

From caution to guidance: a narrative review of CrossFit during pregnancy

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ABSTRACT

Public opinion on engaging in vigorous activity during pregnancy remains divided. While numerous examples exist of pregnant women competing at high levels in sports, concerns persist regarding potential adverse effects on maternal and foetal health. CrossFit, known for fostering community and social connection, often remains a continued practice for female athletes during pregnancy, despite its association with high-intensity exercise, Olympic weightlifting, and dynamic movements. This article aims to synthesise current evidence-based information on CrossFit training during pregnancy, objectively outline potential risks, and provide practical recommendations. A narrative review was conducted, sourcing data from PubMed, Scopus, and Semantic Scholar. Articles were categorised into relevant sections: exercise during pregnancy, high-intensity exercise, resistance training, injuries in CrossFit, and practical applications. In the absence of studies directly assessing CrossFit's impact on pregnant women, available sources allow us to endorse this form of exercise as safe and beneficial for both maternal and foetal health. Certain exercises, such as jumping and burpees, should be adapted to the specific trimester, while others might be best avoided (such as box jumps and bar muscle-ups). Nonetheless, adherence to professional guidance and medical directives is crucial. The recommendations herein are intended for healthy, physically active pregnant women. **Key words:** exercise, resistance training, injury, high-intensity functional training, high-impact, vigorous

Introduction

The public's acceptance of vigorous activity during pregnancy remains cautious, despite the American College of Obstetricians and Gynecologists (ACOG) identifying numerous benefits in its 2020 report [1]. Women face various barriers to exercising during pregnancy, including concerns for foetal health, which contribute to societal pressures, and may lead to concerns about exercise [2, 3]. Historical perspectives, predominantly in the 19th and 20th centuries, have characterised pregnancy as a condition susceptible to harm from exertion or exercise [4]. Such views have the potential to induce kinesiophobia, adversely impacting gender equality, and may lead to unnecessary stigmatisation and sexism, including the sexual objectification of pregnant athletes [5, 6].

A parallel challenge is the dissemination of information through social media and the Internet, which often does not align with official health guidelines [7]. Pregnant women who engage in and share their exercise routines on social networks frequently encounter public criticism, commonly centred around the health of the foetus. Activities such as intensive exercise or strength training with a barbell are often subject to scrutiny [8]. This scrutiny is rooted in a longstanding belief that strenuous activities during pregnancy might jeopardise foetal health, thus placing expectant mothers in the position of dealing with ambivalent societal reactions.

Determining appropriate exercise intensity limits during pregnancy is beneficial. In the realm of sports, there have been instances of pregnant women performing at high intensities or in ways significantly divergent from traditional recommendations [5]. An extreme case cited by Davenport et al. [9] involves a woman in her third trimester ascending to Mount Everest's base camp (approximately 11,500 ft.) without experiencing adverse effects. According to ACOG guidelines [1], physically active women should engage in moderate-

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intensity activities, defined as somewhat challenging and comprising 60–80% of the maximum heart rate, with a preference for safe exercises such as walking, aerobic exercises, light resistance training, and stretching. Activities of higher intensity are considered suitable for elite athletes, accustomed to training an average of five times a week for two hours [1, 10].

CrossFit[®] transcends a mere training methodology, embedding itself into the lifestyle of its practitioners through a pronounced community ethos [11]. The gender dynamic within CrossFit[®] is notably inclusive, with men and women participating in identical workouts, fostering mutual challenges and support. This environment supports exercise for all individuals, provided their health status permits such engagement. It has been reported to empower women, helping them to dismantle stereotypes and instil a sense of pride and resilience – encapsulated in the sentiment expressed by female CrossFit[®] athletes that 'Quitting is not an option' [12].

The core tenets of CrossFit[®] encompass constant variation, functional movements, and high intensity. The regimen's hallmark, the workout of the day (WOD), typically comprises a sequence of compound movements executed with maximal effort within a 5 to 20-minute timeframe [13]. Participants often experience substantial physiological exertion, evidenced by heart rates surging to approximately 184 beats per minute and blood lactate levels ascending to 17.8 mmol/L [14]. The regimen incorporates a diverse array of exercises, ranging from gymnastics (including pull-ups and squats) to metabolic conditioning (such as running and rowing) and weightlifting and throwing (using barbells, dumbbells, medicine balls) [15].

CrossFit® is classified by some authors as high-impact exercise [16-18] due to its inclusion of movements such as running, box jumps, jump rope, landing from the bar/rings, and the bar's impact during Olympic weightlifting. These activities may present heightened risks that could be particularly significant for pregnant women. Concerns vary widely among different exercise modalities: on one end are weight exercises incorporating dynamic movements similar to those found in Olympic weightlifting, and on the other, there are bodyweight resistance exercises that involve compound, high-difficulty movements [19]. Additionally, high-intensity exercises that induce elevated heart rates, increased rating of perceived exertion (RPE), and higher lactate levels may also heighten the risk of musculoskeletal injuries, particularly to the spine and hip joints [20, 21]. Moreover, engaging in high-impact activities during pregnancy may be associated with an increased risk of spontaneous abortion, underscoring the need for careful consideration and potentially modified exercise regimens for expectant mothers [22].

Despite CrossFit's global proliferation, with approximately 12,500 affiliated gyms [23], and its popularity among women aged 20-40 - a demographic frequently encompassing expectant mothers - there is a dearth of research regarding pregnant women's participation in CrossFit[®]. Evidence suggests that physically active pregnant women can go beyond the established conventional official health guidelines and societal norms [24-28]. Consequently, healthcare professionals, including physicians, physiotherapists, and fitness coaches, are increasingly called upon to provide informed guidance to pregnant women engaging in CrossFit[®]. This article aims to synthesise current evidence-based information on CrossFit[®] training during pregnancy, objectively outline potential risks, and provide practical recommendations.

Material and methods

This article presents a narrative review of the literature sourced from the PubMed, Semantic Scholar, and Scopus databases. For the inclusion of 'grey literature', Google Scholar was utilised. Additionally, a backward search was conducted, entailing the assessment of references from the identified studies. The author reviewed studies written in English from peer-reviewed journals, published up until 1 May 2023. Keywords were searched both in isolation and in conjunction (using 'AND' or 'OR'): 'pregnancy', 'CrossFit', 'training', 'exercise', 'high-intensity', 'vigorous', 'functional', 'resistance', 'injury', 'abortion'. In the selection of studies for this review, those with divergent research focuses, not specifically addressing healthy pregnant women, or not written in English, were excluded to maintain a clear and consistent scope. A total of 1458 sources were identified, and from these, 67 were included in the review.

The procedure for creating the review was according to SANRA – a scale for the quality assessment of narrative review articles [29]. The quality of this narrative review was rated at 10 (SANRA scale 0–12).

Each study's design and the level of evidence were carefully considered, with a preference for high-quality evidence from randomised controlled trials, systematic reviews, and meta-analyses. Observational studies, cohort studies, case-control studies, and cross-sectional studies were also reviewed for their contributory evidence, although these are recognised as lower levels of evidence.

The structure of this article into distinct sections exercise during pregnancy, high-intensity exercise, resistance training, injuries in CrossFit®, and practical applications - is intentional, allowing for a focused examination of each area's unique implications and research findings. This organisation also facilitates a targeted discussion that accommodates the complexity of each subject while providing a holistic understanding of the interplay between these elements in the context of pregnant women engaging in CrossFit[®]. The results and discussion sections have been combined to streamline the presentation and to reflect the interconnected nature of the evidence and its interpretation. The final section, practical outcomes, is designed to distil the most pertinent information and recommendations from the preceding sections, offering actionable insights that bridge the gap between theoretical research and practical application.

Results

Exercising during pregnancy

Pregnancy represents a distinct life stage accompanied by extensive somatic transformations [30]. From the onset of the first trimester, hormonal alterations influence physiological processes. Key physiological adjustments encompass the cardiovascular, metabolic, respiratory, musculoskeletal, endocrine, and emotional domains [31]. Cardiovascular adaptations include a 30-50% rise in cardiac output, a 10-30 bpm increase in resting heart rate, and a 40-45% augmentation in blood volume [32, 33]. The endocrine system undergoes significant hormonal shifts, with testosterone levels increasing by up to 30%, and oestrogen, progesterone, and estradiol elevating up to eightfold. Growth hormone levels also rise [34]. The respiratory system experiences a decline in diaphragm function and a 30-50% reduction in minute ventilation. Musculoskeletal changes include weight gain (typically 8-15 kg), a shift in the centre of mass, and increased joint laxity [30].

General recommendations from various organisations (ACOG, American college of Sport Medicine, Royal College of Obstetricians and Gynaecologist, etc.) can be summarised as follows [35]. Exercise should be performed for at least 30 minutes per day at moderate intensity. Light-intensity resistance training, including pelvic muscle exercises, is advised 2–3 times a week, complemented by static or dynamic stretching. Mindbody practices such as yoga or Tai Chi are also beneficial. Safe and advantageous exercises such as walking, stationary cycling, dancing, and aerobic activities are recommended [1]. Special populations, such as pregnant women with obesity, should engage in lowerintensity activities of shorter duration. Occupational lifting should also be optimised to less than 1000 kg total per day and burdens over 20 kg not lifted more than 10 times per day [1].

The consensus across guidelines posits that exercise should be an integral component of expectant mothers' routines [35]. However, most women do not meet the recommended 150 minutes of moderate-intensity exercise weekly during pregnancy [36]. Adequate activity levels are crucial for enhancing or maintaining physical fitness and overall health, aiding in optimal weight management, and acting as a preventive and therapeutic measure against gestational diabetes, which affects up to 13.7% of pregnant women [37]. It likely reduces caesarean section risks and enhances maternal well-being [38]. Furthermore, exercise is both a preventive and therapeutic modality for low-back and pelvic pain [39].

Maternal exercise impacts the foetus as well [40]. Prenatal exercise does not adversely affect the placental or foetal weight, nor does it influence the placentalto-birth weight ratio. Morphological changes in placental tissue (parenchymal tissue volume) have also been observed [10]. Exercise frequency of ≥ 6 times per week is associated with lower birth weight but lacks clinical significance. When exercise intensity is maintained at moderate levels (up to 70% HR) with minimised highimpact activities, there is no increased risk of miscarriage or foetal distress [38]. Overall, maternal physical activity contributes to foetal well-being in terms of intrauterine nutrition and oxygen supply, and the functioning of the autonomic nervous system [40].

High-intensity exercise

High-intensity exercise constitutes a fundamental element of CrossFit[®] and significantly elevates physiological parameters such as heart rate, cardiac output, blood lactate, respiratory exchange ratio, and minute ventilation [13, 14]. It is also correlated with a high RPE. RPE is a psychophysiological scale, typically ranging from 1 to 10 or 6 to 20, used to quantify an individual's subjective assessment of physical activity intensity [14]. This self-reported metric allows individuals to gauge their effort level and exertion during exercise, correlating with physiological markers, such as heart rate and lactate concentration. Participants reach this state through traditional endurance activities, bodyweight exercises, or resistance training [41]. CrossFit[®] does not strictly define 'high-intensity' [42],

but it is understood that practitioners are not required to attain extreme physiological values (e.g., above 90% Heart rate maximum–HRmax) [43]. High-intensity CrossFit[®] activities require considerable effort, which may be characterised by an RPE of 6–7 or higher on a 10-point scale, heart rates at 70% of HRmax or above, and quick transitions between movements [43, 44].

The conventional approach during pregnancy is to prescribe moderate-intensity activities, established as safe and beneficial for both mother and foetus [45, 46]. However, many elite athletes maintain high-intensity and high-volume training during pregnancy. Clapp et al. [26] found that pregnant women in their study reduced their activity volume but still averaged 4.8 hours per week or ran 29 km per week, with heart rates ranging from 110 to 187 bpm. In the study by Kardel [27], it was observed that pregnant athletes who were competing engaged in an average of 8.4 hours of highintensity exercise weekly, while those in a medium-intensity group exercised for an average of 6 hours. This routine included interval training twice a week during which their heart rate reached between 170 and 180 beats per minute. The study notes that these exercise routines were managed by the women themselves and neither adversely affected the growth of the foetus nor resulted in any complications during pregnancy or childbirth.

In a retrospective case-control study using selfadministered questionnaires, the potential increased risks associated with high-impact and high-intensity activities during pregnancy were examined. Despite concerns, the comparative analysis between women engaging in high-impact and those in low-impact activities showed no significant differences in the rates of caesarean sections or the incidence of perineal tears [19]. It is important to note that the study also involved elite athletes who, on average, trained for 8.5 hours per week throughout their pregnancy. In a large study (N =39,187) of first-time mothers, a lower incidence of caesarean sections was observed in the high-impact activity group compared to non-exercisers and regular exercisers [22].

Insights into high-intensity exercise during pregnancy emerge from studies involving stress (ramp) tests, often consisting of treadmill walking with increasing incline and speed. Mottola et al. [47] tested 156 pregnant women, with the 'fit' group (VO₂peak \geq 27.2 mL/kg) reaching an average HRmax of 176.3 \pm 2.1 bpm. Based on these outcomes, exercising below 80% of aerobic capacity (160 bpm) is recommended. Szymanski and Satin [28] conducted similar tests on active and inactive pregnant women, with participants reaching an HRmax of 172.4 ± 11.7 bpm, while foetal heart rates were 147.9 ± 16.2 bpm. Foetal well-being was not compromised as biophysical profiles and heart tracings returned to baseline post-test.

An investigation of six Olympic-level athletes (N = 6) revealed that exercise up to 90% HRmax is safe, as foetal heart rates did not exceed 160 bpm [48]. Higher heart rates were associated with foetal bradycardia, increased umbilical artery pulsatility index, and reduced uterine artery blood flow, but these parameters normalised post-exercise.

Beetham et al. [43] reviewed randomised control trials and cohort studies applying vigorous activity (at least 70% HRmax) during the third trimester, finding no significant differences in gestational age or low birth weight risks. Vigorous/high-intensity exercise (up to 90% HRmax) is deemed a safe practice, not increasing health risks for the mother or delivery, or foetal wellbeing.

In a case study documented by Schlegel [49], the focus was on a pregnant woman participating in highintensity functional training (HIFT) over a span of 38 weeks. Throughout this period, detailed monitoring of heart activity and various physical activity parameters was conducted. The regimen comprised 3–4 weekly training sessions during which the subject consistently achieved high heart rate (HR) values, surpassing 80% of her absolute maximum HR. Notably, this high level of physical exertion did not adversely influence her fatigue levels, which were assessed using heart rate variability (HRV) SDNN indices. Further, no adverse effect on pregnancy or foetal health was found.

Despite evidence suggesting the safety of high-intensity exercise during pregnancy, research has yet to establish precise safety thresholds. Perkins and Dewalt [15] propose an RPE of 13–15 of 20 for CrossFit[®] athletes during pregnancy, though this recommendation is not research-based. RPE may be more suitable as it reflects the immediate effort sense, which can fluctuate.

Resistance training

Exercise programs for pregnant women typically incorporate a mix of resistance training and aerobic exercises, spread throughout various days. Studies have indicated that such blended regimens do not adversely affect the health of the mother or the foetus [10]. Such programs typically incorporate strength exercises utilising light weights, resistance machines, resistance band, or body weight, with prescribed sets (1–3) and repetitions (8–15), often favouring isolated exercises [39, 50]. In recent research by Prevett et al. [51], the health outcomes of 679 individuals who engaged in heavy resistance training during pregnancy were assessed. These participants, primarily recreational athletes, continued practices such as Olympic weightlifting and lifting in a supine position, as well as performing the Valsalva manoeuvre – a breathing technique where one exhales forcefully with a closed glottis, often used to stabilise the core during heavy lifting, but advised against during pregnancy due to potential impacts on blood flow. The study reported that maintaining training levels was associated with fewer reproductive complications, and most athletes returned to their pre-pregnancy exercise regimen shortly after childbirth without adverse perinatal outcomes.

A study by O'Connor et al. [50] had pregnant participants engage in a 12-week strength program, performing five exercises (2 sets of 15 reps) including leg press and lat pulldown, with intensity regulated by an RPE of up to 14 out of 20. Post-program assessments indicated strength increases of 36–56%, with no adverse blood pressure changes or other negative outcomes observed.

Barakat et al. [52] implemented a thrice-weekly program combining resistance and toning exercises, utilising up to 3 kg dumbbells and a resistance band, with 10–12 reps per exercise, aimed at medium intensity. Participants completed the regimen without issues, and no significant differences in gestational age or Apgar scores were noted compared to a control group. Similarly, Garshasbi and Faghih Zadeh [53] found that resistance training thrice weekly effectively and safely mitigated low back pain. Schoenfeld [54] further supports isolated resistance training (1–3 sets, 10–15 reps) as beneficial for maternal health and well-being.

CrossFit's unique approach merges strength and conditioning within a single session. Garnæs et al. [55] administered a composite of medium-intensity aerobic exercise (35 minutes) and resistance training (25 minutes), showing no negative impact on birth weight or neonatal and maternal delivery outcomes. Hall and Kaufmann [56] reported that resistance exercises followed by stationary cycling yielded positive perceptions from pregnant women, with significant improvements in delivery outcomes. Ramírez-Vélez et al. [57] observed increased nitric oxide production and enhanced placental oxygen metabolism following supervised aerobic and resistance exercise sessions (with resistance bands, 3 kg dumbbells, and compound movements).

In CrossFit[®] sessions, the WOD typically comprises weight or bodyweight exercises that significantly challenge and enhance endurance. Petrov Fieril et al. [58] reported no adverse effects on delivery, pain, or blood pressure following a 60-minute strength (weights up to 9 kg) and conditioning workout. Anderson et al. [24] described a CrossFit-like program where pregnant women performed high-intensity interval training (using kettlebell swing, goblet squat, palloff press, chest press, and reverse lunge) with a target RPE of 15–17 and heart rates below 90% HRmax (153–170 bpm), with no detected risks to foetal well-being.

Emerging evidence suggests that seasoned athletes may safely engage in higher-load training during pregnancy, potentially up to 90% of their current maximum capacity, and can participate in Olympic weightlifting throughout the gestation period [49]. Similarly, the incorporation of other dynamic movements, such as handstand push-ups and kipping pull-ups, in conjunction with high-intensity efforts measured by the RPE, appears to be feasible.

Studies incorporating moderate and high-intensity workouts, such as resistance exercises at 60–90% of 10 repetition maximum (RM), did not significantly impact foetal heart rate or maternal blood pressure [25, 59, 60]. Gould et al. [61] monitored intra-abdominal pressure during maximal lifts with a Valsalva manoeuvre, noting a transient increase in vascular flow index without risk.

The examination of intra-abdominal pressure in non-pregnant women during CrossFit[®] exercises provides significant insights, demonstrating slightly higher values for exercises involving external weights (such as back squats, deadlifts, and wall balls) compared to bodyweight exercises (like push-ups, lunges, and sit-ups) [62]. These results were on par with those recorded during running (up to 100 cm H₂O). Notably, the highest values, approximately three times greater, were observed during jump rope activities. This observation is corroborated by Dietze-Hermosa et al. [63], who noted lower intra-abdominal pressure when lifting 18.2 kg from the ground compared to during jump rope exercises (120 vs 153.8 cm H₂O).

It is also essential to acknowledge that women routinely handle objects in their daily lives. For instance, in early postpartum women, intra-abdominal pressure was measured while lifting a 12.5 kg child seat from a car, taking an average of 26.5 seconds. The recorded values were 53.62 ± 10.31 cm H₂O, with no notable differences in lifting techniques observed. Coleman et al. [64] analysed intra-abdominal pressure during the carrying of a 13.6 kg object in various positions, finding values ranging between 55.5 and 77.3 cm H₂O, which are comparable to those seen during a brisk walk or a sit-to-stand transition. The increase in intra-abdominal pressure is a natural occurrence during everyday activities [64]. Conventional, non-dynamic exercises of moderate intensity lead to pressure values akin to those experienced while lifting or carrying everyday objects (such as a backpack or bag), fast walking, or coughing. Such increases are not pathological and do not typically present a heightened risk [65].

It is important to note that as of this writing, no study has specifically investigated the effects of a Cross-Fit[®] program, Olympic weightlifting, or typical CrossFit[®] resistance training on pregnant women. Although existing evidence points to the safety of CrossFit[®], more rigorous randomised controlled or longitudinal studies are necessary to substantiate these findings.

Injuries in CrossFit[®]

Expectant mothers are encouraged to adhere to a consistent exercise routine, though it should be noted that certain forms of exercise may present an elevated risk of injury [1]. Activities are categorised based on potential risk into low-impact and high-impact exercises – the latter including activities such as ball sports, horseback riding, tennis, weightlifting, and CrossFit[®] [19, 22]. The primary concerns involve falls or impacts to the abdomen or torso. It is worth noting that sportsrelated injuries among pregnant women are relatively infrequent (4.1 per 1,000 hours), predominantly resulting in minor injuries such as bruises or scrapes [66].

Valuable insights have emerged from long-term hospital records attributing injuries to CrossFit[®], with the most commonly affected areas being the knee (27–34%), spine (29%), and shoulder (28.7%), although these data vary by source [21, 67–69]. The records' limitations include a lack of detailed information, such as sports or injury history and training specifics. Moreover, the data were derived from men and non-pregnant women, complicating direct risk assessments for pregnant women.

Data from retrospective cohort studies indicate that within CrossFit[®], injury rates range between 0.27 and 3.5 per 1,000 hours of training, which is comparable to the rates found in other activities such as traditional strength training, running, or non-contact sports [70, 71]. A large cross-sectional study indicates that injury risks in CrossFit[®] increase during the initial year of training, with less than three weekly sessions, and competition participation [20, 72]. Training in a licensed gym or under a coach's supervision appears to mitigate these risks [73]. The findings suggest that injuries in CrossFit[®] result not from the sport's inherent charac-

teristics (such as weightlifting or high intensity) but rather from inadequate training plans that fail to address the individual needs and appropriate difficulty levels. Therefore, CrossFit[®] can be considered comparably safe compared to fitness centre activities.

Results from a cross-sectional observational study show that stress urinary incontinence, while not classified as an injury, is more prevalent among women who participate in CrossFit[®]. The incidence rates for this condition range from 47.6% to 52.7%, and it is commonly attributed to the high-impact exercises involved in the program [17, 18, 74, 75]. Such incontinence is often associated with exercises that significantly increase intra-abdominal pressure, such as rope skipping, box jumps, and running. Weakness in pelvic floor muscles or an imbalance in strength and function between the diaphragm and pelvic muscles may contribute to this condition. Functional tests and electromyographic studies indicate that women who engage in CrossFit® have comparable or superior pelvic muscle control to non-practitioners [16, 74]. However, impacts and strenuous effort may compromise pelvic muscle control in some women, which can be mitigated through well-structured training programs.

Urinary stress incontinence during pregnancy, which can affect up to 75% of women and tends to increase with advancing gestational age, is also exacerbated by additional risk factors, such as obesity, smoking, and constipation [76]. While the relationship is not fully elucidated, a higher risk of incontinence may be associated with vaginal delivery [75]. Based on these findings, it can be expected that pregnant CrossFit[®] athletes may have an elevated risk of stress urinary incontinence, which can be considered a health limitation that should be taken into account.

Practical applications

The recommendations herein are derived from a comprehensive synthesis of findings from broader exercise research as well as specific studies pertaining to Cross-Fit[®]. CrossFit[®] is accessible to all, offering scalable modifications to meet individual needs. This scaling encompasses adjusting the exercise difficulty, volume, and selection, ensuring the suitability of each workout [15]. For pregnant women, scaling should be adapted for each trimester, and it may be prudent to minimise or eliminate exercises such as jump rope, box jumps, rope climbs, snatches, cleans (due to bar contact), bar muscleups, running, and sit-ups. However, running is a natural activity that can be well tolerated in many cases [26].

Previous studies have employed light weights (3-6 kg) for participants who were healthy but not at an elite or professional athletic level and not possessing extensive strength training experience [52, 77]. For someone who does not exercise regularly, lifting 5 to 10 kilograms could be quite challenging, whereas a trained athlete can handle significantly higher weights. Resistance training can be effectively performed at up to 70% of an individual's current onerepetition maximum. During the WOD, it is recommended to maintain RPE at or below 7 on a 10-point scale, or 15-17 on a 20-point scale, while keeping heart rates below 170 beats per minute for workouts that typically last between 5 to 20 minutes. Ideally, these exercises should be performed under supervision. In the absence of conclusive evidence, exercises such as Olympic weightlifting and dynamic movements should be undertaken with caution or appropriately modified to ensure safety and correct technique. Additionally, it is advisable to avoid the Valsalva manoeuvre, a diaphragmatic breathing technique commonly used in strength-based sports, during pregnancy.

A significant factor is the individual's pre-pregnancy training program, which informs the body's physical and mental adaptation to exercise. Women accustomed to high-intensity workouts may continue to manage and even benefit from such routines, albeit with monitored intensity (using heart rate, % 1 RM) to correlate subjective exertion with objective measures [19, 27]. Beginners should approach CrossFit[®] with caution, starting at low intensity and incrementally increasing both volume and intensity.

Adherence to general contraindications for exercise – such as vaginal bleeding, dizziness, chest pain, or decreased foetal movement – is imperative, regardless of the activity type [45]. Before initiating an exercise program, women should undergo a basic health check, a physical fitness assessment, and an evaluation of work and leisure activities [35]. The program should be designed by a qualified professional who can also educate the expectant mother on the benefits and potential risks of exercise [78]. The overarching goal for the mother-to-be is to maintain or establish a regular exercise regimen, experience positive feelings post-exercise, and overcome any fear of movement or misconceptions about training [79].

Conclusions

An optimal training program during pregnancy is crucial for maternal health and proper foetal growth. CrossFit[®], widely popular among women of reproductive age, necessitates an evaluation of its benefits and risks to ascertain its suitability during pregnancy. While no studies have specifically assessed the effects of CrossFit[®] on pregnant women, the current literature suggests that when supervised by professionals, the activity is safe and effective for both maternal and foetal health. Despite CrossFit's high-impact nature, the likelihood of injury is minimal when training is supervised or professionally prescribed. High-intensity exercises within a WOD, with an RPE up to 7 on a 10-point scale, are generally safe if perceived positively by the participant. Free weight strength training, up to 70% of the current 1 RM, is also considered lowrisk, although certain movements should be approached with caution. For beginners, it is advisable to start with low intensity and gradually increase difficulty. It is essential to prioritise the mother's comfort with each movement and intensity level, and to adhere to medical guidelines. These recommendations pertain to healthy women not categorised as high-risk pregnancies.

Ethical approval

The conducted research is not related to either human or animal use.

Disclosure statement

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Conflict of interest

The authors state no conflict of interest.

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