ISSN: 2469-5718

Dinardi RR. Int J Sports Exerc Med 2026, 12:281
DOI: 10.23937/2469-5718/1510281
Volume 12 | Issue 1
Open Access

International Journal of Sports and Exercise Medicine

REVIEW ARTICLE

Analysis of International Guidelines on Resistance Training and Their Relationship with Nutritional Prescription During Pregnancy

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Abstract

Introduction: International guidelines recommend regular physical activity during pregnancy, including resistance training, as a safe and effective strategy to promote maternal–fetal health. However, there are variations among countries regarding the specificity of these recommendations, particularly with respect to resistance training prescription.

Objective: To comparatively analyze international recommendations on resistance training for pregnant women, identifying convergences, divergences, and implications for maternal-fetal health.

Methods: A narrative review of guidelines published between 2015 and 2025 was conducted, including documents issued by governmental bodies and scientific societies from Australia, Canada, Denmark, Spain, France, England, Japan, Norway, and the United States. Recommendations were qualitatively synthesized and organized into a comparative table, considering frequency, type of exercise, intensity, safety guidelines, and contraindications.

Results: The analyzed guidelines converge in recommending physical activity during pregnancy, including moderate-intensity resistance training, generally two to three times per week. Exercises targeting large muscle groups, lumbopelvic stability, and pelvic floor strengthening are widely endorsed. Major obstetric contraindications are consistent across countries. Nonetheless, heterogeneity was observed regarding detailed prescriptions of training volume, intensity and progression.

Conclusion: Resistance training is widely recognized as safe and beneficial for pregnant women without contraindications; however, the lack of standardization across guidelines limits precise prescription. Integration with nutritional counseling and individualized programming is essential to ensure safety and optimize maternal–fetal benefits. Future studies are needed to establish more specific prescription parameters.

Keywords

Pregnancy, Exercise, Resistance training, Physical activity, Maternal health

Introduction

The practice of physical exercise during pregnancy has long been widely accepted and recommended by leading institutions such as the American College of Obstetricians and Gynecologists and the World Health Organization [1,2]. During pregnancy, however, a decline in physical activity levels among women is frequently observed, often driven by the mistaken perception that exercise poses risks to maternal-fetal health, as well as by insufficient encouragement and guidance from healthcare professionals [1,3,4].

Nevertheless, international guidelines emphasize that pregnancy represents a favorable period for the adoption of healthy lifestyle behaviors, particularly among women who were previously inactive. Regular physical activity during pregnancy has well-documented

Citation: Dinardi RR (2026) Analysis of International Guidelines on Resistance Training and Their Relationship with Nutritional Prescription During Pregnancy. Int J Sports Exerc Med 12:281. doi.org/10.23937/2469-5718/1510281

Received: January 12, 2026 : **Accepted:** February 21, 2026 : **Published:** February 24, 2026

positive effects for both the pregnant woman and the fetus. Key maternal benefits include improvements in overall physical fitness, appropriate control of gestational weight gain, reduced duration of labor, and faster postpartum recovery. In addition, physical activity is associated with the prevention of clinically relevant conditions such as gestational diabetes mellitus, pregnancy-induced hypertension, and preeclampsia, as well as with a reduced risk of preterm birth [1,5,6].

Exercise prescription for pregnant women follows principles similar to those applied in public health promotion, encompassing both aerobic activities and resistance training [2]. However, such prescriptions must be individualized, taking into account each woman's characteristics and the specific physiological demands of each stage of pregnancy. Resistance training has been widely recommended as an essential component of physical conditioning programs for both the general population and pregnant women [2,7]. Its effectiveness is associated with increases in muscular strength and lean mass, as well as improvements in clinically relevant indicators such as blood pressure, body composition, and insulin sensitivity [1,2,8].

In the context of pregnancy, these benefits are particularly relevant, as muscular strengthening directly contributes to adaptation to biomechanical and postural changes, prevents musculoskeletal pain, especially low back pain and helps maintain functional capacity [8-10]. Additionally, resistance training exerts indirect positive effects on maternal health, including improved psychological well-being, reduced risk of gestational complications such as gestational diabetes, gestational hypertension, and preeclampsia, and facilitation of labor and postpartum recovery [9,10].

To achieve these outcomes, the development of effective training programs and appropriate nutritional control is essential [11]. However, with the widespread availability of information through modern technologies, a vast array of content on exercise training and nutritional management is accessible from multiple sources. Among these, clinical guidelines and specific recommendations for exercise during pregnancy play a crucial role in disseminating evidence-based knowledge. Recently, the World Health Organization [2] published guidelines on physical activity and sedentary behavior, recommending muscle-strengthening activities at least twice per week, explicitly including this guidance for pregnant women.

Savvaki, et al. [12] conducted a systematic review of guidelines related to exercise during pregnancy and found that approximately half of the analyzed documents did not include specific recommendations regarding resistance training. Thus, many fundamental guidelines and recommendations for resistance training prescription remain absent or are addressed incompletely in major pregnancy exercise guidelines. This gap may compromise both exercise and nutritional prescription, negatively impacting expected maternal-fetal health outcomes.

In this context, a critical analysis of these guidelines is essential to improve the practice of professionals in health, physical education, and nutrition, thereby contributing to enhanced training and clinical practice. Therefore, the aim of this study was to analyze international guidelines issued by scientific organizations on physical exercise during pregnancy, with an emphasis on resistance training, and to discuss their relationship with nutritional prescription.

Variables of Resistance Training

The benefits associated with resistance training are directly related to the knowledge and appropriate manipulation of the variables that compose its prescription [7]. In the context of pregnancy, understanding the influence of each variable on training session organization is essential not only to optimize outcomes but also to ensure maternal-fetal safety.

Training volume

Training volume is a fundamental variable in resistance training programs aimed at increasing strength and muscle mass [13]. This parameter reflects the total amount of work performed during a session, week, month, or other training period and is a key determinant of neuromuscular and morpho functional adaptations [14]. Training frequency, session duration, number of sets, number of repetitions per set, and number of exercises per session all directly influence training volume.

The simplest method to calculate volume is the sum of repetitions performed over a given period, such as a session, week, or month [14]. Practically, volume may be quantified as the product of repetitions and sets performed for a given exercise [7]. When load is considered (repetitions × sets × load), a more accurate estimate of total mechanical work is obtained, which is essential for training planning, monitoring, and progression.

For pregnant women, manipulation of training volume should follow principles of gradual progression, continuous monitoring, and individualization to maximize maternal-fetal health benefits and minimize risks. Adequate volume adjustment, combined with proper nutritional prescription, contributes to performance optimization, appropriate gestational weight gain, and enhanced safety throughout pregnancy.

Training intensity

Resistance training intensity represents the magnitude of the load used relative to an individual's maximal strength capacity and is typically expressed as

a percentage of one-repetition maximum (% 1RM) or as the maximum number of repetitions possible with a given load (e.g., 10RM) [13,14]. Selection of appropriate intensity should consider conditioning level, previous experience, training goals, and, in the case of pregnant women, gestational stage and clinical status.

Moderate intensities are generally recommended, as they provide sufficient stimulus to maintain or improve physical fitness without excessive overload on the musculoskeletal or cardiovascular systems [1,2]. For pregnant women, subjective effort monitoring tools, such as the Rating of Perceived Exertion (RPE), are preferred over maximal load testing, as they avoid exhaustive testing procedures [1,15]. Proper manipulation of intensity, together with volume control and appropriate nutritional strategies, contributes to improvements in functional strength, posture, reduction of musculoskeletal discomfort, and exercise safety [1].

Rest intervals

Rest intervals refer to the recovery time between sets, exercises, and training sessions and are determined according to training goals [14]. For example, maximal strength training using high intensities typically requires longer rest intervals (≥ 3 minutes), whereas hypertrophy-oriented training generally employs rest intervals ranging from 30 seconds to 2 minutes due to the greater metabolic and hormonal responses elicited under these conditions [13]. Schoenfeld, et al. [16] classified rest intervals as short (1 minute) and long (3 minutes), observing significant increases in strength and muscle mass in both conditions, with greater hypertrophy gains associated with longer rest intervals.

Repetition duration

Repetition duration refers to the time, in seconds, required to complete each repetition within a set and should be analyzed according to the type of muscular action involved (isometric, concentric, and eccentric) [13].

Exercise selection and order

In resistance training, exercises may be classified as multi-joint or single-joint based on the number of joints involved in the movement. This distinction is practically relevant, as it influences neuromuscular demand, motor unit recruitment, and functional transfer. From a biomechanical perspective, length-tension relationships and muscle activation patterns demonstrate that muscles may be stressed in different ways. Therefore, careful exercise selection allows emphasis on specific functions or muscle portions, optimizing training stimulus and outcomes [13,17,18].

Exercise order refers to the sequence in which exercises are performed during a training session and may significantly influence performance. Exercises performed earlier typically allow greater intensity or number of repetitions compared to those performed later, especially when targeting the same muscle groups. This effect results from accumulated fatigue throughout the session and affects both multi-joint and single-joint exercises [7,13,18].

Training frequency

Training frequency refers to the number of sessions per week in which a given muscle group is stimulated [7,13,18]. It is important to note that more than one training session may occur on the same day.

Methods

Relevant guidelines were identified through a systematic search of electronic databases, including PubMed (MEDLINE), CENTRAL (Cochrane), Scopus, Web of Science, and Google Scholar, complemented by reference list screening and searches of official websites of scientific and health organizations. Publications issued between 2015 and 2025 were included. Search terms (MeSH and keywords) included pregnancy, prenatal exercise, resistance training, strength training, guidelines, physical activity, and their equivalents in the original languages of the analyzed countries. International guidelines published by recognized scientific organizations addressing physical exercise during pregnancy, with emphasis on resistance training and training load variables, were analyzed.

Inclusion criteria

Guidelines published between 2015 and 2025, issued by governmental institutions or scientific societies, containing explicit recommendations on resistance training during pregnancy, and available in full text in English, French, Spanish, Danish, Japanese, or Portuguese.

Exclusion criteria

Opinion articles, educational materials without normative character, guidelines exclusively focused on the postpartum period, and documents without specific resistance training recommendations were excluded.

Data Extraction and Synthesis

Data were independently extracted, including recommended weekly frequency, suggested volume and intensity, safety and progression guidelines, absolute and relative contraindications, and integration with nutrition and maternal-fetal health recommendations when available. Results were synthesized qualitatively and organized into a comparative table including guidelines from Australia [19], Canada [10], Denmark [20], Spain [21], France [22], the United Kingdom [23], Japan [24], Norway [25], and the United States (ACOG) [1].

Results

Nine international guidelines were selected for analysis. All provided explicit or implicit

recommendations for resistance training in low-risk pregnant women, with variations in frequency, volume, intensity, and clinical precautions. (Table 1) summarizes resistance training recommendations and specific features across international guidelines.

Convergences Among Guidelines

The analysis revealed broad agreement on key points:

- Resistance training is safe for healthy pregnant women and recommended as part of regular physical activity.
- A frequency of 2-3 days per week is most commonly recommended.
- Moderate intensity is consistently endorsed, with emphasis on avoiding the Valsalva maneuver.
- Exercises targeting large muscle groups, integrating strength, stability, and pelvic floor training.
- Absolute contraindications include preeclampsia, vaginal bleeding, placenta previa ≥ 28 weeks, ruptured membranes, and signs of preterm labor.

Notable Divergences

Some differences were observed:

- Japan [24] recommends slower progression and lower weekly volume.
- France [22] emphasizes subjective intensity monitoring using the "talk test."
- Canada [10] provides the most detailed recommendations regarding sets and repetitions.
- Denmark [20] and Norway [25] emphasize functional exercises and caution from the second trimester onward (supine position and pelvic instability).

Discussion

The analysis of international guidelines on physical activity during pregnancy demonstrates a unanimous recommendation for the maintenance or initiation of regular physical activity, encompassing both aerobic exercise and muscle-strengthening activities. In addition, the need to adapt exercise prescriptions to the specific demands of each gestational stage, through individualized planning, is consistently emphasized. In this context, the importance of a multidisciplinary approach engaging physicians, nutritionists, exercise professionals, psychologists, among others is highlighted as essential to ensure the maintenance and promotion of maternal-fetal health. In this review, nine international guidelines on resistance training prescription during pregnancy were identified, summarized, and compared. The findings indicate substantial convergence among international guidelines in recognizing resistance training as a safe and beneficial practice during pregnancy. Most recommend a frequency of two to three sessions per week, at moderate intensity, with exercises targeting large muscle groups, lumbopelvic stability, and pelvic floor strengthening. These recommendations are explicitly stated in guidelines from Canada (CSEP) [10], Australia [19], the United States (ACOG) [1], France (HAS / Sports.gouv) [22], the United Kingdom (RCOG / NHS) [23], Norway [25], and Spain [21]. Such guidance reflects a growing consensus regarding the positive effects of resistance training on gestational weight control, prevention of low back pain, and improvement of functional fitness [1,2,10, 26, 27].

Despite overall agreement, important nuances exist across countries. The specificity of resistance training prescriptions varies considerably: some guidelines (e.g., Australia [19], Canada [10], ACOG [1]) outline minimum frequency (≥ 2 sessions/week), types of exercise (elastic bands, free weights, machines, functional exercises), and emphasize pelvic floor training; others (including certain European and Japanese guidelines) adopt a more general approach, focusing on avoidance of high-risk activities and gradual progression, without quantifying load, relative intensity (%1RM), number of sets and repetitions, or periodization parameters. Guidelines such as those from Canada [10] provide more detailed prescriptions, including sets and repetitions, possibly reflecting the strong integration between academic research in exercise training and physiology and the development of public health policies in that country [28]. This heterogeneity appears to stem from two main factors: (i) limitations in primary evidence to support precise load and resistance prescriptions during pregnancy, and (ii) a cautious stance by medical societies to avoid promoting protocols that exceed those tested in controlled studies. Countries such as France [22] and Japan [24] tend to adopt more conservative approaches, relying on subjective intensity monitoring and gradual progression, reflecting cultural and historical perspectives on physical activity during pregnancy.

The observed heterogeneity in specific recommendations does not undermine the central message but underscores the need for local contextualization when applying guidelines. Sociocultural factors, health system structures, and the prevalence of comorbidities influence the prioritization of specific components of resistance training. Nordic countries, for example, emphasize functional exercises and postural stability, consistent with public health policies that value autonomy and preparation for active childbirth.

Notably, very few guidelines provide standardized parameters based on %1RM, movement velocity, or trimester-specific safe maximal loads. Instead, they rely primarily on subjective measures such as ratings of perceived exertion (RPE), the "talk test," or qualitative descriptors of "moderate" to "moderate-to-vigorous" intensity [22]. Similarly, few guidelines specify optimal

sets × repetitions for strength development during pregnancy or offer periodization strategies for previously trained or athletic women. Gaps also remain regarding recovery needs, exercise order adjustments, and postural adaptations as pregnancy progresses. Recent reviews suggest promising but still insufficient evidence to support high-intensity resistance training protocols during pregnancy [29].

While the guidelines support the safe inclusion of resistance training, they consistently recommend that professionals apply clinical judgment, ongoing monitoring, and individualized adaptation, avoiding maximal intensities without qualified supervision. This approach inevitably leads to variability across countries and clinical or community-based programs. For instance, some countries (e.g., Denmark [20] and Japan [24]) explicitly recommend more conservative progression strategies. Thus, while safety is well established for moderate, supervised protocols, extrapolation to high-intensity resistance training remains limited by insufficient evidence.

The interrelationship between resistance training and maternal-fetal nutrition is also critical. Guidelines such as those from the WHO [2] and ACOG [1] emphasize nutritional counseling alongside physical activity recommendations. Evidence indicates that resistance training can improve insulin sensitivity, reduce fat mass gain, and lower the risk of gestational diabetes when combined with balanced dietary intake [30-32]. Both WHO [2] and ACOG [1] stress that nutritional prescriptions should prioritize adequate protein intake, critical micronutrients (iron, calcium, vitamin D, folate), and glycemic control, particularly when resistance training involves moderate external loads [33]. Furthermore, hypocaloric diets during pregnancy are discouraged, as the inappropriate combination of energy restriction and resistance training may increase the risk of ketosis, impair fetal growth, and exacerbate maternal fatigue [34]. Therefore, integrating exercise prescription with nutritional guidance is essential to optimize maternal-fetal health.

Programs that combine nutritional intervention with exercise are more likely to achieve gestational weight gain within recommended ranges and reduce excessive fat mass accumulation, suggesting that integrated interventions improve adherence and outcomes [1]. In resistance training prescriptions, appropriate adjustment of energy and protein intake is critical to prevent lean mass loss or inappropriate caloric restriction. Consequently, when prescribing resistance training for pregnant women, healthcare teams should consistently include nutritional assessment, dietary prescription (energy, macro and micronutrients), and regular monitoring of gestational weight gain and nutritional status. Without such integration, the physical stimulus may become counterproductive.

This study has several limitations that should be acknowledged. Most guidelines do not provide detailed information on intensity, volume, or progression, limiting both prescription precision and cross-country comparisons. Variables such as repetition duration and inter-set rest intervals are largely absent. Additionally,

Table 1: Comparison of international resistance training recommendations for pregnant women.

Country	Recommended Frequency	Specific Resistance Training Recommendations	Contraindications and Warnings
Australia (2020) [19]	≥ 2 days/week	Exercises targeting large muscle groups; moderate intensity; avoid the Valsalva maneuver	Vaginal bleeding, preeclampsia, cervical insufficiency, fetal growth restriction
Canada-CSEP (2019) [10]	≥ 3 days/week combined with aerobic exercise	Resistance training plus core and pelvic floor exercises; 1-3 sets per exercise	Risk of preterm birth, placenta previa ≥ 28 weeks, preeclampsia
Denmark (2022) [20]	≥ 2 days/week	Progressive training until mild fatigue; avoid supine exercises after the first trimester	Regular contractions, chest pain, leakage of amniotic fluid
Spain (2020) [21]	2-3 days/week	8-10 exercises, 12-15 repetitions, moderate intensity	Bleeding, dizziness, severe abdominal pain
France (HAS, 2024) [22]	3 days/week combining exercise modalities	Maintain ability to converse during effort ("talk test"); focus on postural control	Uncontrolled hypertension, vaginal symptoms
United Kingdom (UK Chief Medical Officers, 2019) [23]	≥ 2 days/week	Strength, stability, and pelvic floor exercises; avoid intense isometric exercise	Signs of preterm labor, severe headache
Japan (JSOG, 2017) [24]	1-2 days/week	Light exercises; cautious progression; avoid increased intra-abdominal pressure	Severe anemia, placenta previa, threatened miscarriage
Norway (Helsedirektoratet, 2019) [25]	≥ 2 days/week	Emphasis on functional strength; avoid supine exercises after 20 weeks	Bleeding, severe dyspnea
United States-ACOG (2020) [1]	2-3 days/week	1-2 sets for large muscle groups; avoid the Valsalva maneuver; moderate intensity	Heart disease, severe anemia, uncontrolled diabetes

there is a predominance of data from high-income countries, with low- and middle-income populations and contexts characterized by nutritional deficiencies being underrepresented. Much of the evidence is derived from observational studies or studies with methodological heterogeneity, which may introduce selection bias and limit generalizability.

Another important limitation is the narrative nature of this review, which depends on the heterogeneous level of detail provided by the guidelines. Although the lack of standardization across countries hinders quantitative comparisons, it allows for the identification of global trends and provides direction for future research.

Conclusion

The analyzed international guidelines demonstrate robust consensus that resistance training is safe, effective, and recommended for healthy pregnant women when performed at moderate intensity with attention to obstetric contraindications. However, they provide limited robust evidence regarding specific parameters of intensity, volume, periodization, and outcomes, reinforcing the need for caution and continuous monitoring. Although variations exist in the structure and level of detail among recommendations, fundamental principles are globally shared. Integration of resistance training with nutritional prescription is a central component in promoting maternal–fetal health, contributing to improved metabolic, biomechanical, and functional outcomes. Healthcare professionals should adapt these guidelines to individual characteristics and local contexts, ensuring safe, evidence-based, and culturally appropriate interventions. Methodological advances and randomized controlled trials focusing on resistance training dose and intensity during pregnancy are needed to refine recommendations and reduce variability among international guidelines.

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