Evidence-Based and Practice-Oriented Guidelines for Exercising During Pregnancy

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Abstract

Physical activity is associated with health benefits during pregnancy, delivery, and the postpartum period. The last three decades produced an increasing amount of scientific evidence on the positive effects of the prenatal physical activity on the maternal and fetal health, as well as in pregnancy outcomes. However, authors from different countries observe insufficient level of physical activity in pregnant women. The lack of information among women on the exercises during pregnancy, and lack of social support are two of the reasons hindering engagement in a prenatal exercise program. According to other studies, the knowledge of health benefits can lead to more favorable attitudes toward exercise during pregnancy, among women, exercise professionals, and healthcare providers. The purpose of this chapter is to review the information provided in the current guidelines for exercise during pregnancy in different countries, regarding the contents related to prenatal exercise programs. We analyzed the changes in recommendations over the past 4 years. Nowadays, experts emphasize the need to limit sedentary behaviors in

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pregnant women and to individualize exercise, departing from the total limitation of physical activity and bed rest even in complicated pregnancies. There is a more open approach to the continuation of vigorous sports activities during pregnancy by previously physically active women or female athletes.

Keywords

Guidelines · Exercise · Physical activity · Pregnancy · Postpartum

7.1 Introduction

Physical activity is associated with many health benefits during pregnancy, delivery, and in the postpartum period. Research over the past 30 years has shown that regular physical activity during pregnancy has a positive effect on the physical and psychological conditions of the pregnant woman, pregnancy and fetal development, parturition, and the postpartum period [1–5]. Physical activity started in pregnancy may be the first step to a lifelong change to a health-promoting lifestyle [6]. Research has also proved that prenatal physical activity of mothers has a long-term effect on the health of the children, including a reduction in the risk of obesity in later life [3, 7, 8].

With the increasing amount of scientific evidence on the positive effects of the prenatal physical activity, the authors from different countries observe its insufficient level in pregnant women [9–19]. As the reasons for this phenomenon, the authors list among other things: lack of information among women on the exercises during pregnancy [13, 18] and lack of social support [20, 21]. For some women, pregnancy itself is a sufficient reason for not exercising [19, 20].

There have been few studies regarding the level of pregnant women's knowledge and their attitudes toward prenatal physical activity [22–25]. Gouveia et al. [25] noted that although most mothers in Portugal understand the benefits of physical activity in pregnancy, which does not seem to increase their participation. However, according to other studies, the knowledge of health benefits can lead to more favorable attitudes toward exercise during pregnancy among women from different countries [23, 24, 26]. Cannella et al. [23] showed that women who were informed about the benefits and risks of physical activity, risks of inactivity and also about the exercise techniques, displayed more favorable attitudes toward prenatal physical activity. Many of the women surveyed in their study reported that they had received information about the benefits of prenatal physical activity, but fewer answered that they had received information about how to exercise safely.

The importance of healthcare professionals in promoting the benefits of physical activity and exercise, and advising women on a healthy and active lifestyle during pregnancy, referring them to a prenatal exercise specialist is highlighted in Chap. 1 [27]. Official guidelines for exercise in pregnancy could be an effective tool in fulfilling this task. Tanha et al. [26] have proved that dissemination of such documents among pregnant women contributes significantly to the increase in their participation in prenatal exercise. Official guidelines published by national and international obstetrics, gynecology, or sports medicine institutions should be a trustworthy and comprehensive source of information on the safe and beneficial exercise program

during pregnancy. They should be accessible to all interested in prenatal physical activity: pregnant women and their families, obstetric care providers, and exercise professionals to enable an effective cooperation in the exercise program design.

Pregnancy causes many changes in the woman's body: morphological, physiological, biomechanical, and psychological [28]. This should be taken into account in the planning of the intensity, frequency, and duration of the exercise sessions and also of their content—through a proper selection of the type of exercises and their technique [29–31]. Evenson et al. [32] have shown that nine out of ten guidelines on exercise in pregnancy from different countries contained information on the intensity and duration of exercise. Eight of these documents contained recommendations on the exercise frequency. In this chapter, we aimed to answer the question on what information on the contents of prenatal exercises is provided in the current guidelines for exercise during pregnancy in different countries. The second question was what significant changes have occurred in the approach to exercise in pregnancy in the last 4 years.

We have updated a review study published in 2015 [33] that was focused on detailed information on the contents of prenatal exercises presented in reliable guidelines. The methodological issues are fully described in the original paper. In the first edition of this book, we have analyzed 13 papers. In this edition, we included 11 recent documents, published after 2017. In the following part of this work, depending on the year of publication, we call these documents "old guidelines" (published until the end of 2017) or "new guidelines" (published after 2017). All documents included in the analysis are the official position of national obstetrics, gynecology, or sports medicine institutions on exercise in pregnancy. We have narrowed the documents to those published in English, which ensures their wide usage. The first stage of the update began with a search of documents in the scientific database MEDLINE, with full text. Bearing in mind that the guidelines need not have the character of scientific work, and only represent the official position of credible national institutions; in the second stage, we completed the search of documents in public search engines. We used the keywords: "exercise" or "physical activity" and "pregnancy" and "guidelines" or "statement." The 15th of July 2021 was the last date searched.

In the first stage of the analysis, we looked for the general recommendation on the type of exercise, information on the recommended and not recommended forms of exercise and sports activities for pregnant women. In the second stage of the analysis, we looked for detailed information that might be useful for designing the contents of targeted exercise classes for pregnant women, including special pregnant populations like elite athletes or women with specific health conditions.

7.2 General Features of the Guidelines on Physical Activity in Pregnancy

In the previous edition of this book, we have analyzed 13 documents from seven countries: Australia [34, 35], Canada [36, 37], Denmark [38], Norway [39], South Africa [40], United Kingdom [41], USA [42–45], and an international document supported by the International Olympic Committee [1, 2, 46] (Table 7.1). In this

edition, we have added 11 documents from five countries: Australia [47–49], Canada [50], United Kingdom [51], USA [52–55], and New Zealand [49], and two international documents: one supported by the International Olympic Committee (IOC) [56] and one developed by the World Health Organization (WHO) [57] (Table 7.2). In five documents, authors presented the full methodology of scientific reports selection and evidence quality assessment. Those five documents were affiliated by The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG), The Society of Obstetricians and Gynaecologists of Canada together with The Canadian Society for Exercise Physiology (SOGC/CSEP), The American College of Obstetricians and Gynecologists (ACOG), the IOC and WHO. Four documents, published by Sport Medicine Australia (SMA), Australian Government. Department of Health (AGDH), American College of Sports Medicine (ACSM), Exercise is Medicine/American College of Sports Medicine (EIM/ACSM) are layman-oriented brochures. National Health Service (NHS) guidelines are published entirely online and contain two short videos with exercise examples. All of these materials met our criteria for inclusion in the analysis (were published in English and were the most recent country-specific, official position of national obstetrics, gynecology, or sports medicine institutions).

In our previous guidelines, revision completed at the end of 2017, the year of their publication was a striking feature (Table 7.1). Only five of the 13 documents were published 5 years earlier than that date. For obvious reasons, they were based on scientific works that had been frequently 15 or more years old. Since 2018, 11 new documents on exercise in pregnancy have been released. The advances in the scientific evidence about the effect of physical activity on pregnant women's health have made necessary the update of the main guidelines on this issue.

Both in the scientific research on prenatal physical activity [26, 58, 59], and in educational standards [60], as well as in exercise programs [30], the authors refer to

Table 7.1 Characteristics of analyzed guidelines on exercise in pregnancy, published by the end of 2017

Country	Organization	Title	Year of publication
Australia	Sport Medicine Australia (SMA) [34]	SMA statement:	2002
		The benefits and risks of exercise during pregnancy	Updated 2016 [34]
Australia	Fitness Australia. The Health & Fitness Industry Association [35]	Pre and post-natal exercise guidelines	2013
Canada	Society of Obstetricians and Gynaecologists of Canada;	Exercise in pregnancy and the postpartum period	2003
	Canadian Society for Exercise Physiology SOGC/CSEP [36]		

Table 7.1 (continued)

Country	Organization	Title	Year of publication
Canada	Canadian Academy of Sport and Exercise Medicine (CASEM) [37]	Position statement:	2007
		Exercise and pregnancy	updated 2008
Denmark	National Board of Health [38]	Healthy habits before, during and after pregnancy. First English edition	2010
Norway	Directorate for Health and Social Affairs [39]	A National Clinical Guideline for Antenatal Care. Short Version—Recommendations	2005
South Africa	South African Sports Medicine Association (SASMA) [40]	South African Sports Medicine Association Position Statement on Exercise in Pregnancy	2012
United Kingdom	Royal College of Obstetricians and Gynaecologists (RCOG) [41]	Exercise in pregnancy	2006
United States	American College of Obstetricians and Gynecologists (ACOG) [42]	Committee Opinion: Exercise during	2002
		pregnancy and the postpartum period	Reaffirmed in 2009
			Updated in 2015 [42]
United States	U.S. Department of Health and Human Services (U.S. DHHS) [43]	Physical Activity for Women During Pregnancy and the Postpartum Period	2008
		Chapter in: 2008 Physical Activity Guidelines for Americans	
United States	American College of Nurse-Midwives (ACNM) [44]	Exercise in Pregnancy	2014
United States	American College of Sports Medicine (ACSM) [45]	Current Comment: Exercise during Pregnancy	Not reported
International	International Olympic Committee (IOC); three parts [1, 2, 46]	Exercise and pregnancy in recreational and elite athletes: 2016 evidence summary from the IOC expert group meeting, Lausanne.	2016

the official guidelines for exercise in pregnancy. Although it is difficult to estimate the extent of their impact, the contribution of these documents to change the perception on prenatal physical activity in the past decades is indisputable.

The guidelines issued 30 years ago suggested that exercising women reduce their habitual levels of exertion in pregnancy and that non-exercising women refrain from initiating strenuous exercise program [61]. Such conservative recommendations were based, among others, on the results of scientific studies demonstrating the

Table 7.2 Characteristics of analyzed guidelines on exercise in pregnancy, published after 2017

Country	Organization	Title	Year of publication
Australia	Sport Medicine Australia (SMA) [47]	Exercise in pregnancy (layman oriented brochure)	Not reported Access 2021
Australia	Australian Gavernment. Department of Health (AGDH) [48]	Guidelines for physical activity during pregnancy (layman oriented brochure)	2021
Australia and New Zealand	Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) [49]	Exercise in Pregnancy	2020
Canada	Society of Obstetricians and Gynaecologists of Canada; Canadian Society for Exercise Physiology SOGC/CSEP [50]	2019 Canadian guideline for physical activity throughout pregnancy	2018
United Kingdom	National Health Service NHS [51]	Exercise in pregnancy (online materials on the official webpage)	2020
United States	American College of Obstetricians and Gynecologists (ACOG) [52]	Committee Opinion: Exercise during pregnancy and the postpartum period	2020
United States	American College of Sports Medicine (ACSM) [53]	ACSM information on Pregnancy Physical Activity (layman oriented brochure)	2020
United States	Exercise is Medicine/ American College of Sports Medicine (EIM/ ACSM) [54]	Being Active during Pregnancy (layman oriented brochure)	2019
United States	U.S. Department of Health and Human Services (U.S. DHHS) [55]	Key Guidelines for Women During Pregnancy and the Postpartum Period; Section in: Physical Activity Guidelines for Americans, second edition	2018
International	International Olympic Committee (IOC) [56]	Exercise and pregnancy in recreational and elite athletes: 2016/2017 evidence summary from the IOC expert group meeting, Lausanne. Part 5. Recommendations for health professionals and active women	2018
International	World Health Organization WHO [57]	World Health Organization 2020 guidelines on physical activity and sedentary behavior	2020

negative effects of hard physical work, combined with undernutrition, on the development of pregnancy in laboratory animals [62, 63]. However, the results of research conducted on pregnant women have proved that those assumptions do not apply to people [1, 13, 64–66]. With the current evidence about the positive impact of prenatal exercise on maternal and child health, increasingly, the question is not "if" but "how" pregnant woman should exercise [61].

The breakthrough was the recommendation published in Canadian guidelines in 2003 that "All women without contraindications should be encouraged to participate in aerobic and strength-conditioning exercises as part of a healthy lifestyle during their pregnancy" [36]. ACOG [67] and SMA [68] issued similar recommendations in 2002 and in their latest updates [34, 42]. Finally, in 2015, the ACOG recommendations were updated emphasizing that physical activity in pregnancy has minimal risk and highlighting that women who exercised regularly prior to pregnancy, in the absence of contraindications, can continue and engage in moderate to strenuous activities [42]. Also in this update, several activities were introduced as recommended activities if pregnant women practiced them prior to pregnancy (i.e., aerobics, jogging, running, or stationary cycling). It should be emphasized that it was the first document where physical inactivity has been treated as a risky behavior leading among others to maternal obesity and related pregnancy complications, including gestational diabetes mellitus.

The Sports Medicine Australia recommendations were first updated in 2016 [34], increasing the specification of the recommended physical activities during pregnancy (i.e., resistance training, swimming, or jogging) and introducing pelvic floor exercises as a recommended activity to include in exercise programs during pregnancy. In 2016 and 2017, Bø et al. and the Medical and Scientific Commission of the International Olympic Committee (IOC) drove a discussion about the management of pregnancy for elite athletes, and produced comprehensive evidence summary on exercise during pregnancy [1, 2] and postpartum [46], as well as recommendations for future research [69]. The last part of this report series, published in 2018, has been directed at health professionals and very active women [56].

All new guidelines are in agreement that physical activity in pregnancy is safe and desirable in the absence of obstetrics and medical complications or contraindications and that pregnant women should be encouraged to continue or initiate safe physical activities. Interestingly, the SMA experts emphasized that "there are currently NO known adverse risks associated with meeting the recommended guidelines of at least 150 min of moderate-vigorous physical activity per week" ([47], p. 1). Experts are clearly changing the approach to exercise in complicated pregnancy. In the event of complications, it is more and more often recommended to consult a specialist and individualize physical activity, rather than limiting it completely [48–50, 52, 53].

The fact that for the first time in 2020 the World Health Organization provides specific recommendations on physical activity for pregnant and postpartum women [57] highlights the increasing importance of this topic. For the first time, specific international guidelines emphasizing the need to reduce sedentary behaviors by pregnant women have been presented.

7.3 Exercise Prescription Considering Pre-pregnancy Habits Related to Physical Activity and the Course of Pregnancy

Two of the old guidelines [34, 42] highlighted the importance of considering the habits of pregnant women related to physical activity and exercise prior to pregnancy in order to individualize the prescription of exercise during pregnancy. Since 2018, the experts differentiate recommendations on prenatal exercise for women with different pre-pregnancy physical activity habits in all documents.

7.3.1 Previously Inactive Pregnant Women

According to the old guidelines, the prescription of an exercise program in previously inactive pregnant women should commence with low-intensity activities such as walking or swimming, initially accumulated in short bouts, and follow a gradual progression up to the minimum level of the physical activity and exercise recommendations [42]. A walking program may be a good option for previously inactive pregnant women to become physically active [70], because it has been demonstrated that even mild walking (30% of peak aerobic capacity) improves fitness levels in sedentary women during pregnancy [71]. In the new guidelines, it is emphasized that previously inactive pregnant women should start with a small amount of physical activity and gradually increase the amount and intensity over time based on their own possibilities. Walking and swimming are still the recommended forms of exercise for previously inactive pregnant women.

7.3.2 Previously Active Pregnant Women

Two of the old guidelines [34, 42] addressed the issue of continuing physical activity by previously active women. According the ACOG and SMA experts, pregnant women with habits of physical activity or exercise prior to pregnancy and without obstetrics complications could continue their physical activity or exercise habits throughout pregnancy or until it caused any discomfort [34, 42]. Already in 2015, ACOG stated that pregnant women who were regular exercisers before pregnancy and do not present obstetrics complications were able to engage in high-intensity exercise programs. When high-intensity or prolonged exercise exceed 45 min, they should take into account a proper caloric intake and hydration before, during, and after exercise to minimize the risk of hypoglycemia [42].

Recommendations on the potential continuation of a physical activity exceeding the recommended minimum level or of high intensity are much more popular in the new documents. They were mentioned in 10 of 11 guidelines analyzed [47–50, 52–57].

7.3.3 Elite or Competitive Athletes

The statements endorsed by IOC [1, 2, 46] include scientific evidence about endurance and strength training in elite athlete during pregnancy. In addition, the IOC pointed out that future research should focus on the effects and obstetric risks of specific types of exercise, training place, or strenuous exercise. There is also a need to improve the knowledge on the influence of physiological and anatomical changes related to pregnancy on the training development, or influence of training during pregnancy on the return to the competitive level in the postpartum period. The last part of IOC work [56] is focused on the recommendations for female athletes who want to combine their training regimes with motherhood and to compete during the years of optimal fertility.

Pregnant women who are elite or competitive athletes need to maintain a more strenuous training schedule throughout pregnancy and resume high-intensity postpartum training sooner as compared to non-athlete pregnant women [42]. Their training program should be managed by experts that ensure the safety and well-being of the mother and the child [34]. Although an upper level of safe exercise intensity has not been established, women who were regular exercisers before pregnancy and who have uncomplicated, healthy pregnancies should be able to engage in high-intensity exercise programs. Particular attention should be paid to avoid weight loss and hyperthermia through a proper caloric intake and hydration before, during, and after exercise [42].

Studies show transient fetal bradycardia when the pregnant elite athlete exercises at above 90% of maximal maternal heart rate (HR), but whether these transient fetal HR changes influence neonatal outcomes is unknown. However, to be appropriately cautious, IOC does not recommend maximum rate of oxygen consumption (VO_{2max}) testing and exercise above 90% of VO_{2max}, except in highly supervised (research) settings. Until more data are available in respect of strength training, athletes who prior to pregnancy developed heavy strength training should avoid Valsalva maneuver and large increases in intra-abdominal pressure which may temporarily decrease uteroplacental blood flow [1]. The repercussions to the fetus of these temporary changes remain unknown. Avoiding Valsalva maneuver by exhaling with an open airway also seems prudent [72].

In the absence of studies in elite athletes, IOC agreed that female athletes might consider refraining from repetitive heavy lifting efforts in the first trimester of pregnancy to avoid the potential risk of miscarriage. However, as IOC emphasized, these recommendations are based on low-quality evidence. Available studies were retrospective and based on participant's self-reports, conducted to assess the influence of lifting loads in occupational tasks, not in sport training. Indeed, Juhl et al. [73] observed that women with occupational lifting were more likely to have a first-trimester miscarriage than women with no lifting. Nevertheless, they also noted that women with occupational lifting were more likely to smoke and less likely to engage in physical exercise. Undoubtedly, there is a need for well-designed research on the course of pregnancy, labor and delivery, and fetus development in heavy-lifting athletes to support them with reliable information in terms of the safety of their training process.

The latest update of the ACOG document [52] still emphasizes maintaining proper hydration, avoiding hyperthermia and sustaining adequate caloric intake to prevent weight loss that may affect fetal growth. The ACOG experts stated that pregnant elite athletes should consider a reduction of the pre-pregnancy resistance load and avoid high-impact activities with increased risk of blunt trauma.

Currently, the participation of pregnant women in strenuous sports training and competitions is becoming more and more acceptable. Under some of the new guidelines, when considering athletic competition, or exercising significantly above the recommended levels, pregnant women should seek supervision from a specialist health-care provider [47, 48, 50, 52, 53, 56, 57]. On the other hand, the RANZCOG experts mentioned that regardless of baseline level of fitness and previous exercise routine, pregnancy is not a time for serious competition or aiming to reach peak lifetime fitness [49].

7.3.4 Pregnant Women with Obesity

In three new documents from: Australia and New Zealand [49], Canada [50], and USA [52], the experts individualized recommendations on exercise for pregnant women with obesity. In line with the ACOG guidelines [42, 52], women with obesity should be encouraged to engage in exercise and nutritional interventions aimed at a healthier lifestyle. To start such interventions, low-intensity and short periods of exercise should be considered and gradually increased adequately to the women's exercise capacities. For overweight or obese women, RANZCOG also recommends a shorter duration of exercise (15–20 min) at the commencement of a program, before slowly building up to 30 min.

7.3.5 Exercising in Complicated Pregnancy

What is a completely new approach, in 2020 the ACOG experts removed the list of absolute or relative contraindications to exercise in pregnancy. Instead, they recommend consultation with specialist (i.e., obstetrics and gynecology, maternal-fetal medicine, cardiology, pulmonology) when questions regarding exercise safety exist [52]. In case of obstetric or medical comorbidities, exercise regimens should be individualized. Finally, this ACOG guidelines update advises against activity restrictions in the primary prevention of preeclampsia or preterm birth, which was a common practice in the obstetric care.

According to the RANZCOG guidelines [49] for those women with pregnancy complications, the promotion of exercise may still be appropriate under some circumstances with appropriate medical evaluation and suitable modification of the exercise prescription. In line with the Canadian recommendations, "women with absolute contraindications may continue their usual activities of daily living but should not participate in more strenuous activities. Women with relative contraindications should discuss the advantages and disadvantages of moderate-to-vigorous intensity physical activity with their obstetric care provider prior to participation"

([50], p. 1340). The Canadian experts listed the absolute and relative contraindications to exercise during pregnancy. However, they are far from completely limiting physical activity in the event of these contraindications. A similar approach is presented in the AGDH guidelines [48].

Importantly, the list of contraindications to prenatal physical activity have been substantially modified [50], based on scientific evidence. Meah et al. [74] found that a majority of medical conditions listed as contraindications were based on expert opinion. They identified 11 complications (e.g., gestational hypertension, twin pregnancy) previously classified as contraindications where women may in fact benefit from regular prenatal physical activity with or without modifications.

The routinely prescribed "bed rest" has been strongly criticized by the ACOG experts since 2015 [42, 52]. They highlight the negative health consequences of this practice, such as the risk of thromboembolism, bone demineralization, and deconditioning of the pregnant patient and also the negative psychosocial effects impacting not only the mother but the whole family as well. So far, there are no studies documenting an improvement in outcomes in women at risk for preterm birth who are placed on activity restriction, including bed rest. Taking the above into account, Jain [75] appeals that bed rest should not be treated "as a panacea for all that ails the gravida." Based on available evidence from multiple Cochrane reviews, prescribing bed rest to pregnant patients was even called unethical [76].

7.3.6 Recommendations to Reduce Time Spent in Sedentary Behavior

The WHO guidelines [57] emphasize that in pregnant women, as in all adults, higher levels of sedentary behavior are associated with the following poor health outcomes: all-cause mortality, cardiovascular disease mortality and cancer mortality and incidence of cardiovascular disease, cancer, and incidence of type 2 diabetes. Therefore, pregnant women should be encouraged to reduce the sedentary time.

The WHO experts advise pregnant women to replace sedentary time with any intensity of physical activity, including light intensity. This general recommendation "moving more and sitting less" [77] is exactly the same as for others populations. Furthermore, the previous recommendation for exercise bouts of at least 10-min duration has been removed. Scientific evidence shows that physical activity of any bout duration is associated with improved health outcome [78]. The WHO experts underline that "doing some physical activity is better than doing none" ([57], p. 8), which is in line with the public message "every step counts."

Similar approach has been presented in NHS, EIM, and U.S. DHHS guidelines [51, 54, 55]. The EIM experts suggest pregnant women add more steps by taking the stairs or parking farther away, go for a 10-min walk after two of daily meals and try "walking meetings" when women need no computer or pen and paper. They also add that activities like raking the lawn or heavy vacuuming count toward the weekly activity. Likewise, the AGDH [48] and RANZCOG [49] guidelines state that it is

important to reduce sedentary behavior by minimizing the amount of time spent in prolonged sitting or standing still and breaking up long motionless periods as often as possible. Nowadays, there is growing evidence that breaking up prolonged sedentary time leads to health benefits [79].

When individuals do not meet the minimum physical activity levels, they should start with small amounts of physical activity and gradually increase frequency, intensity, and duration over time. However, more physical activity is better for optimal health. The Canadian guidelines [50] advise pregnant women to undertake more than the recommended levels of moderate-to-vigorous physical activity for greater health benefits. This is in line with the public message that not just the fulfillment of the minimum recommendations is important. Undertaking more than the recommended levels of physical activity may reduce the detrimental potential effects of high levels of sedentary behaviors on health [80].

7.4 Recommended Types of Exercise and Forms of Sports Activities for Pregnant women

For an exercise program to be effective, it must take into account four training components: intensity, frequency, duration, and proper type of exercise [29]. The work by Evenson et al. [32] shows that the guidelines for exercise in pregnancy contain much more information on the intensity, frequency, and duration than on the contents of exercise programs. In fact, the contents of prenatal exercise seem to be particularly important for pregnant women, because during this period, through physical activity, they should pursue both their overall objectives of promoting their own health and maternity.

In Tables 7.3, 7.4, 7.5, and 7.6, we presented the results regarding the general recommendation on the type of exercise and information on the recommended and not recommended forms of exercise and sports activities for pregnant women.

All guidelines published by the end of 2017 contained general recommendations to perform aerobic exercises, 12 of them—to perform resistance exercises and two of them—flexibility exercises (Table 7.3). All new guidelines also advised pregnant women to participate in aerobic activities, as well as in resistance exercise; eight of them—to perform flexibility exercises. The forms of physical activity recommended for pregnancy were listed in 11 old and in eight new documents. In the old guidelines, the most frequently mentioned were walking and swimming (in 9 out of 13). Other recommendations included inter alia: aerobics, water exercise, jogging, cycling (especially stationary), running, and cross-country skiing. The new guidelines also listed walking most frequently (in 8 out of 11 documents). New mentioned forms were stretching [50, 52, 54] and everyday activities [50, 54], like climbing the stairs, raking the lawn or heavy vacuuming. Certainly, in terms of biomechanical analysis, these forms of exercise are very beneficial for pregnancy, but it can be expected that they would not meet the interests and needs of all pregnant women of different countries. And here comes the controversial question

Table 7.3 Guidelines on the type of exercise and forms of sports activities recommended in pregnancy, published by the end of 2017

	Australia (SMA) 2016	Australia (FA) 2013	Canada (SOGC/ CSEP)	Canada (CASEM)	Denmark	Norway	South Africa (SASMA)	United Kingdom (RCOG)	United States (ACOG) 2015	United States (ACNM)	United States (ACSM)	United States (U.S. DHHS)	International (IOC) 2016
General recommendation on the type[a] of exercise:													
Aerobic exercise[b]	+	+	+	+	+	+	+	+	+	+[c]	+[c]	+	+
Strengthening exercise[d]	+	+	+	+	+	+	+	+	+	+[c]		+	+
Flexibility exercise		+											+
Recommended forms[e] of exercise and sports activities:													
Aerobics[f]	+	+				+	+	+	+	+	+		
Cross-country skiing			+	+			+						
Cycling	+				+	+	+			+			
Dancing						+	+						
Exercise in water	+	+	+		+			+	+		+		
Gymnastics						+							
Hiking							+						
Jogging	+					+	+	+	+[g]		+		
Pilates									Modified +				
Racquet sports									+[h]				
Rowing							+						
Running	+						+		+[g]				
Stationary cycling	+		+	+			+		+		+		

(continued)

Table 7.3 (continued)

	Australia (SMA) 2016	Australia (FA) 2013	Canada (SOGC/ CSEP)	Canada (CASEM)	Denmark	Norway	South Africa (SASMA)	United Kingdom (RCOG)	United States (ACOG) 2015	United States (ACNM)	United States (ACSM)	United States (U.S. DHHS)	International (IOC) 2016
Strengthening training	+	+			+				+[g]	+			
Swimming	+		+	+	+	+	+		+	+	+		
Targeted prenatal classes	+	+						Aqua natal					
Walking	+		+	+	+	+	+		+	+	+		
Yoga									Modified +	+			
An advice to consult health care provider on the type of exercise:	+	+	+		+				+	+	+	+	

[a]Based on the provided health benefits

[b]Also called an endurance exercise or cardio exercise; in this kind of exercise, the body's large muscles move in a rhythmic manner for a sustained period of time. Brisk walking, running, bicycling, jumping rope, and swimming are all examples

[c]Based on the recommended forms of sports activities

[d]We searched for the information on muscle-strengthening exercise, also called resistance exercise (this kind of exercise causes the body's muscles to work or hold against an applied force or weight)

[e]Based on the specific nature of the movements, skills, equipment, the environment and the rules that determine participation in it

[f]Is a form of exercise that combines rhythmic aerobic exercise with stretching and strength training routines with the goal of improving all elements of fitness (flexibility, muscular strength, and cardiovascular fitness). It is usually performed to music and may be practiced in a group setting

[g]Recommended if a pregnant woman developed this activity prior to pregnancy

[h]Racquet sports wherein a pregnant woman's changing balance may affect rapid movements and increase the risk of falling should be avoided as much as possible

Table 7.4 Guidelines on the type of exercise and forms of sports activities recommended in pregnancy, published after 2017

	Australia (SMA) 2021	Australia AGDH 2021	Australia and New Zealand 2020	Canada (SOGC/ CSEP) 2018	United Kingdom (NHS) 2021	United States (ACOG) 2020	United States (ACSM) 2020	United States (EIM/A CSM) 2019	United States (U.S. DHHS) 2018	International (IOC) 2018	International (WHO) 2020
General recommendation on the type[a] of exercise:											
Aerobic exercise[b]	+	+	+	+	+	+	+	+	+	+	+
Strengthening exercise[c]	+	+	+	+	+	+	+	+	+	+	+
Flexibility exercise	+		+	+	+	+	+	+			+
Recommended forms[a] of exercise and sports activities:											
Aerobics[d]	+[e]				+	+	+[e]				
Cycling		+									
Dancing		+			+	+		+			
Everyday activity				+				+			
Exercise classes		+									
Exercise in water/Aquafit/ in a pool			+	+		+		+			
Jogging	+						+[f]				
Pilates						+[g]	+[g]				
Running				+[f]	+		+[f]				
Stationary cycling	+		+	+		+		+			

(continued)

Table 7.4 (continued)

	Australia (SMA) 2021	Australia AGDH 2021	Australia and New Zealand 2020	Canada (SOGC/ CSEP) 2018	United Kingdom (NHS) 2021	United States (ACOG) 2020	United States (ACSM) 2020	United States (EIM/A CSM) 2019	United States (U.S. DHHS) 2018	International (IOC) 2018	International (WHO) 2020
Racket sports							+[f]				
Resistance training						+[f]	+				
Stretching				+		+		+			
Swimming	+	+	+	+	+		+				
Walking	+	+	+	+	+	+	+	+			
Yoga				+	+	+[g]	+[g]				

[a]Based on the provided health benefits

[b]Also called an endurance exercise or cardio exercise; in this kind of exercise, the body's large muscles move in a rhythmic manner for a sustained period of time. Brisk walking, running, bicycling, jumping rope, and swimming are all examples

[c]We searched for the information on muscle-strengthening exercise, also called resistance exercise (this kind of exercise causes the body's muscles to work or hold against an applied force or weight)

[d]Is a form of exercise that combines rhythmic aerobic exercise with stretching and strength training routines with the goal of improving all elements of fitness (flexibility, muscular strength, and cardio-vascular fitness). It is usually performed to music and may be practiced in a group setting

[e]Low⁻ impact aerobics was recommended

[f]Recommended if a pregnant woman participated in this activity prior to pregnancy

[g]Modified

Table 7.5 Guidelines on the type of exercise and forms of sports activities not recommended in pregnancy, published by the end of 2017

	Australia (SMA) 2016	Australia (FA) 2013	Canada (SOGC/ CSEP)	Canada (CASEM)	Denmark	Norway	South Africa (SASMA)	United Kingdom (RCOG)	United States (ACOG) 2015	United States (ACNM)	United States (ACSM)	United States (U.S. DHHS)	International (IOC) 2016
Sports mentioned as risky in pregnancy:													
"Hot yoga" or "hot Pilates"									+				
Basketball						+			+	+		+	
Bobsledding													+
Cricket	+												
Cycling											+		
Diving/ Scuba diving	+		+		+	+	+	+	+	+	+		+
Downhill skiing	+			+		+	+		+	+		+	+[a]
Generally contact sports	+	+						+	+				
Gymnastics	+			+			+		+	+	+		
Handball						+							
Hang gliding							+						
Heavy weightlifting	+				+				+[b]	+			+[b]
Horseback riding	+			+		+	+		+	+		+	

(continued)

Table 7.5 (continued)

	Australia (SMA) 2016	Australia (FA) 2013	Canada (SOGC/ CSEP)	Canada (CASEM)	Denmark	Norway	South Africa (SASMA)	United Kingdom (RCOG)	United States (ACOG) 2015	United States (ACNM)	United States (ACSM)	United States (U.S. DHHS)	International (IOC) 2016
Ice hockey	+					+			+	+			+
Luge													+
Martial arts	+												
Off-road cycling									+				
Pole vaulting													+
Skating	+						+						
Sky-diving	+								+				
Soccer	+						+		+	+		+	
Softball	+												
Surfing									+				
Vigorous racket games							+		+	+			
Water skiing	+						+		+				

[a]Downhill ski racing

[b]Referring to low to moderate level of evidence for a negative effect of occupational lifting, female athletes may consider refraining from repetitive heavy lifting efforts in the first trimester to avoid the potential risk of miscarriage

Table 7.6 Guidelines on the type of exercise and forms of sports activities not recommended in pregnancy, published after 2017

	Australia (SMA) 2021	Australia (AGDH) 2021	Australia and New Zealand 2020	Canada (SOGC/ CSEP) 2018	United Kingdom (NHS) 2021	United States (ACOG) 2020	United States (ACSM) 2020	United States (EIM/A CSM) 2019	United States (U.S. DHHS) 2018	International (IOC) 2018	International (WHO) 2020
Sports listed as "to be avoided" in pregnancy:											
"Hot yoga" or "hot Pilates"						+	+	+			
Artistic gymnastics										+[a]	
Basketball							+	+	+	+[a]	
Bobsledding										+[a]	
Cycling				+							
Diving/Scuba diving	+	+		+	+	+	+	+		+	
Downhill skiing				+			+	+	+	+[a]	
Equestrian										+[a]	
Field hockey										+[a]	
Freestyle skiing and ski jumping										+[a]	
Figure skating (some events)										+[a]	
Generally contact sports	+				+	+	+	+	+		

(continued)

Table 7.6 (continued)

	Australia (SMA) 2021	Australia (AGDH) 2021	Australia and New Zealand 2020	Canada (SOGC/ CSEP) 2018	United Kingdom (NHS) 2021	United States (ACOG) 2020	United States (ACSM) 2020	United States (EIM/A CSM) 2019	United States (U.S. DHHS) 2018	International (IOC) 2018	International (WHO) 2020
Gymnastics				+			+	+		+[a]	
Handball										+[a]	
Heavy weightlifting/ Olympic lifts		+	+	+				+			
Horseback riding				+			+	+	+		
Ice hockey				+		+	+	+		+[a]	
Luge										+[a]	
Martial arts (e.g., boxing, judo, kickboxing, taekwondo, wrestling)					+		+			+[a]	
Off-road cycling/ mountain cycling/BMX							+			+[a]	
Rugby										+[a]	

Short track speed skating										+[a]	
Sky-diving		+					+			+[a]	
Snowboard										+[a]	
Soccer (football)						+	+	+	+	+[a]	
Some track and field events										+[a]	
Squash						+					
Surfing							+				
Trampoline										+[a]	
Volleyball										+[a]	
Water skiing							+	+			

[a]Where there is the possibility for contact with other athletes or the environment and subsequent damage to the fetus/placenta. Non-contact training may be continued

related to sports activities, which generally are classified as hazardous for pregnant women.

All old guidelines contained information on the forms of exercise to avoid in pregnancy. It was suggested that women should avoid sports activities with high risks of falling or loss of balance or with high risk of abdominal trauma. Those 14 documents provided specific examples of forms of sports to avoid. For example, in 2015 ACOG guidelines [42] we found: gymnastics, horseback riding and downhill skiing or with a high potential for contact, such as ice hockey, soccer, and basketball (Table 7.5).

All new documents, apart from the WHO guidelines, also mentioned activities to avoid (Table 7.6). However, the experts' approach to the participation of pregnant women in the so-called risky sports is becoming more and more open. For example, in the RANZCOG document, we found that "although there is no strong scientific evidence regarding the risk of participation in activities with an inherent risk of falling (e.g., horse-riding, learning to ski) or impact trauma to the abdomen (i.e., team sport games), common-sense suggests that these activities may be best avoided, or at least undertaken with awareness and serious consideration of the potential risks" ([49], p. 10). According to latest guidelines by SMA [47], women active before pregnancy can continue with their regular sport as long as associated risks and recommended modifications are considered (e.g., contact sports and downhill skiing, rapid changes in direction, etc.). Although IOC [56] published a long list of sports to be avoided, at the same time, they mentioned that non-contact training might be continued in such sports as: artistic gymnastics, equestrian, field hockey, freestyle skiing, ski jumping, figure skating, rugby, short track speed skating, snowboard, some track and field events, trampoline, and volleyball.

It should be noted that there is no reliable research showing that some sports activities are indeed dangerous for pregnancy and fetal development. The classification of the forms of activities as "not recommended for pregnant women" is rather due to the cautious attitude of the authors of the guidelines. For example, in RCOG document, we found that: "Prudence dictates that activities such as contact sports should be avoided" ([41], p. 2). There are more and more studies that change the view of the so-called risky sports in pregnancy. For instance, research has cast doubts on the earlier assumptions that women should not scuba dive in pregnancy, as the fetus is not protected from decompression sickness and gas embolism [36, 41]. Results by Conger and Magann [81] prove that if the woman dived when she did not know she was pregnant, there was usually a normal outcome. Based on recently published review by Reid and Lorenzo, human data on the scuba diving effects on pregnancy outcomes are of poor quality. Nevertheless, scuba diving is the most frequently mentioned form of activity to be avoided during pregnancy, both in the old and new documents (Tables 7.5 and 7.6). To reassure women who have already dived while pregnant, it would be good to add in these guidelines that "inadvertent exposure to recreational diving in early pregnancy is not a reason for pregnancy termination" ([82], p. 1).

It seems reasonable to classify forms of exercise or physical activity, as safe for pregnancy or not, on the basis of multidimensional research analysis. Information to be included in official guidelines for exercise in pregnancy should be treated with extreme caution. Based on the studies of Tanha et al. [26] it can be assumed that these documents significantly influence the choice of the form of exercise by pregnant women. Listing certain forms of activity as potentially dangerous may result in women giving them up. In the case where they decide to continue participation in such sports, they may have to overcome the pressure of society. In the study by Fieril et al. [20], "social reproach was cited as a barrier to exercise. Some women recounted that relatives, friends or colleagues demonstrated their lack of understanding about exercising during pregnancy or questioned a particular type of exercise, such as resistance training" (p. 1140). The research by Krans and Chang also corresponds to this observation [83]. They concluded that health care providers should be aware of cultural myths that prevent many African American women from performing certain activities during pregnancy. Changing social perceptions of various forms of prenatal physical activity can be of key importance for its development.

In the analyzed guidelines, we have noted certain inconsistency in classifying sport activities as recommended to perform or to avoid. Cross-country skiing, cycling, or racket sports that have been proposed to pregnant women (Tables 7.2 and 7.3) may be associated with a high risk of fall for a complete novice. Nevertheless, it will depend on the cultural and social aspects of the country, as well as on the woman's skills in a particular sport. In this vein, a more reasonable position in relation to all forms of activity is presented in the guidelines from South Africa that "the type of exercise needs to be individualized in accordance with the woman's skills, abilities and preference" ([40], p. 70). The latest update of US guidelines includes some activities (i.e., racquet sports or running) as safe if pregnant women usually practiced this activities prior to pregnancy [42]. The need to adapt or modify the exercises for pregnancy was also mentioned in other documents [41, 45, 47, 49, 50, 52, 53, 56]. In the old guidelines, there were no specific guidance on how to implement this task. We found only very brief advice like "Exercise should be safe—there should be minimum injury risk to both mother and fetus" and that "Exercise should be comfortable—especially as the pregnancy progresses" ([40], p. 70). Some more detailed tips appear in the new guidelines [49, 56].

From a practical point of view, it would be valuable to develop guidelines on adaptation of exercises to different needs of pregnant women and action to minimize the risk of participating in various sports activities during pregnancy. This would allow women to self-assess the benefits and risks of a particular physical activity, so that they can make informed decisions about participation. Fieril et al. [20] report that modifying the type of exercise, altering exercise goals and being extra attentive during performance are recommended strategies to overcome exercise barriers in pregnancy.

7.5 Targeted Exercise Classes for Pregnant Women

In Tables 7.7 and 7.8, we presented the detailed information that might be useful for designing the contents of targeted exercise classes for pregnant women. Selecting variables for this analysis, we took into account that they should pursue goals specific to health-related physical activity, as well as specific targets for pregnant women, i.e., positive impact on pregnancy and child development, psychophysical preparation for childbirth and postpartum and to the tasks of motherhood [29–31, 84–88]. For this reason, our analysis of the documents focused on the specific content related to: aerobic exercises (cardio part of the exercise classes), resistance (strengthening) exercises, stretching (flexibility) exercises, specific exercises for pregnancy: abdominal, pelvic floor and body posture exercises[1] and exercises preparing for childbirth: breathing exercises, birth positions, relaxation, pregnancy and birth visualization. Additionally, we searched for any tips on how to exercise when the common pregnancy complaints appear (e.g., diastasis recti abdominis, stress urinary incontinence, lumbopelvic, or back pain). We also analyzed the organizational instructions useful in the implementation of the targeted exercise classes for pregnant women.

The main assumption of the targeted exercise classes for pregnant women should be such a selection of exercises that they are not only safe for the mother and fetus but also bring women the most health benefits, among others by alleviating common complaints of pregnancy [58, 89–91]. To be able to respond to the needs of all participants of the course, it is necessary to propose various versions of the exercises, considering trimester of pregnancy and its progress, the level of skills and abilities of women. Pregnant women should be informed, both what is the correct technique of each exercise, but also how to modify it in case of discomfort during its execution. Fieril et al. [20] recorded that in the opinion of pregnant women participating in resistance training "(…), besides length and intensity, a focus on the quality of the exercise performance was of paramount importance" (p. 1140).

The guidelines analyzed contained surprisingly little information on the exercise technique and other tips that might be useful for designing the contents of the targeted exercise classes for pregnant women (Tables 7.5 and 7.6). Both old Australian documents [34, 35] mentioned pregnancy-specific exercise classes and RCOG [41] recommended aqua natal classes. Only the guidelines of Fitness Australia suggested what such classes should include [35], e.g., gradual warm ups and cool downs for pre-natal circulation and avoidance of blood pooling, general strengthening plus particular focus on pregnancy specific muscles such as pelvic floor core and postural muscle strengthening, modified strength training according to the Fitness Australia Safety Guidelines for Strength Training, modifications for standing and supine positions such as four point kneeling, sitting on a fitball and side lying, flexibility training limited to a comfortable range of movement, relaxation, and

[1] Abdominal, pelvic floor exercises, and body posture are especially important in pregnancy, so for the purposes of this work we have included them in exercises specific to pregnancy. However, differently oriented, they should be performed in all programs of physical activity.

Table 7.7 Guidelines useful for designing the contents of targeted prenatal exercise classes published by the end of 2017

	Australia (SMA) 2016	Australia (FA) 2013	Canada (SOGC/ CSEP)	Canada (CASEM)	Denmark	Norway	South Africa (SASMA)	United Kingdom (RCOG)	United States (ACOG) 2015	United States (ACNM)	United States (ACSM)	United States (U.S. DHHS)	International (IOC) 2016
Aerobic exercises (cardio part):													
General recommendations[a]	+	+				+	+	+	+	+	+		+
Detailed instructions[b]		+				+							+
Muscle-strengthening exercises:													
General recommendations	+	+	+	+	+	+	+	+		+		+	+
Detailed instructions	+	+		+	+	+	+						+
Flexibility exercises:													
General recommendations		+											+
Detailed instructions	+	+											
Abdominal, pelvic floor and body posture exercises:													
General recommendations	+	+			+	+	+		+				+
Detailed instructions	+	+											

(continued)

Table 7.7 (continued)

	Australia (SMA) 2016	Australia (FA) 2013	Canada (SOGC/ CSEP)	Canada (CASEM)	Denmark	Norway	South Africa (SASMA)	United Kingdom (RCOG)	United States (ACOG) 2015	United States (ACNM)	United States (ACSM)	United States (U.S. DHHS)	International (IOC) 2016
Exercises preparing to childbirth:													
General recommendations		+											
Detailed instructions													
Exercises addressing common pregnancy complaints:													
General recommendations	+		+	+	+	+			+				+
Detailed instructions	+				+	+							
Organizational recommendations:													
Structure of the exercise class	+	+	+					+		+			
Exercise positions	+	+	+		+		+	+	+	+	+	+	
Other	+	+						+			+		+

[a]Related to the particular element of the targeted exercise classes for pregnant women
[b]Any tips related to the quality of exercise execution

Table 7.8 Guidelines useful for designing the contents of targeted prenatal exercise classes published after 2017

	Australia (SMA) 2021	Australia (AGDH) 2021	Australia and New Zealand 2020	Canada (SOGC/ CSEP)	United Kingdom (NHS) 2021	United States (ACOG) 2020	United States (ACSM) 2020	United States (EIM/A CSM) 2019	United States (U.S. DHHS) 2018	International (IOC) 2018	International WHO 2020
Aerobic exercises (cardio part):											
General recommendations[a]	+	+	+	+	+	+	+	+	+	+[b]	+
Detailed instructions[c]	+	+	+			+	+	+	+	+[b]	
Muscle-strengthening exercises:											
General recommendations	+	+	+	+	+	+	+	+	+	+[b]	+
Detailed instructions	+[d]		+		+		+	+	+	+[b]	
Flexibility exercises:											
General recommendations	+		+	+			+	+			+
Detailed instructions	+		+				+				
Abdominal, body posture exercises:											
General recommendations				+	+	+				+[b]	
Detailed instructions				+	+						
Pelvic floor exercises:											
General recommendations	+	+	+	+	+		+	+		+[b]	+

(continued)

Table 7.8 (continued)

	Australia (SMA) 2021	Australia (AGDH) 2021	Australia and New Zealand 2020	Canada (SOGC/ CSEP)	United Kingdom (NHS) 2021	United States (ACOG) 2020	United States (ACSM) 2020	United States (EIM/A CSM) 2019	United States (U.S. DHHS) 2018	International (IOC) 2018	International WHO 2020
Detailed instructions	+			+	+ Video			+		+[b]	
Exercises preparing to childbirth:											
General recommendations					+						
Detailed instructions					+ Video						
Exercises addressing common pregnancy complaints:											
General recommendations	+	+	+	+	+	+	+	+		+[b]	+
Detailed instructions										+[b]	
Organizational recommendations:											
Structure of the exercise class	+		+	+	+	+	+				
Exercise positions	+	+	+	+	+	+		+	+	+[b]	+
Other		+	+	+	+			+		+[b]	

[a]Related to the particular element of the targeted exercise classes for pregnant women
[b]Related to very active and elite athletes
[c]Any tips related to the quality of exercise execution
[d]Link to examples of strengthening exercises was provided

labor preparation. The new guidelines did not mention targeted prenatal exercise classes at all. However, they contained some useful information to design it.

7.5.1 Aerobic, Resistance, and Stretching Exercises

In eight old documents, we found only general recommendation to perform aerobics [34, 35, 39–42, 44, 45]; in six documents specified to low impact [35, 39, 40, 42, 44, 45], which is one of the basic modes of aerobic exercise in prenatal exercise classes. There were no tips on the selection and the technique of the aerobics moves and their usage. In the new guidelines, the low-impact aerobics was mentioned only once [53]. There is a growing evidence that pregnant women can safely participate in high-impact aerobics [92].

In relation to the muscle-strengthening (or resistance) exercises, 12 old documents contained only general advice to perform them [1, 34–44]. More detailed tips were inter alia: to pay attention to correct technique [40], to consider that exercises requiring balance and agility may become more difficult while the pregnancy progresses [34, 42, 45] and to work with an instructor or use equipment to reduce the risk of overexertion [38]. It was also recommended to avoid breath holding [35, 37] and the Valsalva maneuver during resistance exercises [35, 40]. For safe and effective training, the guidelines from South Africa [40] and Australia [34] advised pregnant women to use relatively low weights. Other documents also discouraged the use of heavy weights in pregnancy [29, 38, 44].

All new documents mentioned muscle-strengthening exercises as recommended for pregnant women (Table 7.4). To provide examples of strengthening exercises, the SMA guidelines [47] included link to an electronic version of the Canadian PARmed-X for Pregnancy. The RANZCOG advised that movements should be slow and steady and performed with proper breathing technique. Other sensible precautions include avoiding activities that involve straining, holding the breath, or that are isometric in nature [49]. According to the IOC, in general, athletes are advised to pay attention to technique and safety. If there is a feeling of muscle strain or excessive fatigue, exercises should be modified to avoid injury. Strenuous strength training should be adjusted to avoid the Valsalva maneuver and excessive pressure toward the pelvic floor [56]. Two Australian institutions did not recommend heavy weight lifting [48, 49]. Two other guidelines [50, 54] did not advise the Olympic lifts to be performed during pregnancy. However, the upper load limit for resistance exercises has not yet been established. “Heavy” is rather a very relative term, depending on the individual’s fitness level prior to pregnancy.

According to the old SMA document, pregnant women should avoid wide squats, lunges, or any unilateral leg exercises that place excessive shearing forces on the pubic symphysis [34]. Fitness Australia excluded some exercises that significantly involved abdominal muscles [35]. In the new guidelines, RANZCOG stated that walking lunges were best avoided to prevent injury to pelvic connective tissue [49]. However, so far, there was no study published which could indicate negative influences of the above exercises on pregnant woman’s body.

Only the old Australian guidelines [34, 35] provided short practical instructions on stretching exercises. We found recommendations that flexibility training should be limited to a comfortable range of movement [35] and also that it should be controlled and not "over-extended" as joints and ligaments are already loose due to the release of the hormone relaxin in preparation for birth [34]. The Canadian guidelines from 2003 stated that "stretching and strength training exercises such as yoga and Pilates have not been studied in a pregnant population" ([36], p. 4). Nevertheless, in recent years, there have been several scientific publications on yoga [93–95] and Pilates classes [96, 97] for pregnant women. The outcomes of those studies should be disseminated in public sources of information by credible institutions. A change in this aspect is visible in the new guidelines. They recommended pregnant women practice yoga, stretching, or Pilates, sometimes in modified versions [50, 52–54]. According to SMA [47], stretching exercises should be done gently due to the increased joint laxity during pregnancy. The RANZCOG mentioned that "stretching should always be performed in a slow and controlled manner" ([49], p. 9), which is a general advice for all exercisers.

7.5.2 Specific Exercises for Pregnancy and in Selected Pregnancy Complaints

In the old guidelines, we found very limited guidance on how to perform abdominal exercises. The only information available was that "the ability to perform abdominal strengthening exercises may be impeded by the development of diastasis recti and associated abdominal muscle weakness" ([36], p. 4) and that "abdominal exercises are not recommended if diastasis recti develops" ([37], p. 3). In Norwegian guidelines, it was only generally stated that strong stomach muscles can prevent pain in the lower back and bad posture [39]. ACOG guidelines also propose strengthening of both abdominal and back muscles to minimize the risk of low back pain [42].

In 2013 Fitness Australia suggested that any exercise that places significant load on the abdominals or pelvic floor including abdominal curls, sit ups, planks, and hovers should be avoided [35]. Nevertheless, this is not an evidence-based recommendation. The new Canadian guidelines [50] also advised avoidance of abdominal curls for women with diastasis recti abdominis (DRA), as this might worsen the condition, increasing the likelihood of requiring postnatal repair. Contrary to this statement, Mota et al. [98] proved that performing abdominal curls consistently produced a significant narrowing of the inter-rectus distance both in pregnant and postpartum women (IRD). IOC expert group, both in the older and newer documents, presented available scientific data on the diastasis recti abdominis, concluding that the etiology and possible preventive and treatment strategies of this condition were not clear [1, 56].

In the new guidelines, strengthening abdominal exercises are still indicated as prevention or treatment of back pain [51, 52]. Additionally, NHS described a few examples of abdominal exercises to perform during pregnancy.

As regards the pelvic floor exercises, in the old guidelines they were mentioned by Danish [38], Norwegian [39] and Australian experts [34, 35]. They were generally recommended for the prevention of stress urinary incontinence [38] and presented as particularly important during pregnancy and after the birth [39]. Australia Fitness [35] underlined its significance for pregnant women. The Sport Medicine Australia guidelines included instruction to design pelvic floor exercise program for pregnant women. The exercise technique recommended in this document was to contract pelvic floor muscles maximally with an inward and upward squeezing movement, mixing slow and fast controlled contraction in a sitting, kneeling, standing, lying down, or standing with leg astride position. The prevalence of pelvic floor dysfunctions and suggestions for their prevention and treatment, e.g., through supervised training in combination with home exercise were discussed in the IOC summary [1].

All new guidelines, apart from ACOG and U.S. DHHS, recommended that women perform pelvic floor muscle exercises (Table 7.8), highlighting their role in the prophylaxis of urinary incontinence. The ACOG experts [52] addressed this recommendation only to the postpartum women. Three documents [47, 51, 56] provided detailed instructions on how to perform pelvic floor muscle exercises. NHS [51] included a short video with explanations how these muscles work and tips for the exercise performance. EIM [54] recommended visiting a pelvic health specialist during pregnancy to learn the best way to train the muscles of the pelvic floor. IOC [56] emphasized the importance of the pelvic floor muscle training for female elite athletes. They were advised to contract the pelvic floor muscles before and during heavy lifting to counteract the impact on the pelvic floor from increased intra-abdominal pressure.

In the old analyzed documents very little attention was devoted to the body posture, except the note that strengthening exercises would help to maintain it [39, 40]. Pregnant women with pelvic or back problems were advised to cycle [38] or to exercise in the water [38, 39]. Fitness Australia generally recommended postural muscle strengthening [35]. According to the IOC "changes in spinal curvature during pregnancy as well as frequent or sustained pain-provoking postures might influence the pelvic ligaments, causing pain" ([1], p. 582). The experts suggested that women should be aware of their body positions while pregnant to avoid unnecessary load and stress on joint, ligaments and muscles, during exercise and daily activities. They also showed the relationship between pregnancy, exercise and the low back pain or pelvic girdle pain. Other common conditions, illnesses, and complaints typical for pregnancy and the chances of their treatment through prenatal exercise were summarized in the IOC document, as well. The Part 5 of the IOC work [56] contains detailed recommendations for health professionals and active women in this subject.

All new documents, apart from U.S. DHHS (Table 7.8), provided some information on physical activity for women with pregnancy complaints. Experts generally recommended modifying or individualizing the exercise program and consult physical activity pattern with highly qualified specialists. However, more detailed recommendations on how to implement exercise for pregnant patients with specific complaints should be developed, based on available scientific evidence.

In our previous review, the Fitness Australia was the only one organization which presented labor preparation as an important part of activities for pregnant women [35]. Until 2018, the breathing exercises, birth positions, relaxation, pregnancy and birth visualization were not even mentioned in any analyzed document. In guidelines published after 2017, only the NHS [51] emphasizes the importance of exercise in preparing for childbirth. A short instructional video presenting the birthing positions and breathing exercises has for pregnant women been included.

7.5.3 Exercise Positions, Structure of the Exercise Class, and Other Organizational Recommendations

Eleven old guidelines [1, 34–37, 40–42, 44, 45] recommended avoiding or limiting the supine position after the first trimester, or after 16 weeks of gestation, or after the fourth month of gestation. As an alternative solution it was proposed to change the exercises [40] or to put a pillow or towel underneath one hip [44]. ACSM also suggested avoiding prone position until more information becomes available [45].

The information on the potential need to limit the supine position while exercising during pregnancy was mentioned in ten new documents [47–52, 54–57]. The Canadian guidelines explained that some pregnant women may experience lightheadedness, nausea or feel unwell when they exercise flat on their back. The experts from other countries complemented this information with tips like to tilt the upper body to a 45-degree angle or to perform the exercises in different positions, like a side-lying, sitting or standing positions [48–50, 54]. However, IOC experts [56] pointed that some studies report no adverse effect with exercise in the supine position for 2–3 min at a time.

With regard to the structure of the exercise classes in five old documents we found the advice to include a warm up and cool down in any exercise regimen [34–36, 41, 44] and in two documents—to avoid motionless standing [40–42]. Other organizational tips were, e.g., to use properly adjusted exercise equipment and a smooth floor surface [45] and to use pelvic support belts for the weight-bearing exercise in women affected by joint laxity changes [41].

Six new documents [47, 49–51, 53] mentioned the warm up or cool down, as important parts of exercise session for pregnant women. Other recommendations were to use body weight, hand weights, elastic bands, or weight machines in resistance exercises [49, 52–54]. The Canadian experts stated that: “Although the majority of the evidence base for these recommendations used supervised exercise, physical activity during pregnancy does not need to be done in a supervised setting or with any specific equipment” ([50], p. 1344).

7.6 Exercise Professionals and Obstetrics Care Providers

Exercise professionals are supposed to play the most important role in providing information on exercise selection and techniques. However, in our previuos work, we have proved [99] that although the future exercise professionals are generally

aware of the positive impact of prenatal physical activity, they lack detailed knowledge, allowing the implementation of exercise sessions with pregnant clients. Those results demonstrate that there is a need to educate them on the exercise in pregnancy. An attempt at international discussion on how to prepare professionals to conduct exercises for pregnant women was undertaken during the fifth International Standards Meeting in Amsterdam in 2014, organized by the EuropeActive (former European Health and Fitness Association). Representatives from 12 European countries interested in the development of an international educational standard for the Pregnancy and Postnatal Exercise Specialists participated in this work. It is the first document of this type specifying the learning outcomes necessary for design and delivery of a prenatal exercise program, and set within the concept of the European Qualifications Framework [60]. The educational standard should correspond to the official and up to date guidelines for exercise in pregnancy. Thanks to this, professional tasks performed by Pregnancy and Postnatal Exercise Specialists would have a better chance to meet with the approval of pregnant women and medical staff.

In the old guidelines, only the experts from Denmark stated that the exercise during pregnancy should be supervised by an "instructor" [38], especially for the beginners [68]. The analyzed documents did not pay much attention to the exercise professionals' skills and competencies necessary to promote and implement exercise programs, foster women's adherence to exercise, evaluate their training progress and, if needed, to cooperate with a health professional. Only guidelines from The Health & Fitness Industry Association indicated that exercise professionals who offer specific services to pregnant or postpartum women were required to complete a Fitness Australia Continuing Education program [35]. In nine of the 11 new guidelines, experts recommend pregnant women consult with a physical activity or exercise specialist, or exercise physiologist [47, 49, 51, 53–57]. It is clearly visible that the role of this professional group has been strengthening in the last few years.

In eight of 13 old guidelines, pregnant women were advised to consult the health care providers regarding their exercise program [34–36, 38, 42–45]. This recommendation appears in all new documents analyzed. The ACOG guidelines [52] still emphasizes the need for a thorough clinical evaluation before recommending an exercise program, to ensure that there is no medical reason preventing participants from engaging in exercise. Women with medical or obstetric complications should be carefully assessed by obstetricians beforehand to determine an individual physical activity plan. Additionally, women should be advised to stay well hydrated and to stop exercising if any warning symptoms develop (e.g., vaginal bleeding, abdominal pain, regular painful contractions, leakage of amniotic fluid, etc.). The ACOG listed several warning signs to discontinue exercise during pregnancy. Healthcare professionals should inform their patients that as soon as these warning signs appear, pregnant women should stop or significantly reduce physical activity and immediately contact their obstetric care providers. According to some guidelines, pregnant athletes or women exercising significantly above the recommended level should be supervised by a specialist healthcare provider [47, 48, 50, 52, 53, 56, 57].

Such a recommendation seems justified only under the condition that the obstetricians and midwives would be well educated in this area, including the knowledge of the impact of vigorous-intensity physical activity on maternal, fetal, and neonatal outcomes. However, research shows that medical staff often remain at the former conservative position and do not support exercises during pregnancy. Only 1% of doctors in Poland recommend physical activity to pregnant women. What is more, 11% of them recommend that pregnant women limit their physical activity without any medical reason [15]. In the research by Hagen Haakstad et al. [6] only 36% of Norwegian pregnant women surveyed reported that they had received advice about physical activity at least once during their pregnancy from a physician or a midwife. Similarly, Schmidt et al. [100] showed that only 48% of pregnant women surveyed had received information on the subject of physical exercise in pregnancy from their general practitioner or gynecologist.

As noted by Evenson and Bradley [22] more work is needed to understand what advice is being given to pregnant women by their health care providers. In another study Jukic et al. [101] observed that health professionals' advice was associated with the level of prenatal physical activity of their patients. Because health care providers have great influence on patients' health behavior, it is critical that they give pregnant women accurate and sufficient information [23]. In the study by Padmanabhan et al. [102] women felt that their midwives provided detailed information on what they should not do during pregnancy but were rarely given information about what they should do in relation to diet and physical activity for weight management. Consequently, women often used information from a variety of sources which they filtered using "common sense." According to Watson [103] the majority of South African medical practitioners (98%) believe that exercise during pregnancy is beneficial, and were knowledgeable on most of the expected benefits, but at the same time most of them (83%) were unaware of the recommended exercise guidelines. These results highlight the need to educate health care professionals in this topic. Malta et al. [104] proved that after an educational intervention health care professionals were more likely to give their pregnant patients proper guidance regarding leisure-time walking and healthy eating comparing to the control group. In order to prepare obstetricians and midwives to answer pregnant women's questions regarding exercise in pregnancy, they must be given reliable and comprehensive sources of information. The new guidelines seem to be good sources of general information on exercise in pregnancy. Still, close cooperation between obstetric care providers and exercise professionals is essential.

The Canadian guidelines by SOGC/CSEP [36, 50], Australian by Fitness Australia [35] and Sport Medicine Australia [34, 47], American by ACSM [53] and by IOC [56] proposed PARmed-X for pregnancy as a tool for collaboration between a pregnant woman, her obstetric care provider and an exercise professional in terms of the exercise program design [105]. Watson et al. [103] observed that only 24% of health practitioners referred pregnant women to exercise specialists. In the area of prenatal physical activity there is dynamically growing reliable information, both from research and practical experience, in the implementation of various programs of exercise for pregnant women. This should be the basis of educational standards

and materials for pregnancy exercise specialists. Unfortunately, the training providers still rely too often on information that is 20 or more years old.

Another important issue is to prepare professionals, both from the fitness and health sector to supervise pregnant elite athletes. Given the infrequency of pregnancy in athletes competing at the national or international level in any given time period, enrolling these women from around the globe in prospective research trials seems a very challenging task. Therefore, Bø et al. [56] recommend that the IOC develop a prospective international registry of elite competitive athletes who plan to become or are pregnant to allow for the collection and analysis of maternal and neonatal consequences of extreme levels of exercise before, during, and after gestation. This solution would enable the collection of relevant data to develop a specific educational standard for the entire training staff and help female athletes combine both sports and maternal goals.

7.7 Limitations

One of the limitations of the work is the selection of documents for the analysis. Owing to the fact that the guidelines for exercise in pregnancy do not always have the character of scientific work, and only represent the official position of credible national institutions, sometimes it was impossible to find them in the scientific databases. Nevertheless, we have tried to adopt a procedure in seeking material for analysis that would ensure its effectiveness and repeatability. We realize that we might have missed some of the documents that meet the inclusion criteria.

The procedure adopted for qualifying documents for the analysis excludes material published in other languages and not available on the Internet. Because of that, the presented picture of the current guidelines on exercise during pregnancy is incomplete and is not global. It seems justified to continue and expand the international cooperation started by Evenson et al. [32] in order to collect the material published in other languages, understanding their contents, as well as their historical and cultural context. It is necessary to follow the analysis of official guidelines with international implementation activities, promoting exercise in pregnancy. One of them seems to be the development and dissemination of international educational standards for professionals involved in the implementation of programs of prenatal exercise. This task has already been started by EuropeActive in 2014, and published in 2015 [60]. Currently, work is underway in the international team to update this document, as well as to develop an educational program and educational materials for future pregnancy exercise specialists.

Notwithstanding these limitations, the presented review can be a starting point for discussion in the work on updating the existing and creation of new documents in this area. We realize that the specific content that we propose for inclusion in a new version of the guidelines for exercise in pregnancy would significantly increase their volume. However, they would become a much more useful tool, supporting prenatal physical activity.

7.8 Conclusions

Since the last review of the guidelines in 2017, 11 new documents have appeared as official statements of national or international obstetrics, gynecology, or sports medicine bodies on physical activity in pregnancy. Almost half of these documents are evidence-based. There is a visible change in the approach to physical activity in pregnancy. There are more and more recommendations for women with a high level of physical activity and participating in high-intensity sports, including female elite athletes. It is becoming acceptable to continue sports training and participation in competitions. Nevertheless, experts emphasize that there is a lack of scientific data on this topic and that research of good quality is necessary in this area.

The approach to physical activity in complicated pregnancy has completely changed. The list of health conditions that were previously considered contraindications to physical activity during pregnancy has been verified. More and more often there is a recommendation to individualize exercise and maintain normal life activity in the case of a complicated pregnancy. The prescription to bed rest is strongly criticized as harmful to the physical and mental health of the future mother and the whole family.

The new guidelines are still very general in nature, although, compared to the documents published before 2018, there are more detailed provisions on the content of the exercise. It is worth noting that most of the documents contain recommendations on pelvic floor muscle training, mainly as a prevention of urinary incontinence. An innovative element in the British guidelines is the inclusion of short videos on exercise of pelvic floor muscles and preparation for childbirth.

Certainly, the current guidelines can be a good source of information for obstetric care providers who should advise their patients about physical activity during pregnancy. However, specific guidelines for exercise professionals on how to plan and conduct targeted prenatal exercise classes should be developed in separate, broader documents. According to the current trend, a lot of space should be devoted to exercise in complicated pregnancy. It is also important to develop rules for cooperation between obstetric care providers and exercise professionals to enable the safe implementation of exercise programs for pregnant women with different needs.

Analyzed guidelines should be disseminated among all parties interested in prenatal physical activity: pregnant women and their families, obstetric care providers and exercise professionals to enable their effective cooperation and to globally promote exercise in pregnancy. It is important that similar documents are developed and implemented by national maternity care organizations in all countries.

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