reduced risk of incident gestational hypertension, and that PA/exercise may lower maternal arterial pressure. The effects of PA/exercise on pre-eclampsia are unclear.</p>	<p><b>US ACOG Guidelines:</b>  Meher et al. 2006<sup>161</sup> (SR)</p> <p><b>Canadian Guidelines:</b>  Davenport et al. 2018<sup>65</sup> (MA)  Aune et al. 2014<sup>76</sup> (MA)</p> <p><b>US PAG Recommendations:</b>  da Silva et al. 2017<sup>57</sup> (MA)  Zheng et al. 2017<sup>68</sup> (MA)  Wolf et al. 2014<sup>162</sup> (SR)  Aune et al. 2014<sup>76</sup> (MA)  Kasawara et al. 2012<sup>77</sup> (SR)</p> <p><b>IOC Series:</b>  da Silva et al. 2017<sup>57</sup> (SR)  Aune et al. 2014<sup>76</sup> (SR)  Wolf et al. 2014<sup>162</sup> (SR)</p>	<p>DiPietro et al. 2019<sup>64</sup> (UR)  Magro-Malosso et al. 2017<sup>75</sup> (SR)</p>	Inconsistent results range from no effects to significant risk reductions. Quality rating reflects downgraded RCTs and upgraded cohort studies.	<b>Moderate</b>
<p><b>Low Back Pain and Pelvic Girdle Pain</b>  There is little evidence to show that PA/exercise (on land or in water) prevents pregnancy related low back and pelvic girdle pain, but may help to reduce the severity of these musculoskeletal symptoms.</p>	<p><b>US ACOG Guidelines:</b>  Liddle et al. 2015<sup>78</sup> (SR)  Kihlstrand et al. 1999<sup>163</sup> (RCT)</p> <p><b>Canadian Guidelines:</b>  Davenport et al. 2019<sup>82</sup> (MA)</p> <p><b>IOC Series:</b>  Perales et al. 2016<sup>59</sup> (SR)</p>	<p>Shiri et al. 2018<sup>80</sup> (SR)  Steffens et al. 2016<sup>81</sup> (SR)</p>	There is evidence of positive effects of exercise on pain management and sick leave related to these conditions, separately or together. Large heterogeneity in the quality of studies included in the systematic reviews gives an evidence rating of moderate (downgraded RCTs).	<b>Moderate</b>

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<b>Urinary Incontinence (prevention)</b> Regular pelvic floor exercise during pregnancy has a clinically relevant effect on prevention of UI and reduces the risk of UI in late pregnancy, especially when exercise is supervised.	<b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>83</sup> (SR) <b>IOC Series:</b> Perales et al. 2016 <sup>59</sup> (SR) Du et al. 2015 <sup>164</sup> (MA) Boyle et al. 2012 <sup>129</sup> (SR)	Woodley et al. 2017 <sup>84</sup> (SR)	High quality RCT evidence supports the inclusion of pelvic floor exercises in the guidelines for PA/exercise during pregnancy (for prevention of UI).	<b>High</b>
<b>Urinary Incontinence (treatment)</b> It is unclear whether pelvic floor exercise during pregnancy is effective for <i>treatment</i> of urinary incontinence in pregnant women.			Pelvic floor exercise, as a therapeutic approach, may require supervision and more intense exercise, and should be targeted to high-risk pregnant women (such as multiparous, overweight/obese or women of advanced maternal age).	<b>Moderate</b>
<b>Depression and depressive symptoms</b> There is limited evidence that PA/exercise during pregnancy is associated with reduced risk and severity of depressive symptoms during pregnancy.	<b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>87</sup> (MA) <b>US PAG recommendations:</b> Sheffield et al. 2016 <sup>165</sup> (SR) <b>IOC Series:</b> Daley et al. 2015 <sup>88</sup> (SR)	DiPietro et al. 2019 <sup>64</sup> (UR) Gong et al. 2015 <sup>89</sup> (SR)	RCT evidence from low-moderate quality trials with significant heterogeneity.	<b>Moderate</b>
<b>Anxiety</b> PA/exercise during pregnancy does not reduce the risk of anxiety during pregnancy.	<b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>87</sup> (MA) <b>US PAG recommendations:</b> Sheffield et al. 2016 <sup>165</sup> (SR) Shivakumar et al. 2011 <sup>166</sup> (SR) <b>IOC Series:</b> Hofmann et al. 2008 <sup>167</sup> (MA)	DiPietro et al. 2019 <sup>64</sup> (UR)	Limited evidence to suggest an inverse relationship between PA/exercise and anxiety.	<b>Low</b>

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<b>Sleep</b> It is not possible to draw any conclusions about the joint effects of physical activity and sleep on health outcomes during pregnancy at this time.	<b>Canadian Guidelines:</b> Ferraro et al. 2014 <sup>168</sup> (UR) <b>IOC Series:</b> Guendelman et al. 2013 <sup>169</sup> (Case Control)	Rodriguez-Blanque et al. 2018 <sup>93</sup> (RCT) Kocsis et al. 2017 <sup>101</sup> (RCT) Nodine et al. 2016 <sup>95</sup> (RCT)	Studies with heterogeneous designs, measures and quality show mixed effects.	<b>Low</b>
<b>Body image dissatisfaction</b> Limited research suggests women who exercise may have slightly better body image satisfaction.		Sun et al. 2018 <sup>104</sup> (SR)	Mixed effects reported in one systematic review of 4 prospective studies.	<b>Low</b>

## 4.2 Effect of physical activity/exercise during pregnancy on fetal development and birth

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<b>Developmental concerns</b> There is no evidence of detrimental effects of PA/exercise on fetal development.	<b>US ACOG Guidelines:</b> De Oliveria et al. 2012 <sup>45</sup> (RCT) <b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>105</sup> (SR)	Artal 2019 <sup>17</sup> (Review) Beetham et al. 2019 <sup>25</sup> (MA)	Concerns have been raised about hyperthermia and neural tube defects (spina bifida) in the first trimester, but many women are unaware of pregnancy at this time and there are few studies. No studies have shown increased risks of neural development abnormalities in fetuses of exercising women.  PA/exercise is associated with changes in fetal HR – which may reflect normal physiological responses to changes in uterine blood flow.	Low
<b>Miscarriage</b> PA/exercise is not associated with increased risk of miscarriage.	<b>Canadian Guidelines:</b> Davenport et al. 2019 <sup>106</sup> (MA) <b>IOC Series:</b> Schüssel et al. 2008 <sup>170</sup> (SR) Madsen et al. 2007 <sup>107</sup> (Cohort)	Beetham et al. 2019 <sup>25</sup> (MA)	There is serious risk of bias in many studies and the effects of long duration PA/exercise remain unclear.	Low
<b>Gestational age and preterm birth</b> PA/exercise does not have any meaningful effect on gestational age and may have very small protective effects on preterm birth.	<b>US ACOG Guidelines:</b> Palmer et al. 2013 <sup>108</sup> (MA) Owe et al. 2012 <sup>171</sup> (Cohort) <b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>105</sup> (MA) <b>US PAG Recommendations:</b> da Silva et al. 2017 <sup>57</sup> (MA) Yu et al. 2017 <sup>67</sup> (MA) Zheng et al. 2017 <sup>68</sup> (MA) De Mascio et al. 2016 <sup>74</sup> (MA) Muktabant et al. 2015 <sup>58</sup> (SR)	Beetham et al. 2019 <sup>25</sup> (MA) Wen et al. 2017 <sup>112</sup> (MA) Kahn et al. 2016 <sup>111</sup> (SR) Sanabria-Martinez et al. 2016 <sup>110</sup> (MA)	Reported association between long work hours and preterm birth was based on low quality studies. Studies have shown small beneficial effects of leisure time, but not commuting or domestic PA, on reducing the risk of preterm birth.	Moderate

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
	<p>Han et al. 2012<sup>118</sup> (SR)  Thangaratinam et al. 2012<sup>117</sup> MA  Bonzini et al. 2007<sup>109</sup> (SR)</p> <p><b>IOC Series:</b></p> <ul style="list-style-type: none"> <li>Barakat et al. 2014<sup>172</sup> (RCT)</li> <li>Barakat et al. 2014<sup>173</sup> (RCT)</li> <li>Van Beukering et al. 2014<sup>174</sup> (MA)</li> <li>Palmer et al. 2013<sup>108</sup> (MA)</li> <li>Pinzon et al. 2012<sup>175</sup> (RCT)</li> <li>Price et al. 2012<sup>46</sup> (RCT)</li> <li>Haakstad et al. 2011<sup>176</sup> (RCT)</li> <li>Haakstad et al. 2011<sup>177</sup> (RCT)</li> <li>Cavalcante et al. 2009<sup>178</sup> (RCT)</li> <li>Takito et al. 2009<sup>179</sup> (SR)</li> <li>Lewis et al. 2008<sup>180</sup> (SR)</li> <li>Schlüssel et al. 2008<sup>170</sup> (SR)</li> <li>Kramer et al. 2006<sup>44</sup> (RCT)</li> <li>Lokey et al. 1991<sup>181</sup> (MA)</li> </ul>			
<p><b>Labour and birth</b></p> <p>PA/exercise during pregnancy protects against unplanned caesarean section, and may reduce the risk of instrumental delivery, but does not impact on duration of labour.</p> <p>There is no consensus on the effects of PA/exercise on injury during labour.</p>	<p><b>IOC Series:</b></p> <ul style="list-style-type: none"> <li>Bakarat et al. 2012<sup>182</sup> (RCT)</li> <li>Price et al. 2012<sup>46</sup> (RCT)</li> </ul> <p><b>Canadian Guidelines:</b></p> <ul style="list-style-type: none"> <li>Davenport et al. 2018<sup>115</sup> (MA)</li> </ul> <p><b>US PAG Recommendations:</b></p> <ul style="list-style-type: none"> <li>Di Mascio et al. 2016<sup>74</sup> (MA)</li> <li>Muktabant et al. 2015<sup>58</sup> (SR)</li> <li>Wiebe et al. 2015<sup>113</sup> (MA)</li> <li>Han et al. 2012<sup>118</sup> (SR)</li> <li>Thangaratinam et al. 2012<sup>117</sup> (MA)</li> </ul> <p><b>IOC Series:</b></p> <ul style="list-style-type: none"> <li>Perales et al. 2016<sup>59</sup> (SR)</li> <li>Barakat et al. 2014<sup>173</sup> (RCT)</li> <li>Barakat et al. 2014<sup>172</sup> (RCT)</li> <li>Domenjoz et al. 2014<sup>114</sup> (MA)</li> </ul>	<p>i-WIP Collaborative Group. 2017<sup>56</sup> (SR)  Poyatos-Leon et al. 2015<sup>113</sup> (MA)</p>	<p>Four meta-analyses show lower rates of caesarean section and/or higher rates of normal vaginal birth with PA/exercise in the second and third trimesters. No differences in the overall duration of labour among exercise and control groups have been reported.</p> <p>There have been few studies on the effects of PA/exercise on pelvic floor muscle injury during labour.</p>	<b>Moderate</b>

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
	Bayrampour et al. 2010 <sup>183</sup> (SR) Hall et al. 1987 <sup>184</sup> (RCT)			
<b>APGAR scores</b> PA/exercise during pregnancy is not associated with APGAR scores.	<b>IOC Series:</b> Price et al. 2012 <sup>46</sup> (RCT) <b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>105</sup> (SR) <b>US PAG Recommendations:</b> Yu et al. 2017 <sup>67</sup> (MA) Zheng et al. 2017 <sup>68</sup> (MA) Han et al. 2012 <sup>118</sup> (SR) Thangaratinam et al. 2012 <sup>117</sup> (MA) <b>IOC Series:</b> Murtezani et al. 2014 <sup>185</sup> (RCT)	No new evidence	Studies show no differences in 1- and 5-minute APGAR scores between exercising and control group women.	<b>Moderate</b>
<b>Birthweight</b> There is consistent evidence that PA/exercise does not have a clinically relevant effect on birthweight. PA/exercise may reduce the risk of macrosomia and 'large for gestational age' infants.	<b>IOC Series:</b> Kramer et al. 2010 <sup>186</sup> (SR) Leet et al. 2003 <sup>187</sup> (MA) Lokey et al. 1991 <sup>181</sup> (MA) <b>Canadian Guidelines:</b> Davenport et al. 2018 <sup>105</sup> (SR) <b>US PAG Recommendations:</b> Yu et al. 2018 <sup>67</sup> (SR) da Silva et al. 2017 <sup>57</sup> (SR) Zheng et al. 2017 <sup>68</sup> (SR) Di Mascio et al. 2016 <sup>74</sup> (SR) Muktabhant et al. 2015 <sup>58</sup> (SR) Wiebe et al. 2015 <sup>116</sup> (MA) Han et al. 2012 <sup>118</sup> (SR) Thangaratinam et al. 2012 <sup>117</sup> (MA) Oostdam et al. 2011 <sup>159</sup> (MA) <b>IOC Series:</b> Siega-Riz et al. 2009 <sup>188</sup> (SR) Bonzini et al. 2007 <sup>109</sup> (SR) Leet et al. 2003 <sup>187</sup> (MA)	Vargas-Terrones et al. 2018 <sup>189</sup> (Review)	Women who exercise during pregnancy have appropriate gestational weight gain, and appropriate birthweight infants. Evidence that PA/exercise during pregnancy might prevent macrosomia and babies born large for gestational age is low quality.	<b>Moderate</b>

## 4.3 Effects of physical activity/exercise during pregnancy and postpartum (6 months) on postpartum issues

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<p><b>Weight Retention / Weight Loss</b></p> <p>The effects of postpartum PA/exercise on postpartum weight retention (PPWR) and weight loss are confounded by multiple factors which make it difficult to assess whether PA/exercise alone impacts on PPWR or weight loss in the postpartum period.</p>	<p><b>US ACOG Guidelines:</b> Muktabhant et al. 2015<sup>58</sup> (SR) Choi et al. 2013<sup>62</sup> (MA)</p> <p><b>Canadian Guidelines:</b> Ruchat et al. 2018<sup>60</sup> (MA)</p> <p><b>US PAG Recommendations:</b> Berger et al. 2014<sup>123</sup> (SR) Elliot-Sale et al. 2014<sup>124</sup> (SR) Nascimento et al. 2014<sup>121</sup> (MA) Amorim et al. 2013<sup>125</sup> (SR) Van der Pligt et al. 2013<sup>126</sup> (SR)</p> <p><b>IOC Series:</b> Berger et al. 2014<sup>123</sup> (SR) Nascimento et al. 2014<sup>121</sup> (MA) Amorim et al. 2013<sup>125</sup> (SR) Van der pligt et al. 2013<sup>126</sup> (SR) Nehring et al. 2011<sup>190</sup> (MA)</p>	<p>DiPietro et al. 2019<sup>64</sup> (UR) Michel et al. 2019<sup>120</sup> (MA) Dalrymple et al. 2018<sup>119</sup> (SR) Farpour-Lambert et al. 2018<sup>63</sup> (UR)</p>	<p>Very few studies have examined whether PA <i>alone</i> affects PPWR. In overweight and obese women PA/exercise in postpartum results in greater weight loss (about 1 kg less), but it is unclear whether the effects are from diet, PA/exercise or a combination. Effects are confounded by initial weight and weight gain during pregnancy.</p>	<b>Moderate</b>
<p><b>Breastfeeding</b></p> <p>There is no evidence to show that PA/exercise affects either the quality or quantity of breast milk.</p>	<p><b>US ACOG Guidelines:</b> Cary et al. 2001<sup>191</sup> (UR)</p> <p><b>IOC Series:</b> Dewey et al. 1994<sup>127</sup> (RCT) Lovelady et al. 1990<sup>192</sup> (RCT)</p>		<p>There is very little evidence on PA/exercise and breast feeding. Moderate intensity PA/exercise has no adverse effects on lactation hormone levels.</p>	<b>Very Low</b>
<p><b>Urinary Incontinence</b></p> <p><b>Prevention</b> PFMT during and following pregnancy is effective in reducing risk of UI postpartum.</p>	<p><b>US ACOG Guidelines:</b> Davenport et al. 2018<sup>83</sup> (SR)</p> <p><b>IOC Series:</b> Boyle et al. 2012<sup>129</sup> (SR) Morkved et al. 1997<sup>85</sup> (RCT)</p>	<p>Woodley et al. 2017<sup>84</sup> (SR) Morkved et al. 2014<sup>86</sup> (SR)</p>	<p><i>Prevention:</i> Continent women who start a PFMT program before the birth are 30% less likely to develop UI postpartum.</p>	<b>High</b>

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<b>Treatment</b> Intensive supervised PFMT is recommended as a conservative strategy for treatment of postnatal UI.			High heterogeneity in programs and adherence. Effects are stronger if PFMT is supervised.	<b>Moderate</b>
<b>Depression and depressive symptoms</b> Post-natal PA/exercise improves mild-to-moderate depressive symptoms and increases the likelihood that mild-to moderate depression will resolve in the postpartum period.	<i>US ACOG Guidelines:</i> Davenport et al. 2018 <sup>87</sup> (SR) <i>US PAG Recommendations:</i> McCurdy et al. 2017 <sup>131</sup> (MA) Poyatos-Leon et al. 2017 <sup>132</sup> (MA) Teychenne et al. 2013 <sup>136</sup> (SR) <i>IOC Series:</i> McCurdy et al. 2017 <sup>131</sup> (MA) Poyatos-Leon et al. 2017 <sup>132</sup> (MA) Teychenne et al. 2013 <sup>136</sup> (SR) Daley et al. 2009 <sup>193</sup> (SR) Daley et al. 2007 <sup>194</sup> (SR)	Carter et al. 2019 <sup>130</sup> (SR) DiPietro et al. 2019 <sup>64</sup> (UR) Nakamura et al. 2019 <sup>134</sup> (SR) Pritchett et al. 2017 <sup>133</sup> (SR)	Benefits are more pronounced in women with greater symptomatology, and in co-interventions (eg with dietary change or social support).  The overall quality of the RCTs included in the systematic reviews is low.	<b>Moderate</b>
<b>Anxiety</b> PA/exercise during pregnancy does not reduce the risk of anxiety during the postnatal period.	<i>US ACOG Guidelines:</i> Davenport et al. 2018 <sup>87</sup> (SR)	No new evidence		<b>Very low</b>
<b>Musculoskeletal complaints</b> PA/exercise initiated during pregnancy does not appear to reduce the risk of musculoskeletal complaints (eg back pain, pelvic girdle pain, diastasis recti) postpartum.	<i>US ACOG Guidelines:</i> Pennick et al. 2013 <sup>195</sup> (SR) Kihlstrand et al. 1999 <sup>163</sup> (RCT) <i>Canadian Guidelines:</i> Davenport et al. 2019 <sup>82</sup> (MA) <i>IOC Series:</i> Mota et al. 2015 <sup>196</sup> (Cohort) Benjamin et al. 2014 <sup>197</sup> (SR) Chiarello et al. 2005 <sup>198</sup> (RCT) Stuge et al. 2004 <sup>199</sup> (RCT)		Wide heterogeneity in design, intervention strategies (mostly clinical treatment trials), measures and quality of the research in this area. (Pelvic floor muscle injury is considered in 'labour and birth' above).	<b>Low</b>

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<p><b>Infant neurodevelopment</b> PA/exercise during pregnancy is not associated with infant neurodevelopment.</p> <p><b>Longer term development of NCDs in the mother and child</b> There is limited evidence on the effects of PA/exercise during pregnancy on the long term development of NCDs in mothers or their offspring.</p>	<p><b>US ACOG Guidelines:</b> Davenport et al. 2018<sup>105</sup> (SR)</p> <p><b>IOC Series:</b> Berger et al. 2014<sup>123</sup> (SR)</p>	<p>Cruz et al. 2018<sup>137</sup> (SR)</p> <p>Chaivaroli et al. 2018<sup>143</sup> (RCT) Guillemette et al. 2018<sup>145</sup> (SR) van Elton et al. 2018<sup>144</sup> (SR)</p>	<p>Cohort follow up was 1-8 years post birth and RCT follow up 20 months. Longer term follow-up is required.</p> <p>It is difficult to assess effects of PA/exercise during pregnancy on long term development of NCDs because of effects of confounding chronic or continuing inactivity and other risk factors on NCD risk.</p>	<b>Very Low</b>  <b>Moderate</b>

## 4.4 Effects of sedentary time and occupational physical activity on maternal and infant health outcomes

Issue and evidence summary	Central evidence included in review sources	Key additional evidence (published since 2015, not included in column 2)	Comments	Quality rating
<p><b>Sedentary Time (ST)</b></p> <p>Although this evidence base is rapidly increasing, it is difficult to draw conclusions about the effects of high ST during pregnancy on pregnancy-related outcomes at this time.</p>	<p><b>US ACOG Guidelines:</b> Marquez-Sterling et al. 2000<sup>53</sup></p>	<p>van Poppel et al. 2019<sup>149</sup> (RCT) van der Waerden et al. 2019<sup>150</sup> (Cohort) Wagnild 2019<sup>148</sup> (Review) Fazzi et al. 2018<sup>147</sup> (SR) Fazzi et al. 2017<sup>146</sup> (SR)</p>	<p>Low quality research shows inconsistent associations between ST during pregnancy and indicators of infant and maternal health risks. There is wide heterogeneity in study designs, measures, quality and findings, and few studies assess the potential confounding effects of PA/exercise or BMI on outcomes.</p>	Low
<p><b>Occupational Physical Activity (OPA)</b></p> <p>There is limited and mixed evidence on associations between OPA and fetal/ maternal health outcomes.</p>	<p><b>US ACOG Guidelines:</b> Palmer et al. 2013<sup>108</sup> (SR)</p> <p><b>IOC Series:</b> van Beukering et al. 2014<sup>200</sup> (MA) Palmer et al. 2013<sup>108</sup> (SR) Bonzini et al. 2007<sup>109</sup> (SR) Leet et al. 2003<sup>187</sup> (MA)</p>	<p>Cai et al. 2019<sup>201</sup> (MA) Runge et al. 2013<sup>151</sup> (Cohort)</p>	<p>Inconsistent associations found between indicators of OPA (work hours, shift work, lifting, standing, and physical work load) and: preterm birth; low birthweight; small for gestational age; pre-eclampsia; gestational hypertension.</p>	Low

## APPENDIX 5

# Summary of International and National Recommendations and Statements



Photo courtesy of Melanie Hayman

Canadian Guidelines 2019 <sup>8</sup>	ACOG 2015 <sup>10</sup>	USA PAG 2018 <sup>11</sup>	RANZCOG 2016 <sup>3</sup>	Swiss Guidelines 2018 <sup>9</sup>	SMA 2016 <sup>4</sup>	UpToDate® 2019 <sup>17</sup>
<b>A. GENERAL RECOMMENDATION</b>						
All women without contraindication should be physically active throughout pregnancy.	Physical activity in pregnancy has minimal risks and has been shown to benefit most women, although some modification to exercise routines may be necessary because of normal anatomic and physiologic changes and fetal requirements.		Women without contraindications should participate in regular aerobic and strength conditioning exercise during pregnancy. Women should be advised that there is no evidence that regular exercise during an uncomplicated pregnancy is detrimental to the woman or fetus.	For women who have been previously active prior to their pregnancy: usual activities can be maintained to the same extent as long as comfortable. If necessary, style/mode and technique can be adjusted and duration and intensity can be reduced.	For healthy women, physical activity/ exercise during pregnancy is safe and is associated with numerous benefits to the mother and unborn child/fetus.	Women with uncomplicated pregnancies should be encouraged to exercise as part of a healthy lifestyle before, during and after pregnancy.
<b>B. DOSE</b>						
<b>Duration</b>	At least 150 minutes/week.	>=20–30 minutes/day.	>=150 minutes/week.		At least 2.5 hours/week.	
<b>Frequency</b>	A minimum of 3 days/week; being active every day is encouraged.	Most or all days of the week.	Spread throughout the week.		Ideally, the physical activity should be split over several days a week.	5–7 days/week.
<b>Intensity</b>	Moderate intensity (intense enough to noticeably increase heart rate; a person can talk but not sing during activities of this intensity; target heart rate zones for pregnant women)	Moderate intensity RPE 13–14 on a scale of 6 to 20, 'talk test—can talk while exercising.	Light to moderate intensity RPE 5–6 on a scale of 0 to 10, 'talk test'—can talk while exercising. Women who engaged in vigorous intensity aerobic activity can continue these	Exercise prescription for pregnant women requires appropriate consideration of the frequency, intensity, duration and mode of exercise.	For healthy women without complications, at least 2.5 hours of movement/ physical activity in terms of ordinary/ everyday activity or exercise at moderate intensity.	Women who were inactive prior to pregnancy: commence with low intensity activities such as walking and swimming, progressing to the lower end of the range  For most healthy pregnant women: moderate intensity (able to carry on a conversation during exercise). Physically active women can engage in moderate

	Canadian Guidelines 2019 <sup>8</sup>	ACOG 2015 <sup>10</sup>	USA PAG 2018 <sup>11</sup>	RANZCOG 2016 <sup>3</sup>	Swiss Guidelines 2018 <sup>9</sup>	SMA 2016 <sup>4</sup>	UpToDate® 2019 <sup>17</sup>
	based on age and 'talk test').		activities if they remain healthy and discuss with their health care provider.			recommended in the Australian, Canadian and US national guidelines (ie 150 minutes per week).	to vigorous PA.
Type	Pregnant women should incorporate a variety of aerobic exercise and resistance training activities, including brisk walking, stationary cycling (moderate effort), swimming or aquafit, carrying moderate loads, household chores (eg gardening, washing windows).	Aerobic and strength-conditioning exercises including walking, swimming, stationary cycling, low-impact aerobics, modified yoga or Pilates, running, racquet sports.	Women with uncomplicated pregnancies should be encouraged to engage in aerobic and strength-conditioning exercises before, during, and after pregnancy.				Include aerobic exercise and strength training.
Pelvic floor muscles	PFMT (eg Kegel exercises) may be performed on a daily basis to reduce the odds of urinary incontinence. Instruction on proper technique is recommended to achieve optimal benefits.					In addition to their regular aerobic and muscle strengthening exercises, all pregnant women are advised to do pelvic floor exercises.	
Other	Adding yoga and/or gentle stretching may also be beneficial.			Exercise prescription for the pregnant woman should consider her baseline level of fitness and previous exercise experience, and take into account the physiological adaptations to pregnancy.	For all pregnant women: Make breaks/ interrupt long seated periods Additional, low intensity/ easy strengthening and pelvic exercises as well as adjusted stretching can be beneficial for health and well-being.		Some sports should be avoided in pregnancy: including contact sports, sports with high risk of falls/trauma, SCUBA diving.

	Canadian Guidelines 2019 <sup>8</sup>	ACOG 2015 <sup>10</sup>	USA PAG 2018 <sup>11</sup>	RANZCOG 2016 <sup>3</sup>	Swiss guidelines 2018 <sup>9</sup>	SMA 2016 <sup>4</sup>	UpToDate® 2019 <sup>17</sup>
<b>C. MEDICAL AND HEALTH CARE</b>							
<b>Assessment</b>	A thorough clinical evaluation should be conducted before recommending an exercise program to ensure that a patient does not have a medical reason to avoid exercise.			Assessment of medical and obstetric risks should be undertaken to identify potential contraindications to exercise for the pregnant woman prior to commencing an exercise program.	For women with health issues/ problems: Physical activity can have several positive effects. Benefits and risks should be considered carefully from a medical point of view.	It is important that all pregnant women (inactive, active, sportswomen, and athletes) consult with their health care providers (which could include a GP, obstetrician, midwife or physiotherapist) about physical activity /exercise during and after pregnancy.	Prior to participation in an exercise program, pregnant women should be evaluated for medical and obstetric contraindications to exercise.
<b>Risks</b>	Obstetrician-gynecologists and other obstetric care providers should carefully evaluate women with medical or obstetric complications before making recommendations on physical activity participation during pregnancy. Although frequently prescribed, bed rest is only rarely indicated and, in most cases, allowing ambulation should be considered.					International guidelines on exercise during pregnancy concur that there are contraindications, signs and symptoms, which indicate that physical activity/exercise is not recommended. SMA suggests that exercise professionals and health care providers should be familiar with these.	Maintenance of hydration is particularly critical to heat balance during prolonged exercise in hot, humid weather.

**Abbreviations:** ACOG, American College of Obstetricians and Gynecologists; USA PAG, USA Physical Activity Guidelines report; RANZCOG, Royal Australian and New Zealand College of Obstetrics and Gynaecology; SMA, Sports Medicine Australia; RPE, rating of perceived exertion from the Borg scale<sup>202</sup>, PFMT, pelvic floor muscle training.

## APPENDIX 6

# Revisions to draft Guidelines made during the review process



**During the course of development, the guidelines were reviewed three times:** first by the International Advisory Group in September 2019 (see Appendix 2.1); then by local clinical (medical) experts in early December 2019 (see Appendix 2.2); then by National Stakeholders in December 2019 and January 2020 (see Appendix 2.3). Changes were made in response to the feedback received at each stage, as shown below. (Numbers show those who responded positively to these questions: Is the guideline appropriate? Is the wording clear? Is the evidence grade correct? Responses were 'yes' or 'no', with additional free format response options).

	Version 1 September 2019 Reviewed by International Advisory Group	Version 2 December 2019 Reviewed by local clinical experts	Version 3 December 2019–January 2020 Reviewed by national stakeholders	Version 4 Submitted to Department of Health March 2020
<b>For general overall health</b>	<p>Physical activity (PA) /exercise during pregnancy and the postpartum period is safe, has health benefits for the mother and her unborn child, and reduces the risks of some pregnancy related complications.</p> <p><i>Evidence Grade = 'A'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 7/7  <b>Clear wording?</b> 7/7  <b>Evidence:</b> 6/7  <i>(evidence is only for those without contraindications)</i></p>	<p>PA/exercise during pregnancy and the postpartum period is safe, has health benefits for the mother and her unborn child, and reduces the risks of some pregnancy related complications.</p> <p><i>Evidence Grade = 'A'</i></p> <p><b>Review:</b>  Approved</p>	<p>PA/exercise during pregnancy and the postpartum period is safe, has health benefits for the mother and her unborn child, and reduces the risks of some pregnancy related complications.</p> <p><i>Evidence Grade = 'A'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 12/15 (change 'mother' to 'woman'; may not be safe for all women?)  <b>Clear wording?</b> 11/15 (definition of postpartum? Stress this is for uncomplicated pregnancies)  <b>Evidence:</b> 12/15 (data from RCTs?)</p>	<p><b>Overarching statement:</b>  PA/exercise during pregnancy and the postpartum period<sup>a</sup> is safe, has health benefits for the woman and her unborn child, and reduces the risks of some pregnancy related complications.</p> <p><i>Evidence Grade = 'A'</i></p>

<sup>a</sup> Defined by health professionals as six-eight weeks following the birth.

	Version 1 September 2019 Reviewed by International Advisory Group	Version 2 December 2019 Reviewed by local clinical experts	Version 3 December 2019– January 2020 Reviewed by national stakeholders	Version 4 Submitted to Department of Health March 2020
Dose of physical activity/exercise	<p>All women with an uncomplicated pregnancy should be encouraged to comply with the national Physical Activity (PA) and Sedentary Behaviour (SB) Guidelines before, during and after pregnancy.</p> <p>(National PA and SB guidelines provided).</p> <p><i>Evidence grade – 'mixed' 'A' for physical activity, 'B' for general muscle strengthening and 'C' for sitting time.</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 4/7 (issues raised about high intensity, gradually increasing towards the target).  <b>Clear wording?</b> 5/7 (include the national guidelines IN these guidelines).  <b>Evidence:</b> 4/7 (evidence is for DURING pregnancy, not postpartum; sitting time evidence is a 'D'?)</p>	<p>All women with an uncomplicated pregnancy should be encouraged to comply with the National Physical Activity and Sedentary Behaviour Guidelines before, during and after pregnancy.</p> <p>(National PA and SB guidelines provided).</p> <p><i>Evidence grade – 'mixed' 'A' for physical activity, 'B' for general muscle strengthening and 'C' for sitting time.</i></p> <p><b>Review:</b>  Many pregnancies are 'complicated'. Use contraindications instead. Change 'comply with' to 'meet'; use simple language; add picture of exertion scale to supporting information.</p>	<p>All women without absolute contraindications should be encouraged to meet the National Physical Activity and Sedentary Behaviour Guidelines before, during and after pregnancy.</p> <p>(National PA and SB guidelines provided).</p> <p><i>Evidence grade – 'mixed' 'A' for physical activity, 'B' for general muscle strengthening and 'C' for sitting time.</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 15/15  <b>Clear wording?</b> 10/15 (refer to contraindications in supporting information; is the list for women or health professionals? Suggest working towards guidelines for those currently inactive).  <b>Evidence:</b> 12/15 (difficult to assess without the evidence review; sitting might be a 'C')</p>	<p>All women without contraindications<sup>a</sup> should be encouraged to meet the National Physical Activity and Sedentary Behaviour Guidelines before, during and after pregnancy.<sup>b</sup></p> <p>(National PA and SB guidelines provided).</p> <p><i>Evidence grade – 'mixed' 'A' for physical activity, 'B' for general muscle strengthening and 'C' for sitting time.</i></p>

<sup>a</sup> As shown in the Supporting Information.

<sup>b</sup> Further information on progression, types and intensity of activities, is provided in the Supporting Information.

	<b>Version 1</b> September 2019 Reviewed by International Advisory Group	<b>Version 2</b> December 2019 Reviewed by local clinical experts	<b>Version 3</b> December 2019–January 2020 Reviewed by national stakeholders	<b>Version 4</b> Submitted to Department of Health March 2020
<b>Modifications to physical activity/exercise</b>	<p>Some modifications to physical activities and/or exercise programs may be required to accommodate the anatomical and physiological changes which occur as the pregnancy progresses.</p> <p><i>Additional explanation was provided in attachment 3 in supporting material with information about 'Types and Intensity of PA/exercise' and about 'Safety Precautions'.</i></p> <p><i>Evidence grade = 'consensus'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 7/7  <b>Clear wording?</b> 4/7 (include the supporting information IN the document instead of in an appendix; explain exertion scale).  <b>Evidence:</b> 6/7 (Surprised this is not evidence based)</p>	<p>Some modifications to PA/exercise may be required to accommodate the anatomical and physiological changes which occur as the pregnancy progresses.</p> <p><i>Notes to aid interpretation of guidelines 1-4 were provided at the meeting</i></p> <p><i>Evidence grade = 'consensus'</i></p> <p><b>Review:</b>  Some changes to wording recommended: be more assertive: modifications <i>will</i> be required; exercises <i>should</i> be modified etc. Add information about breast support to notes.</p>	<p>Some modifications to physical activities and/or exercise programs may be required to accommodate the anatomical and physiological changes which occur as the pregnancy progresses.</p> <p><i>Additional explanation was provided in attachment 3 in supporting material with information about 'Types and Intensity of PA/exercise' and about 'Safety Precautions'.</i></p> <p><i>Evidence grade = 'consensus'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 14/15 (women should discuss with their maternity care provider)  <b>Clear wording?</b> 9/15 (remove 'some'; complex language eg anatomical and physiological; make this one clearer /stronger; wording is quite clinical).  <b>Evidence:</b> 15/15</p>	<p>Modifications to PA/exercise may be required to accommodate the physical changes which occur as the pregnancy progresses.<sup>a</sup> If there are any concerns (including warning signs and contraindications<sup>b</sup>), women are advised to seek advice from a qualified health professional.</p> <p><i>Evidence grade = 'consensus'</i></p>

<sup>a</sup> Examples include modifying supine exercises (lying flat on the back) and some yoga poses after 28 weeks. See Supporting Information.

<sup>b</sup> A list of warning signs and contraindications is provided in the Supporting Information.

	Version 1 September 2019 Reviewed by International Advisory Group	Version 2 December 2019 Reviewed by local clinical experts	Version 3 December 2019- January 2020 Reviewed by national stakeholders	Version 4 Submitted to Department of Health March 2020
Pelvic floor muscle exercises	<p>In addition to regular aerobic and resistance-based PA/exercise, all pregnant women are advised to do pelvic floor muscle strengthening exercises during and following pregnancy.</p> <p><i>Evidence grade – 'A'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 6/7 (<i>instruction in proper technique is important</i>).  <b>Clear wording?</b> 6/7 (<i>some adjustments may be necessary after 26-28 weeks</i>).  <b>Evidence:</b> 5/7 (<i>Surprised that there are RCTs to support this A rating</i>).</p>	<p>In addition to regular aerobic and resistance-based PA/exercise, all pregnant women are advised to do pelvic floor muscle strengthening exercises during and following pregnancy.</p> <p><i>Evidence grade – 'A'</i></p> <p><b>Review:</b>  Begin PF exercises as soon as comfortable after the birth.</p>	<p>In addition to regular aerobic and resistance-based PA/exercise, all pregnant women are advised to do pelvic floor muscle strengthening exercises during and following pregnancy.</p> <p><i>Evidence grade – 'A'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 14/15 (<i>should only apply to women with uncomplicated pregnancy; timeframe should be specified, how long after the birth?</i>)  <b>Clear wording?</b> 13/15. (<i>exclusions?</i>)  <b>Evidence:</b> 13/15 (<i>why is this A and earlier guideline on muscle strengthening a B?</i>).</p>	<p>All pregnant women are advised to do pelvic floor exercises<sup>a</sup> during and after pregnancy.</p> <p><i>Evidence grade – 'A'</i></p>

<sup>a</sup> If unsure, seek advice on how to do these correctly. Recomence as soon as possible after the birth, and continue for life.

	Version 1 Sept 2019 Reviewed by International Advisory Group	Version 2 December 2019 Reviewed by local clinical experts	Version 3 Dec-2019-Jan 2020 Reviewed by national stakeholders	Version 4 Submitted to Department of Health March 2020
<b>Medical and health care</b>	<p>Women and healthcare professionals should both play an active role in decisions about PA/exercise during and following pregnancy. Healthcare professionals should only advise women to refrain from activity if they report / experience any major contraindications.</p> <p><i>A list of safety precautions, including contraindications was developed and provided with this guideline.</i></p> <p><i>Evidence grade – 'consensus'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 5/7 (health professionals do not need to be involved in every case; women do not need to see a HP before continuing to be physically active; for emerging contraindications some exercises may need to be modified).  <b>Clear wording?</b> 3/7 (how will women know if there are complications if they do not see a HP? It is vital for the HP to make a diagnosis for some of the listed conditions).  <b>Evidence:</b> 6/7</p>	<p>Women who are healthy and already active do not need to seek clearance for PA/exercise during pregnancy. However, all women and their obstetric health professionals are encouraged to play an active role in decisions about PA/exercise during and following pregnancy. Healthcare professionals should only advise women to refrain from physical activity if there is any major contraindication.</p> <p><i>A list of safety precautions, including contraindications was developed and provided at the meeting.</i></p> <p><i>Evidence grade – 'consensus'</i></p> <p><b>Review:</b>  First consider if there is a contraindication; if so appropriate advice should be provided.</p>	<p>All women and their obstetric health professionals are encouraged to play an active role in decisions about PA/exercise during and following pregnancy. Women who are healthy and already active do not need to seek medical clearance for PA/exercise during pregnancy. If there is a contra-indication (see p6) then appropriate advice should be provided by a healthcare professional.</p> <p><i>A list of safety precautions, including contraindications was developed and provided to accompany this guideline.</i></p> <p><i>Evidence grade – 'consensus'</i></p> <p><b>Review:</b>  <b>Appropriate?</b> 13/15 ('obstetric' not inclusive of all who provide care; split this one into two – one about support and shared decision making, the other about contraindications).  <b>Clear wording?</b> 8/15 (what is appropriate advice? Obstetric/maternity care or health care? Two main points: shared decisions and no need to seek clearance).  <b>Evidence:</b> 14/15</p>	<p>Health professionals should support women to take an active role in shared decision-making about their PA/exercise during and after pregnancy. All health professionals who provide care during pregnancy should be familiar with contraindications, signs and symptoms which suggest that PA/exercise should be modified or avoided.<sup>a</sup></p> <p><i>A list of safety precautions, including contraindications was developed and provided to accompany this guideline.</i></p> <p><i>Evidence grade – 'consensus'</i></p>

<sup>a</sup> An update of the scientific evidence on physical activity/exercise and pregnancy is available in the Guidelines report.

# APPENDIX 7

## NHMRC Guidance

### Standards for Guidelines

The NHMRC advises that, to be trustworthy guidelines need to be of high quality and reflect international best practice in guideline development.<sup>20</sup> The NHMRC suggests nine standards for guideline developers (available from <https://www.nhmrc.gov.au/guidelinesforguidelines/standards>).<sup>5</sup> These are listed below in a table which also outlines how the current project addressed each standard.

Standard	Response
<b>1. To be relevant and useful for decision making guidelines will:</b>	Address a health issue of importance; clearly state the purpose of the guideline and the context in which it will be applied; be informed by public consultation; be feasible to implement.
<b>2. To be transparent guidelines will make publicly available:</b>	The details of all processes and procedures used to develop the guideline; the source evidence; declarations of interest of members of the guideline development group and information on how any conflicts of interest were managed; all sources of funding for the guideline
<b>3. The guideline development group will:</b>	Be composed of an appropriate mix of expertise and experience, including relevant end users; have clearly defined, documented processes for reaching consensus.

Standard	Response
<b>4. To identify and manage conflicts of interest guideline developers will:</b>	
Require all interests of all guideline development group members to be declared: establish a process for determining if a declared interest represents a conflict of interest, and how a conflict of interest will be managed	The Consultants declared no interests outside their roles in academia and clinical practice. No interests were perceived to be in conflict with development of these guidelines.
<b>5. To be focused on health and related outcomes guidelines will:</b>	
Be developed around explicitly defined clinical or public health questions; address outcomes that are relevant to the guideline's expected end users; clearly define the outcomes considered to be important to the person/s who will be affected by the decision, and prioritise these outcomes.	The guidelines explicitly address the issue of PA/exercise during pregnancy. They address outcomes that are relevant to pregnant women. The outcomes (critical elements) are not explicitly prioritised as all are considered to be important for the health of pregnant women.
<b>6. To be evidence informed guidelines will:</b>	
Be informed by well conducted systematic reviews; consider the body of evidence for each outcome (including the quality of that evidence) and other factors that influence the process of making recommendations including benefits and harms, values and preferences, resource use and acceptability; be subjected to appropriate peer review.	The guidelines are informed by a critical review of systematic reviews of the evidence published from Jan 2010 to November 2019. The evidence relating to each 'critical element (outcome) was considered in light of its quality (strength) and clinical / professional judgements about benefits and harms, values, preferences and acceptability were used to translate the evidence into guidelines. The draft guidelines were reviewed by a panel international experts then revised and reviewed by a small group of eminent local clinicians with expertise in the delivery of clinical services for pregnant women (see pages 24-25). They were then revised again before being sent to national stakeholders for peer review (see page 25).
<b>7. To make actionable recommendations guidelines will:</b>	
Discuss the options for action; clearly articulate what the recommended course of action is, and when it should be taken; clearly articulate what the intervention is so it can be implemented; clearly link each recommendation to the evidence that supports it; grade the strength of each recommendation.	<p>As described on page 21, once approved by the Department of Health, the guidelines should be made available free of charge to end users.</p> <p>Each recommendation has been assigned an evidence grade, reflecting the evidence in the narrative review which supports it.</p>

Standard	Response		
<b>8. To be up-to-date guidelines will:</b>	Ensure that the recommendation is based on an up-to-date body of evidence; propose a date by which the evidence and the guideline should be updated. This may be specific to each recommendation		
<b>9. To be accessible guidelines will:</b>	Be easy to find; Ideally be free of charge to the end user Be clearly structured, easy to navigate and in plain English Be available online	The review was based on scientific evidence available up to November 2019; this should be reviewed in five years. See page 21 for more information in "Next Steps".	We believe this report will be made widely available through the Department of Health website, and that it is easy to navigate and in plain English. The Department will make the actual guidelines available to the public and to health professionals, and they will be responsible for developing the communication material that will accompany their release.

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Contact details for further information on this report:

**Professor Wendy J Brown**

T +61 7 3365 6240  
E [wbrown@uq.edu.au](mailto:wbrown@uq.edu.au)  
W [uq.edu.au](http://uq.edu.au)