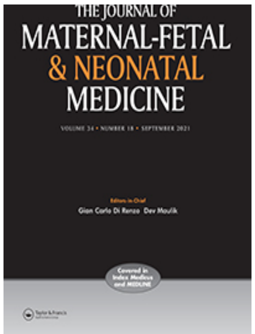

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REVIEW ARTICLE

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Risk factors for accidental falls during pregnancy – a systematic literature review

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ABSTRACT

Introduction: Falls during pregnancy occur in 25–27% of women and can cause serious harm to both the mother and the fetus. The objective of this systematic review was to identify intrinsic and extrinsic risk factors for falls during pregnancy by reviewing original studies and addressing possible forms of prevention.

Methods: We searched PubMed, Cochrane library, and Web of Science databases for studies assessing risk factors for falling after a fall has occurred or by using posturographic assessment.

Results: Fourteen studies were included in the review. The identified extrinsic risk factors include slippery floors, cluttered areas, uneven ground, inappropriate shoes, hurrying, walking on stairs, carrying additional loads, poor lighting or obstructed view, sedentary lifestyle and working in physically demanding jobs. The identified intrinsic factors include age less than 30, height more than 160 cm, advanced pregnancy, unintended pregnancy, multiparity, hyperemesis gravidarum, low back pain, gestational diabetes, increase in abdominal circumference, lower ankle stiffness and joint laxity. Physical activity, maternity support belts, and education are possible strategies for fall prevention.

Conclusion: Our systematic review identified 13 intrinsic and 11 extrinsic risk factors for falling during pregnancy. With the knowledge of risk factors and the optimal prevention strategy, healthcare providers could incorporate this information in the treatment of pregnant women and reduce the risk of falling.

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Pregnancy; fall; risk factor; accidental fall; balance

Introduction

During pregnancy, various hormonal, anatomical, and physiological changes occur to counterbalance the increasing physical and metabolic requirements. Significant physiological changes occur in the cardiovascular, respiratory, haematological, renal, gastrointestinal, and endocrine systems to enable the development of the fetus [1]. With the advancement of pregnancy, many changes occur in the musculoskeletal system that cause postural changes [2], and different adverse effects such as pelvic and low back pain [3], lower extremity pain [4,5] and urinary incontinence [6].

Pregnant women gain approximately 10–15 kg in body mass [7]. The increase in body mass, along with the enlarged uterus, lead to the anterior displacement of the center of mass (COM) and lengthen the movement arm of the pelvic girdle and spinal structures [8]. With the anterior displacement of the COM, the center of gravity (COG) no longer falls between the feet; thus, women may need to lean backwards to gain equilibrium which results in disorganization of the spinal curvatures [9]. The anterior pelvic tilt increases during pregnancy and with it there is a greater dependence on the hip extensor and abductor muscles as well as the ankle plantar muscles to avoid falling forward [10]. Knee hyperextension occurs as a consequence of the anterior displacement of the COM [11].

Additionally, changes occur in body habitus and ligament laxity due to the hormonal changes. The symphysis pubis and sacroiliac joints are particularly affected [12]. Therefore, adaptations in the musculoskeletal systems are important to accommodate postural changes and altered postural balance that increases the risk of falling [13]. Falls during pregnancy occur in 25% to 27% of women [14], a rate comparable to adults aged 65 or older [15]. Falls are the second most common cause of trauma and

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hospitalization during pregnancy, second only to motor vehicle accidents [16,17]. Falls during pregnancy may be harmful to both mother and fetus [18]. Pregnant women who were hospitalized due to a fall have elevated rates of pre-term labor, placental abruption, labor induction and cesarean births as well as twice the incidence of fetal distress and hypoxia [19]. Adverse pregnancy outcomes are difficult to predict based on the degree of injury from a fall [20]. Despite high fall rates and the severity of injuries, little attention has been paid to developing fall prevention programs for pregnant women.

To date, two previous review articles reviewed risks associated with falls during pregnancy [14,21]. They concluded that the musculoskeletal, sensory and psychological changes that occur during pregnancy, as well as lifestyle, could be associated with falls during pregnancy [14,21]. The risk factors associated with musculoskeletal changes include increased body mass [14], spinal curvature [21], abdominal circumference [21], joint laxity [22] and diminished abdominal muscle function [14,21]. Increased interstitial fluid volume can lead to decreased kinesthetics sensation and diminished coordination [23]. The sensory alterations include increased reliance on the visual system [13], altered vestibular functions [13], which could be associated with auditory and vestibular complaints [24] and together or individually may lead to an increased center of pressure (COP) movement [25,26]. Stress, anxiety, arousal, fatigue, and depression can also affect pregnant women's motor control and readiness to respond to postural perturbations [27]. Cakmak et al. [21] reported that sedentary lifestyle, gestational diabetes, and hyperemesis gravidarum are associated with the increased risk for falling during pregnancy.

The previous review articles have some limitations. Both were narrative reviews and did not systematically review the literature, nor did the authors state the methodological approaches used. Wu and Yeoh [14] reviewed articles that measured associations between pregnancy and fall risks, using an existing fall accident investigation framework to identify the possible intrinsic factors associated with falls during pregnancy. Cakmak et al. [21] reviewed studies that investigated changes in postural sway and associated risk of falling during pregnancy, mainly focusing on the influence of postural balance on the risk of falling during pregnancy. To our knowledge, no systematic reviews have been conducted that investigated both intrinsic and extrinsic risk factors, associated with falls during pregnancy. This systematic review aims to identify both intrinsic and extrinsic risk factors for falls during pregnancy by reviewing original studies that assessed the risk factors for falls during pregnancy after a fall has occurred or by using posturographic assessment to determine the risk for falling as well as to assess possible prevention strategies to reduce the risk for falling during pregnancy. With the knowledge of risk factors and the optimal prevention strategy, healthcare providers could incorporate this information into the treatment of pregnant women and reduce the risk of falling.

Methods

A search of studies published until March 2020 was conducted using bibliographic databases, PubMed, Cochrane library, and the Web of Science. Search terms included pregnancy, falls, risk factors, balance. The full search strategy for PubMed was: (pregnan* OR obstetric OR maternal OR prenatal) OR antenatal] AND (fall* OR balance OR stability OR equilibrium OR sway) AND risk. On the other databases, the search strategy was modified, but the same terms were used.

Inclusion criteria were cohort studies that included pregnant women, aged 18 or over, who were able to walk and stand without assistance. We included studies that aimed to identify the risk for falls by [1] reviewing risk factors after a fall had occurred or [2] by using posturographic or kinematic assessment of posture and balance. The included studies had to be written in English. We excluded studies that measured possible factors associated with falls during pregnancy without assessing if a fall had occurred because or in association with it. We also excluded studies that evaluated risk factors for falling after an epidural or in the postpartum population of women. Exclusion criteria were also not original studies or conference abstracts.

All articles were reviewed by title. After removing duplicates, the studies were reviewed by title and abstracts. If a study was deemed to fulfill the inclusion criteria by title and abstract review potentially, the full text was retrieved and assessed. Studies that fulfilled the inclusion criteria in the full text were included in the review. The authors independently evaluated the methodological quality of the included studies using the Newcastle-Ottawa scale. The scale involves three subcategories: the selection of cases, the comparability of different outcome groups and the outcomes. A star system is used to assess the study quality. A maximum of nine stars may be awarded, depending on the criteria met by the assessed study [28].

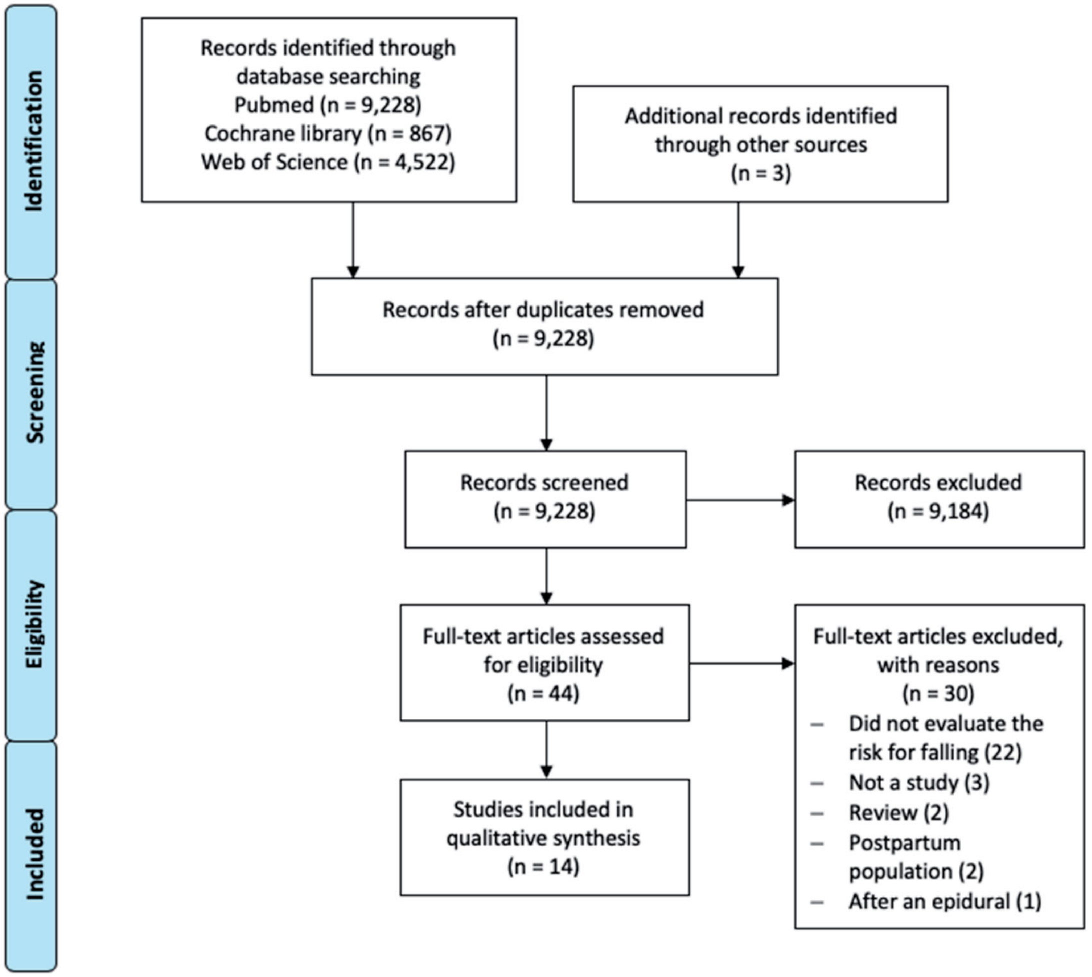

Figure 1. PRISMA checklist [29].

Results

Our search yielded 479 publications eligible for screening. After reviewing the publications in title and abstract, 34 articles were included for full-text review. Fourteen of these met our inclusion criteria. The search and screening process, conducted using the PRISMA checklist [29] is presented in Figure 1.

Participants

The studies included from 41 [30] to 3997 [31,32] participants, cumulatively 10,197 participants. The average age of the participants ranged between 25.5 [33] and 32.2 [34]. The study population is defined in Table 1. Four studies used questionnaires as a method for risk factor analysis [31,32,34,40], nine studies assessed postural sway and balance by posturography [25,33,35–39] and one study performed kinematic analysis of torso kinematics and step width during gait [41].

Types of assessment protocols

Of the nine studies that assessed postural sway by posturography, three [30,33,36] used the Biodex Balance System, which consists of a movable balance platform that provides up to 20° of surface tilt in a 360° range of motion. The fall risk is evaluated using overall, anteroposterior, and medio-lateral stability indexes. A high score in the stability indexes indicated poor balance. In two studies [25,37], translational surface perturbations in the anterior and posterior directions were generated using the Equitest Motor Control Test. The COP movement was directly measured, and the COG was estimated. In the study by Ozturk and colleagues [38], the Tetrax system, consisting of four independent and integrated platforms, was used. The frequency bands of the postural sway were measured. The risk of falling was calculated and expressed as a percentage. Takeda and colleagues [39] used two force plates. The COG was moved as far as possible in the anterior, posterior, right and left directions. The area in which the body sways and the COG movement

Table 1. Characteristics of studies included in the systematic review.

Author	Year	Design	Population	*N*	Age	Methods	Newcastle-Ottawa Scale
Dunning et al. [31]	2003	retrospective cohort	Women up to 8 weeks postpartum	3997	29.9 ± 9	Questionnaire	5
Dunning et al. [32]	2010	retrospective cohort	Women up to 8 weeks postpartum	3997	29.9 ± 9	Questionnaire	5
McCrory et al. [25]	2010	cross-sectional cohort	Pregnant women in 2nd and 3rd trimester and non-pregnant women, 18–45 years	81	28.8 ± 4.9	Posturography, dynamic stability	6
McCrory et al. [35]	2011	observational cohort	Pregnant women in 2nd and 3rd trimester and non-pregnant women, 18–45 years	81	28.8 ± 4.9	Posturography, dynamic stability	6
Cakmak et al. [36]	2014	observational cohort	Pregnant women; 18–40 years	90	26.3 ± 5.2	Posturography, static and dynamic stability	8
Ersal et al. [37]	2014	retrospective cohort	Pregnant women in 2nd trimester and non-pregnant women	69	28.8 ± 4.9	Posturography, dynamic stability	5
Inanir et al. [33]	2014	observational cohort	Pregnant and non-pregnant women; 18–40 years	110	25.5 ± 5.2	Posturography, dynamic stability	7
McCrory et al. [35]	2014	observational cohort	Pregnant women in 2nd and 3rd trimester and non-pregnant women, 18–46 years	70	28.8 ± 4.9	Posturography, dynamic stability	5
Okeke et al. [34]	2014	cross-sectional	Pregnant women presenting in labor for delivery	332	32.2 ± 2.7	Questionnaire	5
Cakmak et al. [30]	2015	observational cohort	Pregnant women; 18–37 years	41	26.5 ± 4.6	Posturography, dynamic stability	4
Özturk et al. [38]	2015	observational cohort	Pregnant women in 3rd trimester	68	30.2 ± 3.4	Posturography, static stability	7
Takeda et al. [39]	2018	observational cohort	Pregnant women in 2nd trimester; 20–30 years	82	32 ± 3.2	Posturography, dynamic stability	8
Awoleke et al. [40]	2019	cross-sectional cohort	Women up to 9 weeks postpartum	1110	30.3 ± 4.9	Questionnaire	6
McCrory et al. [41]	2020	observational cohort	Pregnant women in 2nd and 3rd trimester and non-pregnant women, 18–45 years	69	28.4 ± 5.4	Kinematic analysis	5

N: number of participants.

were assessed. In the two studies that assessed dynamic stability during gait [35] and stair locomotion [35], a Bertec force plate was embedded in the walkway. The subjects were equipped with a retroreflective marker on the L3L4 spinal segment to determine walking velocity.

McCrory et al. [41] used markers that were placed in accordance with the modified Helen Hayes marker configuration. Two force plates were hidden in the runway. Walking velocity, step width, stride length, and torso kinematic movement was assessed.

Four studies included a questionnaire to assess the risk factors for falling during pregnancy [31,32,34,40]. In two of the studies, telephone and internet surveys were conducted. The questionnaire was formed based on previously identified risk factors for falling in non-pregnant populations and based on other instruments including the Job Content questionnaire, the NIOSH Questionnaire for Mature Workers, and the Fall from Elevation Questionnaire [31,32]. Okeke and colleagues [34] developed a questionnaire seeking information in sociodemographic characteristics, history of any falling incident, risk factors for falls, cause of the fall and other associated problems. The questionnaire was self-administered. Awoleke and colleagues [40] formed a questionnaire based on other injury evaluation instruments from three other studies [31,42,43]. The questionnaire was self-administered.

Extrinsic risk factors

Five studies identified different extrinsic factors that are associated with falls during pregnancy and performed a frequency analysis to measure the effect size [25,31,32,34,40]. The percentages of falls that occurred due to an extrinsic factor are presented in Table 2.

The odds ratio for falls during pregnancy in the employed population was 1.03 [34]. The occupations with the highest rates for falling at work were food service (13.2%), other services, such as beauticians or house cleaners (12.8%), teaching or childcare (10.2%) and healthcare professionals other than nurses (7.9%) [31]. Working in a loud environment is a significant risk factor, with an odds ratio of 1.9 (95% CI: 1.2 – 3.0). Higher education demonstrated a reduced odds ratio of 0.4 (95% CI: 0.2–0.9), less than a college education demonstrated an odds ratio of 2.1 (95% CI: 1.2–3.8) [31]. Employment, as such, was not a risk factor for falling during pregnancy [31,32].

Table 2. Proportions of falls that occurred due to an extrinsic risk factor.

Authors cause	Dunning et al. [31] (%)	Dunning et al. [32] (%)	McCrory et al. [25] (%)	Okeke et al. [34] (%)	Awoeke et al. [40] (%)
Stairs	43.4	39.2	12.5	39.8	7.2
Slippery floor	33.9	33.4	17.0	35.2	17.3
Water	22.1	14.3	/	20.4	/
Snow	16.5	14.7	/	/	/
Other	10.7	/	/	/	/
Bathtub/shower	/	4.4	/	1.9	/
Uneven ground	28.4	25.4	/	29.6	/
Poor lighting	18.5	17.1	/	14.8	/
Obstructed view	12.3	10.7	/	19.2	/
Hurrying	39.3	30.2	/	35.2	17.3
Running	2.7	/	/	/	/
Carrying an object or child	30.3	28.7	17.0	29.6	24.8
Turning, reaching or bending	25.8	/	/	/	/
Getting up/down	/	6.2	/	4.6	/
Inappropriate shoes	/	/	/	/	21.2
Loose, slick or backless	25.4	31.0	42.0	/	/
Heel higher than 1 inch	16.2	15.0	/	/	/
Cluttered area	11.4	7.0	8.0	4.6	/

Intrinsic risk factors

The risk of falls increases with the advancement of pregnancy, with the majority of falls occurring in the third trimester [32,33,36,39]. Almost two-thirds (61.3%) of pregnant women fell during gestational months six through eight, with the majority of falls occurring in the seventh month of pregnancy [32]. Okeke et al. [34] reported that women taller than 160 cm had a significantly higher risk of falling, and primigravidae women had an almost threefold risk of falling. Some co-morbidities, including low back pain [38], gestational diabetes [32] and hyperemesis gravidarum [30], were also found to increase the risk of falling. McCrory et al. [25] reported that pregnant women that did not participate in regular physical activity were significantly more likely to fall ($p = .005$).

Cakmak et al. [36] studied the effect of maternity support belts on dynamic postural stability in pregnant women in each trimester. Pregnant women were measured twice with and without the maternity support belt. With the use of maternity support belts, the risk of falling was significantly lower ($p < .05$) in each trimester [36]. Results are presented in Table 3.

A study that compared the ability to maintain a stable standing position while the COG was moved as far as possible forward, backward, right and left in pregnant fallers and non-fallers and non-pregnant women found that there were differences in stability measures between pregnant fallers and non-fallers. In the fall group, the antero-posterior and lateral COG movements were significantly decreased as pregnancy progressed. Pregnant women in the fall group exhibited an increase in abdominal circumference, as well as decreased COG movement in the antero-posterior and lateral directions, decreased stability limits [39].

Two studies evaluated the postural responses via the COP movement of pregnant fallers, non-fallers and controls to translational surface perturbations in the anterior and posterior directions [25,37]. When a translational perturbation was applied, there was less COP movement in the pregnant fallers group [25]. The magnitude of perturbations was a significant factor, but the perturbation direction was not. Theoretical results of the study indicate that pregnant fallers have lower ankle stiffness [37].

During walking, there were no differences in the ground reaction forces and COP between the trimesters or between pregnant fallers and non-fallers, when walking velocity was considered [35].

Pregnant women who fell had less thoracic frontal and transverse plane movement at heel strike and throughout the gait cycle. Pregnant non-fallers exhibited greater step width and frontal and transverse plane angles at heel contact and range of motion over the gait cycle [41]. When walking on stairs, pregnant fallers did not differ in the velocity of walking. When ascending the stairs, the antero-posterior impulse, the time to the braking impulse, the medial impulse as well as the minimum between the vertical ground reaction force peaks were increased in the pregnant faller group. During descent, pregnant fallers demonstrated smaller antero-posterior propulse peak as well as a greater minimum between vertical ground reaction force peaks. Pregnant women had less mediolateral excursion of the COP during descent. These changes likely reflect a gait strategy intended to increase stability while walking on stairs [35].

Discussion

To our knowledge, this is the first systematic review of the cause and incidence of both intrinsic and extrinsic

Table 3. Reported Intrinsic risk factors for falling during pregnancy.

Authors	Year	Incidence (%)	Measured variable	Determined risk factors	Measure of effect size
Dunning et al. [31]	2003	26.8	Incidence of fall	Age <30 years;	Odds ratio 1.5;
Dunning et al. [32]	2010	26.8	Incidence of fall	Age <24 years; Gestational diabetes;	Odds ratio 1.9; Odds ratio 1.5;
McCrory et al. [25]	2010	52.0	Postural direction time and COP movement	Non participation in regular physical activity	Chi square test for exercise categorization 7.759 [$p=.005$]
Cakmak et al. [36]	2014		Fall risk score	Third trimester of pregnancy	First trimester 0.9 ± 0.3 Second trimester 1.3 ± 0.5 Third trimester 1.7 ± 1.0; [$p<.001$]
				Not wearing maternity support belt	With belt 0.88 ± 0.35 Without belt 1.27 ± 0.52 [$p<.01$]
Ersal et al. [37]	2014		Ankle torque	Lower ankle stiffness	Fall group 1.0 Non-fall group 1.2 [$p < 0.05$]
Inanir et al. [33]	2014		Fall risk score	Third trimester of pregnancy	Non-pregnant 1.0 ± 0.5 Second trimester 1.3 ± 0.6 Third trimester 1.9 ± 1.1; [$p<.001$]
Okeke et al. [34]	2014	32.0	Incidence of fall	Age <30 years; Height >160 cm; Primigravidae	Odds ratio 2.23; Odds ratio 0.37; Odds ratio 2.73
Cakmak et al. [30]	2015		Fall risk score	Hyperemesis gravidarum	Hyperemesis gravidarum 1.9 ± 0.9; Control 1.1 ± 0.5; [$p=.002$]
Ozturk et al. [38]	2015		Fall risk score	Low back pain	Low back pain 49.4 ± 24.5 No pain 28.5 ± 19.6; [$p < 0.0001$]
Takeda et al. [39]	2018	12.0	Change rate	Increase in abdominal circumference	Fall group 9.9% Non-fall group 6.9%; [$p < 0.05$]
Awoleke et al. [40]	2019	25.0	Incidence of fall	Age >30 years; multiparity; unintended pregnancy; delivery age <40 weeks	Odds ratio 1.36; Odds ratio 1.54; Odds ratio 1.48; Odds ratio 1.71

Legend: COP: center of pressure.

factors associated with falls during pregnancy. Even though falls are the second leading cause of injury among pregnant women and result in approximately 20% of pregnancy-associated injuries [44], there is a paucity of research identifying risk factors for falling during pregnancy and prevention strategies to reduce the risk of falling.

In our systematic review, we identified 13 intrinsic risk factors for falling during pregnancy. Many had been identified as possible intrinsic risk factors in the previous review by Wu and Yeoh [14] and Cakmak and colleagues [21]; however, unintended pregnancy, primigravidae, multiparity, increase in abdominal circumference, lower ankle stiffness, and low back pain were not identified in previous reviews. The findings in our systematic review confirmed that musculoskeletal and sensory adaptations during pregnancy as well as some co-morbidities are major risk factors for falling during pregnancy. However, no studies evaluated psychological factors; therefore, we cannot confirm that psychological changes are risk factors for falling during pregnancy. However, in a study by Nagai and colleagues [45], the body sway area was significantly larger in pregnant women with high anxiety.

Eleven extrinsic factors for falling during pregnancy identified were in our study and included cluttered area, slippery floors, walking on stairs without holding a railing or on uneven grounds, wearing inappropriate shoes, carrying additional loads, hurrying, poor lighting or obstructed view, sedentary lifestyle, and working in a physically demanding job. Interestingly, these risk factors are similar to those identified by Ambrose and colleagues [46], which were identified as the risk factors for falls among older adults. Additionally, slippery floors were by far the largest cause (63%) for falls, also among working women who were not pregnant [46].

Visual cues are vital in maintaining balance, so obstructed views and poor lighting are important risk factors for falling during pregnancy. As identified by Butler and colleagues [13], pregnant women rely more on visual cues to maintain balance, which was demonstrated by the increasing difference between the eyes open and closed center of COP path length measured while quietly standing on a stable force platform.

The results of our systematic review suggest that pregnant women aged 30 or less have a higher risk for falling [31,32,34], which could be explained by the fact that younger women are usually more active and more likely to be engaged in activities that could predispose them to falling. A previous study also reported that younger workers, of both sexes, are at higher risk for falling [47]. In addition to age, the identified high-risk occupations for falling during pregnancy were similar to the reported female occupations associated with high rates of falls at work. These include social work, child nursing, home help, lodging and catering service, care-taking, and cleaning work [46].

With the progression of pregnancy, the risk of falling increases proportionally, with the majority of falls occurring during the seventh month of pregnancy. Our findings are consistent with other studies that evaluated postural stability during pregnancy. Opala Berdzik and colleagues [48] reported that postural equilibrium remained comparatively stable during the first trimester; however, the second- and third-trimester COP movement values significantly increased when compared to the values in the control group. The increased risk for falling could be explained by the musculoskeletal changes that become more prominent in the third trimester of pregnancy [1]. During the third trimester, with the greater abdominal circumference, the COM shifts forward. The range of motion of the hip joint is restricted due to the forward tilt of the pelvis and joint laxity increases. Because of the restricted range of motion in the hip joints, the support surface decreases, especially in the antero-posterior direction, and the risk for falling increases. Another possible explanation for the increased fall risk during the third trimester is weight gain. The higher rate of weight gain during the third trimester may explain the increase in COP movement in a similar manner as abdominal circumference. Increase in abdominal circumference may lead to the dysfunction of deep and superficial core muscles, which is associated with a higher probability of a decreased maintenance of the stability of posture [39]. Similar observations were reported for obese people, particularly those with a higher body fat percentage in the abdominal area, for which a higher risk for falling was observed [49].

When walking on an even surface, there were no differences in balance measurements between pregnant fallers and non-fallers; however, there were differences in walking on stairs and in response to perturbation. The smaller peak values of the COP movement in the pregnant fallers group, measured after a surface perturbation, might indicate that the pregnant fallers cannot generate adequate corrective torque in response to the surface perturbation [37]. Due to an increased joint laxity during pregnancy that affects mainly the pelvis, the ankle stiffness could be lower, especially in the pregnant fallers group. Joint stiffness provides passive component during balance correction after a perturbation [49]. Increased ankle stiffness could be an important strategy to prevent falls in pregnancy [37]. Pregnant non-fallers exhibited more torso movement during walking, which may indicate better adaptability that would allow them to overcome a balance perturbation. The differences during stair locomotion seem to indicate that pregnant fallers want to achieve a more stable base during ascent and a more controlled manner to descent the stairs [35].

In our review, one study reported that sedentary pregnant women had a higher risk for falling [25], and an exercise intervention was proposed as a prevention strategy to reduce the risk for falling in five studies [25,37–39,41]. Exercise during pregnancy may enable women to learn how their bodies move and change as pregnancy advances, so that they may develop strategies to stabilize their bodies and recover from perturbations. To date, only one study has been published that confirmed the positive effect of yoga during pregnancy on balance. Pregnant women that practised yoga had greater walking speed and were faster in the timed up-and-go test, had shorter double support and turn times during walking, which indicates they have better stability [50]. Pregnant women who exercised had beneficial adaptations to lower limb kinematics during gait [51]. Strategies for fall prevention in other fall prone populations include physical activity, which has been proven to reduce the risk of falling and reduce the occurrence of falls by 30% in the elderly [52,53]. Given that pregnant woman fall at a similar rate as women aged 65 or over [15], exercise could be beneficial for reducing the risk of falling in pregnant women as well.

Education regarding fall prevention is another known fall prevention strategy. Brewin and colleagues [54] stated that most pregnant women receive no fall prevention information. They expressed a desire for educational material and were open to using some form of exercise as a prevention tactic [54]. Krkeljas [55] concluded that pregnant women should be educated about exercise programs targeting core strength and pelvic stability in order to prevent falls. Pregnant women suggested that fall prevention guidance should be introduced early in pregnancy and repeated at least once a trimester. A combination of written and verbal information was suggested as most helpful [54].

Another possible form of fall prevention is the use of maternity support belts, as advocated by Cakmak et al. [36]. During pregnancy, joint laxity increases, which causes a decrease in stability [1]. Because of the external support and the rigidity of the maternity support garments, the joint laxity decreases and stability increases. The use of maternity support garments should be advised to women with a higher risk of falling and for shorter periods as regular use of maternity support belts lower the activation of some trunk muscles [56].

To date, only one tool to assess risk for falls in pregnant women has been developed. The Obstetric Fall Risk Assessment System (OFRAS) [57] was created to improve the accuracy of fall risk assessment the obstetric unit and designed to assess potential risk factors that a woman might encounter throughout her stay. The authors identified six fall risk categories: prior history of fall, cardiovascular, hemorrhage, neuro-function, motor activity and medication. The implementation of the OFRAS tool has decreased the number of falls and increased staff awareness of obstetric fall risk factors [57]. Based on the identified risk factors, the OFRAS tool is applicable in the obstetric hospitalized patients, but is not applicable to the general pregnant population, as it does not include many of the risk factors that were highlighted in our findings.

There are several limitations to this systematic review. There are not enough high-quality studies available to generalize the risk factors associated with falls among pregnant women. A major limitation of this review is that several studies in which posturographic assessment was performed, but fall rate was not assessed, as well as the relationship between falling and posturographic assessment, could not have been included in the review. There is also a possibility that not all published articles were included in the review that are available in other databases or published in other languages. Future research should further investigate both extrinsic and intrinsic risk factors for falls during pregnancy. There is also a need to investigate ways to increase postural stability and prevent falls during pregnancy. As exercise is a possible prevention strategy, future research should focus on establishing what form of exercise is effective in preventing falls during pregnancy.

Conclusion

In this systematic review, we identified 11 extrinsic and 13 intrinsic risk factors for falling during pregnancy. Pregnant women younger than 30 years old and taller than 160 cm are more likely to experience a fall during pregnancy. Musculoskeletal and physiological changes that occur during pregnancy challenge the postural balance and increase the risk of falls. Walking on stairs, hurrying, slippery floors, carrying an object or child, walking on uneven ground, wearing inappropriate shoes, poor lighting and cluttered area are the most important extrinsic risk factors for falls during pregnancy. Pregnant women should use hand railings when walking on stairs and take extra care when rushing or carrying an object or child. Joint laxity and increasing abdominal circumference as pregnancy advances shift the center of gravity of the body that leads to postural instability and increased risk for falling. Some disorders, such as gestational diabetes, hyperemesis gravidarum and low back pain as well as a sedentary lifestyle also increase fall risk during pregnancy. Exercise was identified as a possible prevention strategy as it helps pregnant women to learn how their bodies move and change as well as increases ankle stiffness. For pregnant women with a higher risk of falling, the use of maternity support belts should be considered. Pregnant women should receive some form of education on risk factors for falling and how to reduce it. Future research should focus on prevention strategies and education of pregnant women as a possible mean to lower the incidence of falls during pregnancy.

Disclosure statement

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