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The Role of Physical Activity in Preconception, Pregnancy and Postpartum Health

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Abstract

The rise in obesity and associated morbidity is currently one of our greatest public health challenges. Women represent a high risk group for weight gain with associated metabolic, cardiovascular, reproductive and psychological health impacts. Regular physical activity is fundamental for health and well-being with protective benefits across the spectrum of women's health. Preconception, pregnancy and the early postpartum period represent opportune windows to engage women in regular physical activity to optimize health and prevent weight gain with added potential to transfer behavior change more broadly to children and families. This review summarizes the current evidence for the role of physical activity for women in relation to preconception (infertility, assisted reproductive therapy, polycystic ovary syndrome, weight gain prevention and psychological well-being) pregnancy (prevention of excess gestational weight gain, gestational diabetes and preeclampsia as well as labor and neonatal outcomes) and postpartum (lactation and breastfeeding, postpartum weight retention and depression) health. Beneficial outcomes validate the importance of regular physical activity, yet key methodological gaps highlight the need for large, high-quality studies to clarify the optimal type, frequency, duration and intensity of physical activity required for beneficial health outcomes during preconception, pregnancy and postpartum.

Keywords

preconception; pregnancy; postpartum; physical activity; exercise

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The increasing prevalence of overweight and obesity worldwide represents a complex and chronic public health challenge. Recent estimates highlight the burden, with only 40% of the adult population in Australia and the United Kingdom and 30% in the United States within a healthy weight range.[1] Trends demonstrate that overweight and obesity are affecting the population at a younger age, with the most rapid rate of weight gain reported between 20–40 years of age.[1,2] Women are at the highest risk, with a higher conversion to overweight and obesity compared with men on cross-sectional analysis.[3]

Increased weight in reproductive aged women is associated with cardio metabolic (glucose intolerance, dyslipidaemia, Type 2 Diabetes [T2DM] risk factors for Cardiovascular Disease [CVD]), reproductive (anovulation, Polycystic Ovary Syndrome [PCOS], infertility) and psychological (Depression, Quality of Life [QoL]) health risks. Pregnancy exacerbates obesity risk, with the majority of women exceeding international Institute of Medicine (IOM) recommendations for gestational weight gain (GWG).[4–7] Excessive GWG increases postpartum weight retention, and in conjunction with progressive weight gain, drives long-term obesity risk independent of pre-pregnancy body mass index (BMI).[8,9] With modest weight gain from a healthy BMI contributing to risk of preventable disease,[10] preventive strategies are now a key international priority and lifestyle modification is the first line approach.[11,12] Physical activity is an important lifestyle modification component, with protective health benefits, as well as a clear role in weight gain prevention, independent of diet.[13] This review evaluates current evidence for the beneficial role of physical activity in relation to preconception, pregnancy and postpartum health. Research utilizing physical activity and/or exercise as a stand-alone therapy is presented to evaluate its efficacy independent to other lifestyle therapy components.

Adult Physical Activity Recommendations

Current Australian Physical Activity (PA) recommendations[14] are presented in Fig. 1, with corresponding exercise intensities[15] depicted in Fig. 2. International guidelines with similar recommendations are published for US and UK populations.[16,17] Despite the documented benefits, ~55% of women in developed countries aged 18–45 do not meet current PA recommendations.[18] Data from longitudinal studies demonstrate a downward trend in PA with increasing age, as well as an upward trend in weight gain.[19] Common barriers reported by women include time constraints, motivation, caregiving, cost, low self-efficacy and a low level of PA prioritisation.[20]

The Role of Physical Activity in Preconception Health

Despite the barriers in engaging otherwise healthy women prior to pregnancy for preconception healthcare, previous studies demonstrate PA intention[21] and participation[22] can be improved following lifestyle counselling of 2–6 sessions. PA interventions are lacking however, with two recent systematic reviews finding no previous studies investigating PA for improved health outcomes in the preconception period, even in higher risk overweight and obese populations.[23,24] Given preconception PA is a strong predictor of continued PA during pregnancy,[25] establishment of regular PA prior to pregnancy should be an important component of healthy pregnancy planning.

Infertility and Assisted Reproduction

Overweight and obesity impair female fertility and reduce the chance of spontaneous and assisted conception. Weight management, including regular PA, is important in preventing and treating infertility.

Evidence suggests that moderate regular PA positively influences fertility and Assisted Reproductive Therapy (ART) outcomes. A recent study has shown that in obese women undergoing IVF ($n = 216$), regular PA is associated with higher success rates (39% versus 16% in sedentary women) and improved live birth rates (24.4% versus 7.4%),[26] with comparable results demonstrated elsewhere.[27] However, the evidence for the effects of vigorous exercise on fertility and/or ART success is equivocal. A 2002 study of 26,955 women, found that each hour per week of vigorous activity was associated with a 7% lower relative risk of ovulatory infertility (5% on adjustment of BMI).[28] Yet, a population based health survey in 3887 women under 45 years of age reported an association between vigorous (exercising daily or to exhaustion) exercise and subfertility.[29] However no associations were reported with lower intensity PA.[29] Similarly, a prospective cohort study of 2232 women reported that at least 4 hours of higher intensity PA for a year or more prior to IVF was associated with a 5 fold increase in cycle cancellation, a 2.5 fold increase in failed implantation, a 30% lower chance of successful pregnancy and a 50% reduction in live births compared with women who reported no regular PA.[30]

Polycystic Ovary Syndrome

Recognized as the leading cause of anovulatory infertility, Polycystic Ovary Syndrome (PCOS) affects up to 12–18% of reproductive aged women.[31–33] PCOS is a multifaceted disorder with metabolic (insulin resistance [IR], T2DM and CVD risk factors), reproductive (hyperandrogenism and oligoovulation) and psychological sequelae.[34–38] Varying phenotypes of PCOS increase complexity,[39] complicate the path to diagnosis[31] and together with clinical factors, increase anxiety and depression[36] and reduce QoL.[40]

Diagnosis requires at least two of clinical or biochemical hyperandrogenism, anovulatory menstrual dysfunction and polycystic ovaries on ultrasound, in the absence of secondary causes.[41,42] Although not required for diagnosis, insulin resistance (IR) and intrinsic insulin signaling defects are strongly implicated in the etiology of PCOS[43,44] and underpin both reproductive and cardio-metabolic disturbances. Obesity, present in 40–88% of women with PCOS,[45–47] worsens IR[48] and exacerbates the metabolic, reproductive and psychological features of PCOS.[49,50]

Lifestyle change is recommended as a first line treatment strategy for PCOS[51] and physical activity is an important component, with a single exercise bout enhancing whole body glucose disposal[52] and continued, regular exercise reducing T2DM risk in high risk, glucose intolerant groups.[53]

In studies addressing exercise as an independent therapy in PCOS, the most consistent improvements appear to be to IR with either neutral or small changes noted in other cardio-metabolic parameters including weight, body fat, waist-to-hip ratio, lipids and blood pressure. When measured directly with the gold standard euglycaemic clamp, intensified

exercise training improved IR by 16% in overweight and obese women with PCOS, yet in BMI matched non-PCOS controls a 23% improvement was noted, emphasizing the intrinsic IR defects of the disorder.[54] Other studies using indirect measures of IR have reported a 9–30% improvement in fasting insulin[55,56] as well as in the IR indices, HOMA-IR and AUC_{INC}, following exercise.[55,56] All previous studies have reported improvements with 12 weeks of exercise intervention, independent of the type or frequency of exercise, with 3–5 sessions per week of both moderate (40–70% VO2 max) and higher intensity interval training (95–100% VO2 max), shown to be effective.[54–56]

Reported changes to BMI with exercise are ~1.5kg/m^2 (−0.85 to −2.1kg/m^2) within three to six months of exercise.[57–59] A higher percentage of weight loss (~10.6%) has been reported in PCOS when diet is combined with exercise,[60] confirming that a larger energy deficit is more likely to lead to weight loss in line with general populations.

Evidence for the effect of exercise on fertility in overweight and obese women with PCOS is limited, with three studies identified in a systematic review.[55] Improved menstrual and/or ovulation frequency was reported in 60% of women following a moderate intensity exercise intervention three times per week for 45 minutes for 12 weeks compared with minimal therapy. However, menses frequency during the study period and minimal therapy group results were not provided so these findings should be interpreted with caution.[57] Similar findings using the same exercise intervention (3 moderate intensity sessions of 30 minutes per week) but with a 24 week duration were also reported compared with a low-calorie, high-protein diet.[61] Further research is required to confirm whether exercise is superior to dietary intervention for improved ovulation and menses regularity in PCOS.

Continuity of exercise is important, with cessation reversing metabolic improvements and weight benefits.[59] Research is limited by small, low quality studies and further research is required to optimize exercise therapies for PCOS including frequency, duration and intensity of PA for the differing phenotypic profiles of PCOS. With a lack of PCOS specific recommendations, all women should be encouraged to exercise regularly, as per population guidelines for PA.

Weight Gain Prevention, Weight Loss, and Prevention of Weight Regain

It is generally accepted that exercise, as an independent therapy without change to caloric intake, is insufficient to induce significant weight loss beyond the definitions for weight maintenance (i.e.≥3% of baseline weight[62]). Because of the excessive amount of exercise required to induce even modest weight loss, dietary restriction is more effective, achievable and practical for general populations. However, when exercise is combined with dietary restriction as part of a lifestyle intervention to induce weight loss, the combination of both on the daily energy deficit potentiates weight loss compared with dietary intervention alone.[62,63]

Yet, regular PA is important for weight gain prevention, with those achieving the higher end of the recommended activity range less likely to gain weight long-term than sedentary individuals.[62] Current recommendations for prevention of weight gain include at least 60 minutes per day of moderate PA or the equivalent volume of more vigorous PA. Modest

changes in weight of between 2–3kg are noted when PA level is higher at 225–420 minutes/week; equivalent to ~45 minutes per day.[62]

There is also a role of regular exercise in the prevention of weight regain following weight loss.[64] Those maintaining weight for at least 5 years in the National Weight Control Registry report high levels of PA (~1 hour/day) as well as a low-calorie and low-fat diet, regular self-monitoring and consistent eating patterns.[65] A prospective study assessing weight regain in reproductive aged women found 80% of women regained above 30% of their initial weight loss,[66] confirming the difficulties of weight maintenance following weight loss. However, PA at least 30 minutes/day reduced the likelihood of weight regain compared with remaining sedentary (OR 0.69, 95% CI 0.53, 0.89).[66] A dose–response effect was also reported, with less weight regain in those undertaking more vigorous exercise, than in those who walked (−3.26kg vs −1.69kg).[66]

Well-Being, Anxiety, Depression, and Quality of Life

The established link between regular PA and psychological well-being demonstrate its importance across several health outcomes including mood, self-efficacy, symptoms of anxiety[67] and depression[68] and health related QoL.[69–72] The impact of regular PA on the psychological health of young women is particularly important. An extensive population based study in ~20,000 men and women, reported a higher prevalence of anxiety, depression and anxious depression in women than in men aged between 20–35 years.[73] However, a lower prevalence of all three conditions was reported in women who maintained at least 60 minutes/week of self-reported moderate intensity PA compared with sedentary women.[73] Further, compared with diagnosed depression in 22.4% of women classified as sedentary (<5,000 steps/day), the prevalence was halved (9.3%) in women reporting ≥7,500 steps/day.[68] Health related quality of life (HQoL) is positively associated with regular PA. A systematic review of 11 interventional studies (1406 healthy male and female participants), reported significantly improved psychological and physical HQoL with 3–6 months of light or moderate intensity PA compared with no treatment.[74]

In infertile populations, where psychological implications are higher, regular PA improves depression,[75] body image distress[76] and HQoL.

Better psychological health outcomes occur with a diverse range of PA patterns including self-reported leisure time activity and structured exercise interventions of varying frequency, duration and intensity. There is some evidence to support a dose response relationship, with higher levels of leisure time PA of moderate or vigorous intensity or a combination associated with better measures of well-being,[72] lower anxiety symptoms,[67] lower depression[68] and higher HQoL scores,[70,71] than lower intensity PA levels.

The Role of Physical Activity during Pregnancy

Physical Activity Recommendations

Current physical activity recommendations are informed by general advice for healthy adults[14] with the American College of Obstetricians and Gynecologists advising 20–30 minutes of moderate PA of moderate intensity on most or all days of the week in the absence

of contraindications.[77] Contraindications to exercise include heart or lung disease, incompetent cervix, multiple gestation with risk of premature labor, persistent second- or third-trimester bleeding, placenta previa after 26 weeks gestation and preeclampsia.[77]

With a safe upper level of exercise intensity yet to be established,[77] PA that can be easily quantified to monitor perceived intensity and exertion is recommended, including the use of perceived exertion scales,[77] which may be more practical than continuous heart rate monitoring in general populations, A score between 13–14 out of 20 on the Borg's Rating of Perceived Exertion scale is indicative of moderate intensity[78] (Fig. 2).

Overall, there is little evidence to suggest that regular moderate intensity PA throughout pregnancy is detrimental to foetal development or raises maternal core body temperature sufficiently to impose risk.[77] Therefore, in normal pregnancies, and when PA is at recommended levels, there is general agreement that the benefits of exercise during pregnancy far outweigh any risks to the mother or fetus,[79] with guidelines advising adequate hydration and PA in cool environments with participation in contact or higher risk sports restricted.[77,80]

Despite the documented 'teachable moment' of pregnancy with increased motivation for healthy lifestyle behaviors,[81–84] pregnancy is usually associated with decreased levels of PA. Concerns about safety and potential adverse effects on the developing fetus, as well as changing body shape, tiredness and time constraints are the most commonly cited barriers to regular activity during pregnancy.[85]

Gestational Weight Gain

Increased gestational weight gain (GWG) is a risk factor for antenatal complications (addressed elsewhere in this issue). Exacerbating risk is pre-existing overweight and obesity which in itself is an established risk factor for maternal complications including miscarriage, hypertension, gestational diabetes mellitus (GDM) and caesarean delivery[86] as well as large-for-gestational age (LGA) neonates.[87] Excess weight gain in early to mid pregnancy is particularly important, as maternal fat accretion peaks at 30 weeks gestation and directly correlates with total GWG and long-term obesity development.[6,88]

A recent Cochrane review of 13 RCT exercise intervention studies (n = 10 supervised exercise intervention, n = 3 unsupervised self-directed exercise) supports the role of PA for the prevention of excess GWG, reporting a 21% (11–31% range overall) reduction in risk compared with standard care.[89] On further analysis, the most protective benefit of PA was in women with a healthy BMI, with a 31% reduced risk of excessive GWG, compared with a 16% reduced risk when obese women only were included (23% reduced risk in the total sample).[89] Additionally, in 3 studies reporting total GWG (n = 1134 participants) a significant mean reduction of 1.35kg overall (95% CI −1.80, −0.89) was noted.[89] Encouragingly, on analysis of the total sample, this review found that increased PA was as effective as dietary intervention for reducing risk of excessive GWG, with a 23% reduced risk noted with a low glycaemic load diet and a 14% reduction with diet and PA counselling.[89] Substantial heterogeneity in the dietary intervention studies (n = 36) prevented pooling of data, however most reported no benefit on risk of excessive GWG; only 5 of 36 studies

noted a significant effect.[89] The most benefit in risk of excessive GWG was found in studies that included both supervised exercise training and dietary intervention, with a 29% reduction overall. These findings are supported by a previous systematic review with comparable results.[90]

Prevention and Treatment of Gestational Diabetes Mellitus

Gestational diabetes mellitus (GDM), defined as glucose intolerance with onset or first recognition during pregnancy, is closely related to obesity, IR and T2DM in women and its prevalence has dramatically increased in parallel with recent rises in obesity rates in women.[91] Modifiable and unmodifiable factors drive GDM risk,[92] with development associated with a progressive rise in insulin resistance (IR) with advancing pregnancy.[93,94] Prevalence varies depending on the population studied and diagnostic criteria applied, however current estimates indicate GDM affects 6–14% of pregnancies.[95] GDM increases neonatal and maternal risks, including LGA neonates, neonatal hypoglycaemia and morbidity, as well as increased rates of delivery by caesarean section.[96] Long term, maternal progression to T2DM occurs in 15–70% of women with a history of GDM[97–99] and offspring are at an increased risk of obesity development as well as T2DM.[100]

A 2015 systematic review of 10 RCT studies comparing increased PA as a stand-alone intervention with standard care in 3401 participants of whom 275 developed GDM estimated a 28% lower risk in the development of GDM on meta-analysis (RR 0.72, 95% CI 0.58–0.91, $p < 0.005$).[101] The majority of studies enrolled women in the first or early second trimester and included women of all BMI levels with the exception of three studies targeting overweight or obese women. These studies involved aerobic PA of varying types, with the majority involving 3–4 exercise sessions of 45–60 minutes duration per week. Four studies included a resistance training component.[101]

In pregnancies complicated by GDM, treatment centres on achieving glucose control through lifestyle change as a first line approach.[102,103] The potential theoretical use of PA as an adjunctive therapy for GDM treatment is promising due to its effects on glucose uptake and utilization. Yet despite this, evidence for the role of exercise in the treatment of GDM is inconclusive. A 2006 Cochrane review of four trials, with a combined 114 GDM cases, reported no significant difference between combined exercise and diet therapy intervention and minimal or dietary therapy alone on glucose control, insulin prescription, or neonatal and maternal outcomes.[104] The included studies commenced exercise in the third trimester for a minimum of 6 weeks duration, 3–4 times weekly at moderate intensity (≤50–70% $VO_{2\ max}$). With insufficient evidence on the role of exercise in GDM treatment, advice regarding the optimal type, frequency, intensity and duration of exercise required for blood glucose control remains unclear. Larger, high quality studies are required to elucidate the independent role of exercise in treating GDM.[79]

Prevention and Treatment of Hypertension and Pre-Eclampsia

Hypertensive disorders of pregnancy are one of the most common maternal complications, affecting ~10% of pregnant women. Risk factors mirror those in the general population and include advanced maternal age, ethnicity, family history of hypertension and increased CVD

risk factors as well as a sedentary lifestyle.[105] Chronic, pre-existing hypertension (prior to 20 weeks gestation) and gestational hypertension (transient hypertension manifesting after 20 weeks gestation and resolving by 6 weeks postpartum), affects ~5–8% of women and is characterized by a systolic blood pressure (BP) ≥140mmHg and/or a diastolic BP ≥90mmHg.[105] Preeclampsia is a multisystem disorder of increased severity on the spectrum of hypertensive disorders, affecting ~5–8% of pregnancies and is typically characterized by hypertension and proteinuria manifesting in the second half of pregnancy.[105]

Despite the protective role of PA in hypertension in the general population, its role in preventing preeclampsia is yet to be fully elucidated. Systematic reviews in the area report contradictory findings, potentially owing to methodological differences, including criteria for included studies. A Cochrane review of two small RCT studies in 45 women reported insufficient power to detect any beneficial role of PA in the prevention of pre-eclampsia in women at increased risk prior to, or in, early pregnancy.[106] These studies included moderate intensity exercise (Fig. 2) at least 3 times per week of 30–45 minutes duration, from 18 weeks gestation for 10 weeks or 34 weeks gestation until term.[106]

Yet a second recent systematic review including case-control and cohort studies only reported an inverse relationship between increasing PA before or during early pregnancy and reduced risk of preeclampsia. Using prospective cohort studies, the authors report a 35% relative risk (RR) reduction in women exercising in the highest category prior to pregnancy (4 studies, $n = 9733$ participants of whom 420 developed pre-eclampsia) and a 18% RR reduction with high levels of PA in early pregnancy (7 studies, $n = 162,558$ participants of which $n = 5077$ developed pre-eclampsia[107]). The meta-analysis also included a dose–response analysis of PA pre-pregnancy and risk of pre-eclampsia and reported a non-linear trend with the most protective benefits found with between 5–6 hours of activity per week, with a 40% reduction in risk, overall.[107] However, as the review included only observational studies, with no reported methodological quality analysis, results should be interpreted with caution and further research is required.

Labor and Delivery

In theory, the stronger and more physically fit a women is at term, the better her ability to cope with labor and delivery.[108] However limited evidence exists that PA during pregnancy improves labor, labor duration and perceived ease of delivery.[90,109,110] There is evidence from recent prospective cohort studies that sufficiently active pregnant women have a lower risk of medical intervention during delivery, including caesarean delivery.[111–113] Cultural factors have more effect than PA on procedures such as episiotomy, epidural induction of labor and method of delivery.[111–113]

Neonatal Outcomes

Although some observational studies have reported associations between PA, gestational age and neonatal birth weight, the effects are extremely small with the general consensus being that PA of light, moderate or vigorous intensity does not affect infant birth weight when appropriate confounding factors are controlled for.[114,115] A Cochrane review of 14 intervention studies with over 1000 women reported no significant effects of exercise on

birth weight.[116] A meta-analysis reported had 31% less risk of having a large baby (>90th percentile) with regular PA, and that babies of exercising women were ~31 g lighter than non- exercising women.[117] Data from a large Norwegian study found lower adjusted odds (0.76–0.91) for pre-term birth among exercising women, compared with non-exercising women, however the mean difference was only 1–2 days.[118]

The Role of Physical Activity in Postpartum Health

Lactation and Breastfeeding

Moderate to vigorous PA does not negatively affect breast milk composition and volume, provided adequate food and fluid intake is maintained,[119] with the caloric cost of breast feeding estimated to be ~600 kcal/day.[120] Recommendations include breastfeeding prior to exercise, postponing breast feeding to one hour after exercise, or expressing if required, in cases where infants are unsettled with feeding immediately after the mother exercises.[119]

Postpartum Weight Retention

With ~60% of women exceeding IOM guidelines for GWG, postpartum weight retention is common with up to 20% of new mothers retaining 5 kg or more one year postpartum, driving long-term health risk.[121] PA in the postpartum period is important for weight maintenance as well as other health benefits, however may not induce sufficient weight loss as a standalone therapy. While a 2007 Cochrane review of two studies with 53 participants overall[122] found an insignificant change in postpartum weight following exercise intervention of −0.10kg (95% CI −1.90, 1.71) compared with usual care, a recent review of six studies found a significant weight loss of −1.63kg (95% CI −2.16, −1.10).[123] Both these and other reviews,[124] have noted a greater effect on weight loss in intervention studies that included a dietary component, with mean changes in weight of between 2–4.3 kg. More intensive dietary interventions and more structured activity programs incorporating HR monitors or pedometers, were associated with higher weight loss.[124]

Postpartum Depression and Quality of Life

Postpartum depression (PPD) is a prevalent condition affecting ~10–15% of women within the first year of birth.[125] Severity and duration varies, however approximately half of all cases occur within the first 12 weeks following birth and severity may be exacerbated by the added demands placed on new mothers following birth.[125] PA and/or exercise interventions for the prevention or treatment of PPD are limited, with few high quality RCTstudies, small sample sizes and high variability in time from delivery at recruitment. Data from a recent meta-analysis of 6 exercise intervention studies within 12 months postpartum reported a weighted mean reduction in Edinburgh Postnatal Depression Score (EPDS) of 2.22 (95% CI 0.48, 3.96), with this change remaining below the clinical significance indication of a 4 unit change, increasing equivocality. Studies comprised either structured exercise classes ($n = 4$) or provided tailored exercise advice ($n = 4$). Overall, the meta-analysis supported a moderate effect of exercise for the treatment of PPD.[126] Walking groups may also be beneficial for reducing PPD with data from two small RCT studies of between 20–24 women reporting a 59–65% reduction in scores following a 12 week intervention of 2–3 walking sessions per week.[127,128] These results are supported by cohort studies showing comparable results with

low-moderate[129] and vigorous exercise interventions[130] commencing both in pregnancy or the postpartum period.

Although studies evaluating causation between increased PA and reduction in indicators of PPD are needed, PA may potentially act to elevate mood, improve self-efficacy and sleeping patterns, alleviate stress and increase coping strategies. Women report a greater sense of well-being[126,131] and health related QoL with postpartum exercise.[132] As preconception and antenatal exercise are associated with reduced PPD risk following pregnancy, women should be encouraged to engage in regular activity to enhance potential benefits on mental well-being post-pregnancy.[133,134]

Conclusion

Women of reproductive age are a high risk group for progression to obesity; increasing the risk of morbidity and contributing to the global economic health burden. Preconception, pregnancy and the early postpartum period represent opportune windows to engage women in regular PA to optimize health and prevent weight gain with added potential to transfer behavior change more broadly to children and families Fig. 3. Yet, many reproductive aged women do not meet PA guidelines preconception, with pregnancy and the postpartum period marking further PA decline, warranting public health efforts in this population. To date, few studies have evaluated PA as a standalone therapy and key methodological gaps necessitate further research. Large, comparative, high-quality studies, addressing barriers to exercise with objective PA measurement and with reporting of compliance and adherence are now needed to clarify the optimal type, frequency, duration and intensity of PA required for beneficial health outcomes for women, during preconception, pregnancy and postpartum.

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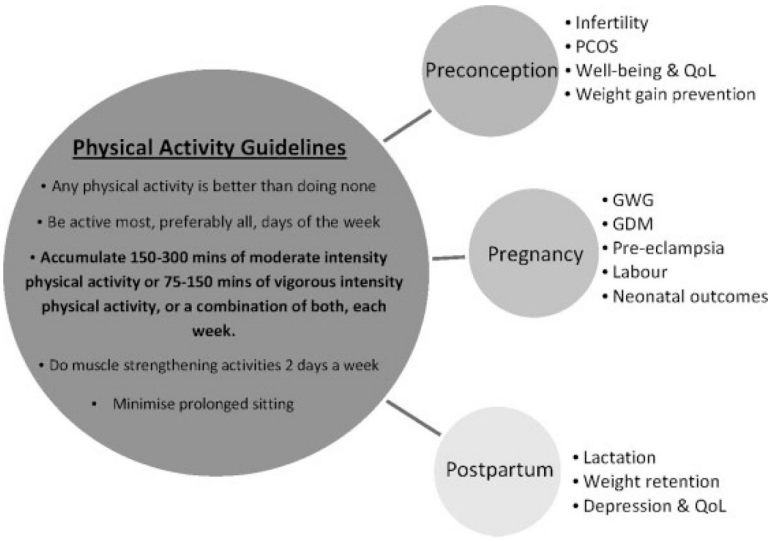

Fig. 1.

Adult physical activity recommendations and the association of physical activity with preconception, pregnancy and postpartum health. PCOS, polycystic ovary syndrome; QoL, Quality of Life; GWG, gestational weight gain; GDM, gestational diabetes mellitus.

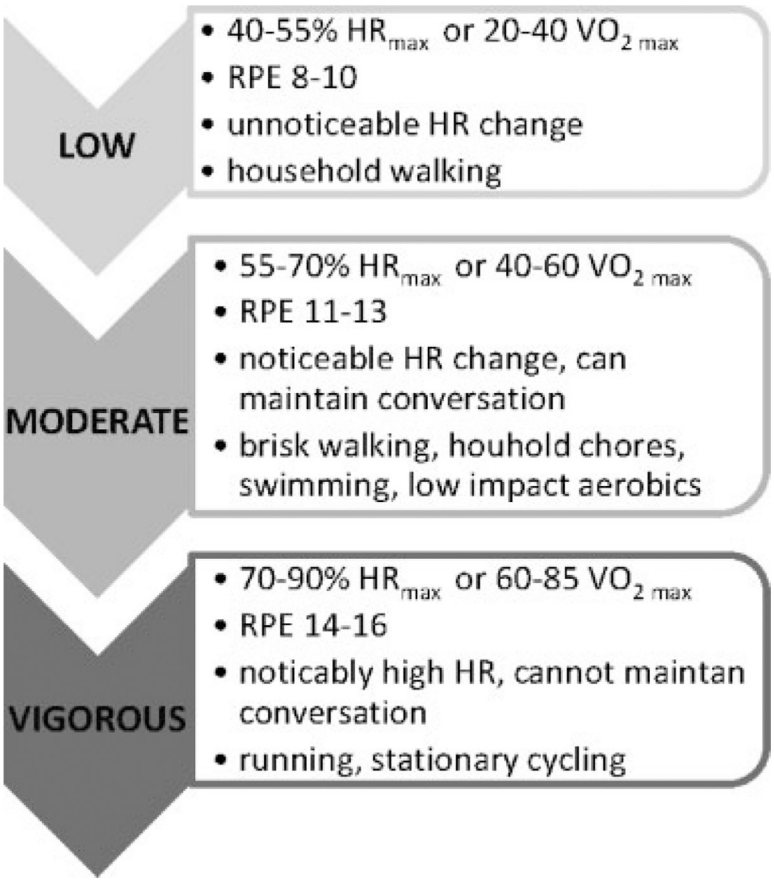

Fig. 2.

Physical activity intensity terminology[15] and corresponding Rating of Perceived Exertion (RPE) scores.[75]

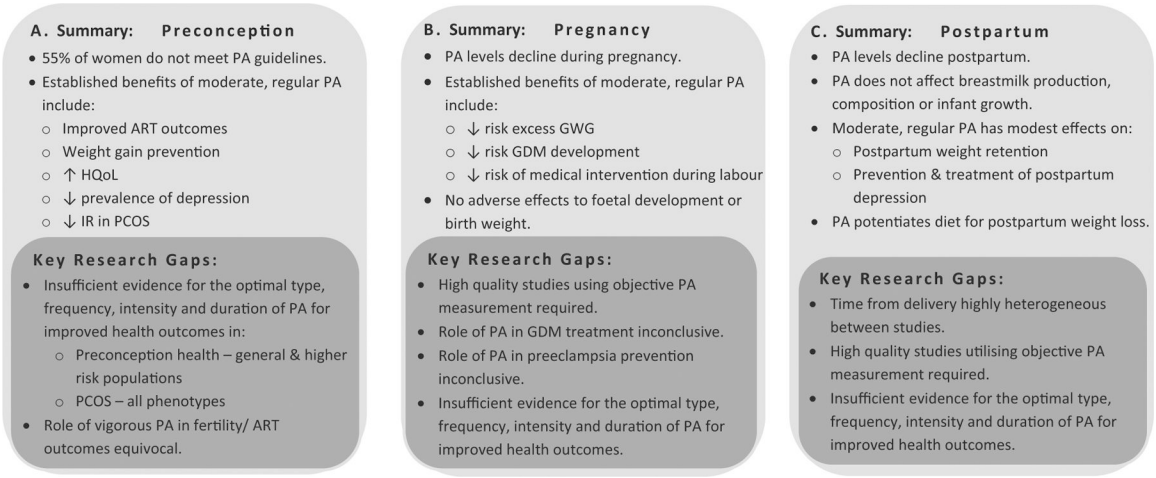

Fig. 3.

Summary of the role of physical activity across (a) Preconception (b) Pregnancy and (c) Postpartum health.