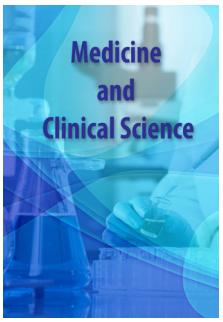
Medicine & Clinical Science

Original Article



The Impact of the Gestational Period and Weight on Individual, Task and Environmental Constraints as Related to Perceived Confidence when Completing Ambulatory Tasks in Pregnant Women

Abigayle E Fontaine, Eryk P Przysucha* and Taryn Klarner

School of Kinesiology, Lakehead University, Thunder Bay ON, Canada.

Correspondence

Eryk P Przysucha
School of Kinesiology, Lakehead University, Thunder Bay ON, Canada.

- Received Date: 06 Dec 2023
- Accepted Date: 20 Dec 2023
- Publication Date: 26 Dec 2023

Keywordst

Newell's Model of Constraint's, Gait, Ambulation, Motor control, Gestational age, Trimester, ADL's.

Abstract

Background: *Pregnancy and the physical, sensory, perceptual, and motor changes that coincide with pregnancy can affect a person's ability to perform basic activities of daily living (ADL's) that involve ambulation. Previous research suggested that weight and gestational age (trimester) are factors that impact woman's ability to ambulate through daily tasks, however, these issues require further investigation. Newell's model of constraints was used as a framework to shape the questionnaire investigating the ability to perform different ambulatory activities across various constraints. Thus, the purpose of this study was to examine whether variables such as pre-pregnancy weight (under vs. over 155 pounds) and trimester (before vs. after 26 weeks) had an impact on the ability and perception to perform different tasks requiring ambulation.*

Methods: *Twenty pregnant or postpartum women (M = 29.7 years; SD = 3.6) were recruited and asked to complete a 15-item online survey exploring their abilities to complete a variety of daily tasks involving balance. Also, open ended questions were posed to gain qualitative insight into their experiences. A series of independent samples T-tests were used to analyse the data.*

Findings: *The results revealed predominantly no statistical differences between the levels of the variables manipulated. At the descriptive level the women indicated that they were relatively comfortable performing the different tasks. However, the qualitative responses suggested that although they were capable, they expended a substantial amount of energy to avoid falling, resulting in fatigue and soreness. Also, they experienced overall mental anguish and feelings of being overwhelmed when performing even simple tasks involving gait.*

Conclusion: *Overall, it was surprising that weight and gestational age, which intuitively should have an impact, did not have a more pronounced effect on the women's confidence in performing ambulation tasks. Nevertheless, qualitative responses confirmed the challenging effects of pregnancy on the way women engage in activities of daily living.*

Introduction

Pregnancy coincides with adverse changes throughout the gestational and post-partum period [1]. These changes have been reported to affect a woman's perceived ability to navigate through the activities of daily living due to changes in proprioception and in their motor control abilities [1,2]. The pregnancy journey as well as the birthing process, produces large-scale systemic and musculoskeletal changes to the pelvic girdle as well as changes in the centre of mass as the pregnant belly grows larger creating a need for adaptations [3,4]. Importantly, there is also the release of the hormones which are responsible for relaxing joints to create space in preparation for delivery [5]. Joint laxity and instability increase with advanced gestational age and are often accompanied by a perceived lack of competence in completing activities of daily life without falling or staggering. This is particularly relevant when walking on flat surfaces and even more so when ambulating up and down the stairs. Inoue-Hirakawa et al, [6] and more recently Waugh et al, [7] and Fontaine et al, [8] confirmed that joint laxity, instability, and perceived lack of competence were factors which increased both pain and fear of injury for women attempting to complete activities of daily living. From the biomechanical standpoint, the lasting effects of joint laxity, specifically in the knees and hips resulted in decreased stability in the knee joint stabiliser muscles and ligaments [5]. It was also indicated that the physiological changes which accompany pregnancy cause a cascade of long-term issues such as osteoarthritis and articular stresses that affect force distribution within the joint, resulting in further deterioration of these weight-bearing joints which are critical in ambulation [5].

Citation: Fontaine AE, Przysucha EP, Klarner T. The Impact of the Gestational Period and Weight on Individual, Task and Environmental Constraints as Related to Perceived Confidence when Completing Ambulatory Tasks in Women Who Are Pregnant. Med Clin Sci. 2023;5(8):1-6.

As pregnancy progresses there is an increased reliance on visual cues when completing tasks involving ambulation as women cannot visualize their foot placement over their pregnant bellies [2]. Thus, the need to correct their posture as they walk increases, and this issue becomes exacerbated as the women move further along their pregnancy [9]. Flores et al, [10] found that when walking on the treadmill women who were pregnant exhibited more postural corrections than those who were not, thus further supporting the notion that dynamic balance and related activities involving ambulation are affected by pregnancy. Furthermore, weight gain which often accompanies the pregnancy may affects gait and a person's ability to complete ADLs with confidence. In research investigating the effect of weight gain, Inoue-Hirakawa et al, [6] found that excessive weight proved to be a barrier to performance of appropriate adaptive movements and created excess strain on joints which were already unstable as a result of the aforementioned physiological and morphological changes that accompany pregnancy.

Given that the impact of gestational age as well as weight on ambulation has been noted, and the current body of research often does not consider people who are more than six weeks postpartum more research is warrened. Thus, the purpose of this research was to examine the perceived ability of pregnant women to ambulate through their environment while performing activities of daily living with confidence and competence. It was hypothesised that women who are at a more advanced stage of pregnancy would have increased difficulty ambulating through their environment, and in their performance of ADL's respectively. Additionally, it was expected that larger weight gain would have greater impact on perceived difficulty navigating through their environment.

Methods

Participants

Twenty participants between the ages of 23 and 36 were recruited from local medical clinics via purposive and snowball sampling. Once ethical approval was granted, participants were recruited through the use of posters which were posted at three different clinics; Maternity Care Midwives, the Lakehead Nurse Practitioner Clinic, and Oakenfold's fitness (private fitness company for pregnant and postpartum women) as well as through social media (Facebook and Instagram). To be included in the study participants had to be 18 years of age or older and be currently pregnant or up to 6 months postpartum. Participants who indicated their desire to participate in the study and met the inclusion criteria were sent a link to the questionnaire via Survey Monkey. This platform also provided the information letter and informed consent form. The letter informed the participants of their right to not answer any question that they did not wish to as well as explaining that they were not obligated to complete the full survey. Once the appropriate contact information was given, the participants were able to continue the survey. The date capturing the demographic as well as morphological characteristics of the participants is conveyed in Table 1.

Protocol

In this study, the ability to carry out tasks involving ambulation was analysed in several different contexts. Newell's Model of Constraints [11,12] was utilised to provide structure to the questionnaire that was distributed to the participants. The questionnaire investigated gait in the context of environmental constraints which potentially affect the quality of a person's motor behaviours when ambulating in various terrains such as icy steps or uneven sidewalks. Individual constraints were broken down further into two categories. Structural constraints referred to the morphological characteristics of an individual such as height, weight or belly circumference. In this context the functional constraints were related to the level of anxiety, perceived competence, and level of fear. Finally, task constraints highlighted activities which require a predetermined set of movements to accomplish a goal and included tasks such as ambulating while carrying a load, or walking up and down steep slopes/stairs, doing exercise or household chores, walking on icy sidewalks, or being in hot temperatures and navigating through crowded spaces.

Each participant filled out a survey which was categorised into 5 sections. First, demographic information was collected (see Table 1). Section two included fifteen questions divided into three different constraints; five in each section investigating environmental, individual and task constraints as it relates to confidence in gait as they navigate their environment throughout pregnancy. Additionally, women who were in their last trimester as well as postpartum were asked five questions surrounding their motor capabilities as they are affected by late stage pregnancy. A Likert scale was used to grade their responses, one representing a significant lack of confidence to complete the ADL's and five representing a high degree of confidence. The last section posed an open ended question which was intended to provide a space for the participants to share any important experiences or concerns that they had. This section was included intentionally to gain qualitative insight into women experiences.

Statistical analysis

The SPSS program (statistical package for the social sciences) was utilized to analyse the quantitative data. A series of independent samples T-tests were carried out at 0.05. A between subjects design was incorporated with gestational age status (before vs. after 26 weeks) and weight status (above vs. below 155lbs) as the independent variables.

Table 1. Descriptive statistics for weight, age, gestational age (pregnant/postpartum), and physical activity status.

	Minimum	Maximum	Mean	Std. deviation
Participant age (Yrs.)	23	36	29.7	3.6
Pre-pregnancy weight (lbs.)	115	260	156.75	35.86
Activity level (min/week)	0	420	168.5	123.64
Gestational age (weeks)	8	39	25.27	9.16
Postpartum duration (weeks)	7	29	14.25	10.04

Results

Impact of trimester on gait

The data regarding the effect of gestational age as a factor which affects a woman's ability to navigate through her environment did not show any statistically significant results across contexts. Data was analysed across three main categories: individual, structural and functional constraints (Figure 1 questions 1-7), task/context constraints (Figure 2 question 1-6) and environmental constraints (Figure 3 questions 1-6). The data showed that women of more advanced gestational age greater than 26 weeks reported that their ability to ambulate without falling was equal to or better than those who were in their first or second trimester (pregnant for 26 weeks or less).

Individual constraints

Individual constraints were analysed across the pregnancy timeline with regard to gait and the effects individual constraints pose on a pregnant person's confidence while ambulating (Figure 1 questions 1-7). Again, no statistical differences were noted between groups. Regardless of trimester the participants displayed very similar scores across all seven questions pertaining to their confidence in their ambulatory abilities. Question 1 pertained to the participant's ability to avoid bumping into things. Questions 2 and 6 looked at the confidence to ambulate with excessive pelvis pressure, and excessive pelvic pressure with an increased sensation of needing to urinate. Additionally, the confidence to ambulate whilst not being able to visualize their feet (question 3) and the confidence in the ability to avoid fatiguing more quickly than they did while not pregnant (question 4) was measured.

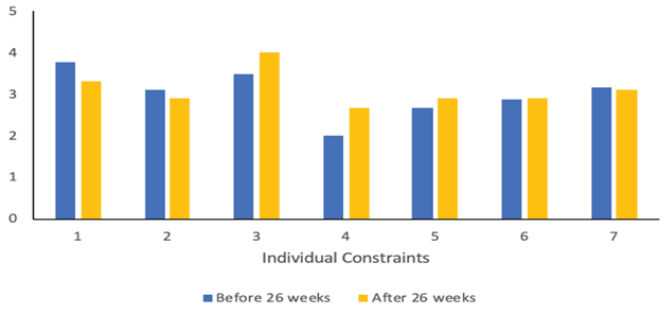


Figure 1. Average participant responses to questions investigating confidence ambulating as it pertains to individual constraint.

Task constraints

The data demonstrated that across all ambulatory tasks the scores were relatively high on the likert scale measuring confidence. Additionally, there are no significant differences between groups (trimester 1/2 and trimester 3/4). Participants in both groups perceived themselves as fairly confident in their ability to carry loads to and from their house without falling (question 1), as well as in their ability to step onto and off of escalators without a fear of falling (question 2). Question 3 pertained to their confidence in completing yard chores such as raking leaves or shovelling without falling. Task-related questions also asked about the participants' confidence in participating in exercise or sport that they previously participated in before becoming pregnant (question 4). Finally, questions 5 and 6 inferred the participants' confidence in completing work tasks (question 5) and daily activities (question 6) without excessive fatigue.

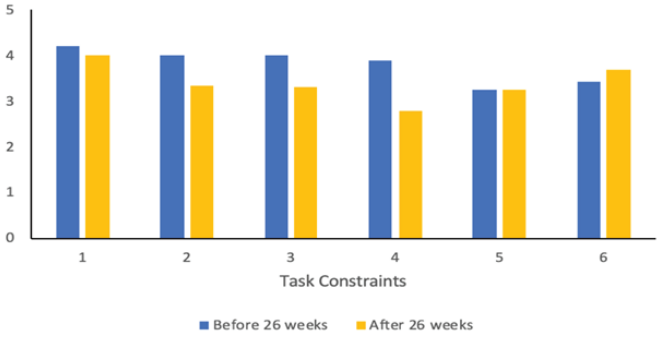


Figure 2. Averaged participant responses pertaining to questions investigating confidence while completing various ambulatory tasks.

Environmental constraints

Lastly, environmental constraints were examined in regard to the participants' confidence when ambulating through various environments (figure 3 question 1-6). No statistical significance was observed between groups throughout this category. In fact, the participants expressed high degree of confidence across all 6 questions. Question 1 and 2 looked at the participants' abilities to walk up and then down stairs with confidence while pregnant. Question 3 investigated the participants confidence ambulating in crowded spaces when people walk past them rapidly. Additionally, the survey asked participants about their confidence level ambulating in snowy or icy weather, and again the data did not reveal any significant differences between groups (question 4). The same was true when the participants were asked about their experiences when completing normal walks without excessive fatigue (question 5) or ambulating with confidence while walking in rainy weather (question 6).

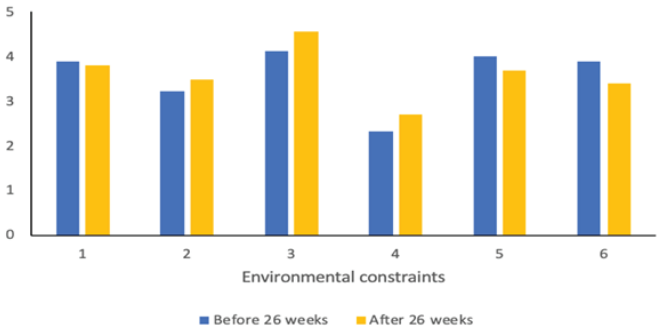


Figure 3. Averaged participant responses pertaining to questions investigating confidence while ambulating through various environments.

Impact of weight on gait

In addition to analysing trimester as a possible factor which influences ability to ambulate, also the potential impact of weight was considered. In line with the previous analysis, statistical differences were not observed across the contexts. The data in Figure 4, questions one through seven, captured the results pertaining to individual constraints, whereas Figure 5, questions one through six, allowed to make inferences about task related constraints. Lastly, Figure 6 revealed the perceptions as related to the impact of the environmental constraints.

Individual constraints

Participants were categorized by weight into those who were under or over 150lbs. When analysing the individual constraints as related to gait, both groups reported that they were confident across questions, assessing their abilities around three and four on the Likert scale. This indicates moderate amount of confidence. Question one investigated proprioception and the pregnant person's ability to avoid bumping into things. Question two highlighted pelvic pain or pressure and question three was where participants scored themselves highest in regard to their confidence walking when they could not visualize their feet over their pregnant belly. The lowest scores were derived from the question which focused on the participants' ability to be involved in activities they did pre-pregnancy without fatiguing more quickly (question four). Once again the participants perceived themselves as having low to moderate degree of confidence. Question five examined the participants' ability to ambulate with back pain and pressure. Excessive pelvic pressure resulting in the sensation of needing to urinate was assessed in question six, where the greatest difference appeared in women who were later in pregnancy. Question seven revealed that on average these women had a higher level of fear and anxiety when undertaking ambulatory tasks.

Task constraints

The impact of weight on the ability to ambulate was also assess across different task demands. As per previous analysis, also here there the data failed to show statistically significant differences. Women who were lighter tended to perceive themselves as more confident consistently with the exception of question three. Question three showed an opposite effect, however the results were still relatively consistent with other questions in the survey. The items related to task constraints examined participants' confidence when carrying groceries to and from a car (question 1), confidence stepping onto and off of an escalator (question 2), while question three asked the participants about their confidence when doing yard work or similar outdoor chores. Question four investigated the confidence completing exercise in which they had participated pre-pregnancy. Finally, questions five and six investigated the participants' ability to complete tasks in their work (question five) and when engaged in ADL's (question six) without experiencing excessive fatigue.

Environmental constraints

It was also important to investigate the participants' confidence when navigating through various environments. As such, the questions allowed to make inferences about their confidence ambulating up and down stairs (questions one and two), when walking in a crowded space where people might bump into them (question three), and their ability to walk with confidence on snowy or icy terrain (question four). Also, they were asked about their ability to complete normal walks, such as walking the dog, without experiencing excessive fatigue (question five), and finally question six asked the participants about their confidence walking in rainy or cold weather.

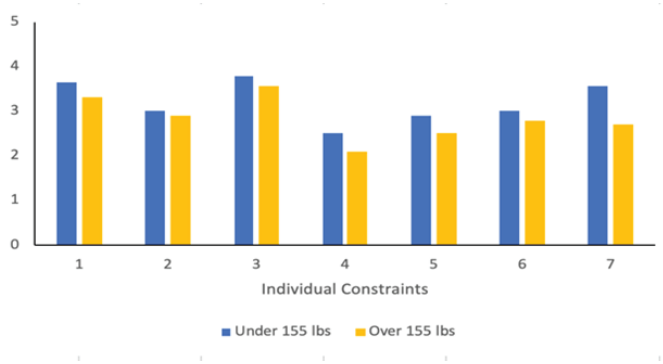


Figure 4. Average responses to individual constraint survey questions regarding weight and confidence with ambulation.

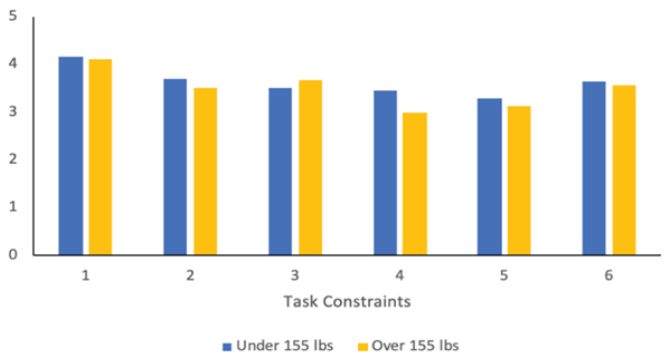


Figure 5. Averaged participant responses pertaining to questions investigating confidence while completing various ambulatory tasks categorized by weight above or below 150lbs.

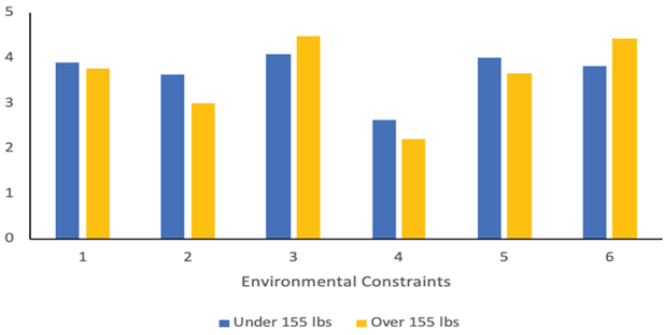


Figure 6. Averaged participant responses pertaining to questions investigating confidence while completing various ambulatory tasks categorized by weight above or below 150lbs.

Qualitative insights

The inferences gained from the qualitative component of this research were somewhat contradictory to the quantitative data reported. As evident from Table 2, several themes emerged. These themes include the presence of pain, specifically pelvic girdle pain. Also, instability was noted, when ambulating due to the morphological changes and resultant lack of balance in later stage pregnancy. Also, several participants identified a lack of resources available to support them, which is a unique constraint to northern Ontario, and which directly impacted some of the women's ability to ambulate.

Discussion

The purpose of this research study was to delineate which factors play a significant role in the perceived competence when completing gait related tasks for pregnant women. Newell's model of constraints (1986) was used as a guiding framework to

Table 2. Qualitative reports/key themes of ambulatory barriers during pregnancy

Fear/anxiety and pain as barriers to ambulation.
Participant 2 - "Taking things a lot slower than I have pre-pregnancy when going out for longer walks or in uneven/slipper terrain to have someone with me to be able to use for stability if needed."
Participant 5 - "using a squatty potty when going to the washroom to help alleviate added tension/pressure on the pelvic floor."
Participant 6 - "My pelvic bone hurt daily to walk, climb stairs, change weight from one leg to another and in bed (my pelvic bone throbbed while asleep)."
Participant 7 - "Moving slowly on stairs (I recently fell down a full flight of stairs"
Participant 8 - I'm a miserable human at the moment I do believe that the modified bed rest is directly correlated to my decreased immobility, weight gain, and increased third trimester pregnancy symptoms such as pregnancy induced carpal tunnel syndrome and pitting edema
Participant 9 - "going down the stairs while carrying something large (think full laundry basket) is scary."
Participant 12 - Using handrails on stairs while carrying another baby. Walk slowly (waddle) on ice, Frequent breaks housecleaning.
Participant 21 - "anxiety and fear of falling 100% affects my confidence when walking and actually makes me more at risk for injury as I don't walk/move naturally but more stiff/robotic like"
Participant 31 - "consciously giving myself more space to sit down/get up and choosing more accessible placed to sit (when playing on the floor with my other child, I'd get up/down beside the couch or a chair so I had something to steady myself if needed, instead of int the middle of the room"
Participant 31- "I tried to consciously avoid multitasking or carrying out one task at a time (not carrying groceries while talking on the phone and walking upstairs while trying to dodge the dogs like I normally would"

formulate the items presented to the participants. Collectively, the quantitative analysis did not reveal any significant differences between the variables being examined. This was an unexpected result given that less than optimal gait patterns of pregnant women were reported in the past research [9]. Also, intuitively the physical, sensory and perceptual changes associated with pregnancy were expected to result in significant differences due to weight as well as trimester.

Trimester as it affects ambulatory abilities

Previous research suggested that women who are further along their gestational age will exhibit more functional issues resulting in less confidence in completing their daily activities. This pattern of discomfort should exponentially increase as pregnancy progresses [1,2]. It was hypothesized that women who were further along in their pregnancies would exhibit this trend. However, this was not confirmed by the quantitative data regarding ambulation when participants were grouped by their gestational age. It was reported that women across the contexts were confident in their abilities to complete their ADL's. It was also noted that three of the lowest scoring questions, when investigating trimester, revealed that women who were in their first and second trimester experienced greater fatigue when participating in activities in which they had participated pre pregnancy. As evident from Figure 1, question four examined specifically the women's ability to complete ADL's without fatiguing more quickly as compared to their pre-pregnancy behaviour. Additionally, question five showed the same trend where the scores did not differentiate between groups. It can be hypothesized that women in their earliest stages of pregnancy may be exhibiting a more enhanced senses of fatigue as a result of a lower confidence in the abilities to complete their daily tasks. This pattern of results may be due to the fact that the concept of pregnancy is novel to them. As such, any change may result in more extensive adaptation because it is an entirely new experience for them psychologically in addition to the changes in their physical bodies. Also, in relation to fatigue in general, during the first trimester there is a large-scale hormonal change that occurs within the body which additionally places greater stress on the pregnant woman [5]. Thus, a number of interacting factors, which place an increased demand on the body, may result in a greater perceived fatigue in women who are at the beginning of their pregnancy.

The study showed that the expected impact of individual constraints, as well as some specific environmental constraints, on gait was observed as originally hypothesied. Women in later stage of pregnancy reported that they were more confident than their first and second trimester counterparts. Individual constraints included things such as fear, anxiety, and confidence, as well as morphological characteristics such as belly circumference or weight. These women, who weighed more due to their gestational status and had greater morphological differences to their pre-pregnancy bodies, perceived themselves as being more confident. It was hypothesized that this surprising result may have been due to the fact that these women had been pregnant longer, thus they were able to gain adaptive strategies as compared to those who were in their early-stage of pregnancy. Additionally, as their pregnancy was more apparent, it is possible that other people were more aware of them. This may have resulted in additional offers of help or others being more careful to avoid physical contact with them.

Weight as it affects ambulation in pregnant individuals

Weight was predicted to be a factor that would impact the ability to ambulate when performing the activities of daily life. This was supported by previous work [6], showing that increased gestational weight gain negatively impacted a woman's confidence to complete dynamic balancing and ambulatory tasks. However, the women in this study regardless of their pre-pregnancy weight perceived themselves as highly confident across constraints. As evident from Figure 4, question four displayed the lowest score and mimicked the trends of previous research that indicated that lighter women would have an easier time in the ambulatory tasks. This question asked participants to assess their ability to participate in activities which they participated in pre-pregnancy. Women who were over 155lbs pre-pregnancy scored themselves around 2.5 on the Likert scale while their under 155lbs partners self-scored 3.2 on the scale from 1-5. Additionally, in reference to Figure 5, the women scored relatively high across questions indicated increased confidence. In line with the current body of research, women who were lighter had increased confidence as opposed to the women who were heavier. When investigating environmental constraints, several questions presented interesting insights. Figure 6 indicated that across both groups question four was scored relatively low. On the other hand, questions three and six, produced results that were contradictory to what the current body of research suggested. Question three asked about the women's confidence when people bumped into them unexpectedly, while question six looked at their ability to walk outside in slippery environments. The responses for both questions indicated that

women who were heavier actually perceived more confidence than those who were lighter, in this context. Collectively, in contrast to the initial hypotheses, women in both groups had similar, high degree of confidence and comfort across the different constraints.

Qualitative

The qualitative data provided more in-depth insights into the experiences of the women. Several themes arose from the qualitative data which did not confirm the findings of the quantitative data. Fear and anxiety, as well as pain were repeatedly identified by the participants as issues which interfered with their ability to complete their ADL's. For example, women reported significant physiological impairments caused by pregnancy which affected their ability to ambulate. This pattern of results was in line with previous work [7]. Two participants reported severe pelvic girdle pain as a result of either the pregnancy itself, or because of the delivery. Participant six wrote "My pelvic bone hurt daily to walk, climb stairs, change weight from one leg to another and in bed (my pelvic bone throbbed while asleep)" (Table 2). Participant five reported that she has been "using a squatty potty when going to the washroom to help alleviate added tension/pressure on the pelvic floor" (Figure 2). Overall, the inferences emerging from the qualitative data indicated that pain was a significant factor which required these women to make adaptations to their daily routines in activities as simple as shifting weight from one foot to another, which is the basis of any ambulatory activities.

In the qualitative data, more participants reported that fear or anxiety was a contributing factor to their lack of confidence. One participant stated that "anxiety and fear of falling 100% affects my confidence when walking and actually makes me more at risk for injury as I don't walk/move naturally but more stiff/robotic like". Participant nine shared that "going down the stairs while carrying something large (think full laundry basket) is scary." Clearly participants were experiencing fear and anxiety, even if this was not preventing them from participating in their ADL's. Some participants indicated the adaptations that they adopted in order to manage their daily lives allowed them to function more effectively. One participant indicated "I tried to consciously avoid multitasking or carrying out more than one task at a time (not carrying groceries while talking on the phone and walking upstairs while trying to dodge the dogs like I normally would" (participant thirty-one). Thus, the self-adaptations that were noted above may have contributed to the lack of reported anxiety in the quantitative data making the results of this study equivocal.

Limitations

From the sampling perspective, it is possible that including women who were in their fourth trimester (post-partum) may have skewed the results to reveal a more positive representation of their abilities. This group of individuals placed a unique constraint on the data because they were no longer pregnant and as such their bodies were no longer under the demand of gestating a foetus. Additionally, the physical activity status of the participants varied greatly and as such may have been an important aspect to investigate when analysing the participant data. From the standpoint of the items included in the questionnaire, their relevance and representativeness may constitute an additional limitation to a more accurate representation of the participants' experiences.

Conclusions

The purpose of this research was to examine the perceived ability of pregnant women to ambulate through their environment while performing activities of daily living with confidence and competence. In contrast to the available research, quantitative data demonstrated that the participants were generally confident across different contexts. Also, uniformly there were no differences between the groups being examined. The qualitative data, however, seemed to be in line with previous work indicating that anxiety and a fear of falling, as well as pain, were factors which affected the ability to complete the different ambulatory tasks. The discrepancy evident here, when qualitative and quantitative data was triangulated, further supported the importance of both type of inferences to be considered when perception of various physical and psychological issues are investigated.

Declarations of conflict of interest

There are no competing or conflicts in the creation of this paper by any of its authors.

Acknowledgments

The authors of this paper would like to thank The Lakehead Nurse Practitioner Led Clinic, Oakenfold Fitness, and Maternity Care Midwives in Thunder Bay Ontario for their assistance in recruitment efforts.

References

1. Branco M, Santos-Rocha R, Aguiar L, Vieira F, Veloso A. Kinematic analysis of gait in the second and third trimesters of pregnancy. J Pregnancy. 2013;2013:718095..
2. Butler EE, Colón I, Druzin ML, Rose J. Postural equilibrium during pregnancy: decreased stability with an increased reliance on visual cues. Am J Obstet Gynecol. 2006;195(4):1104-1108.
3. Fontana Carvalho AP, Dufresne SS, Rogerio de Oliveira M, et al. Effects of lumbar stabilization and muscular stretching on pain, disabilities, postural control and muscle activation in pregnant woman with low back pain. Eur J Phys Rehabil Med. 2020;56(3):297-306.
4. Miller JM, Low LK, Zielinski R, Smith AR, DeLancey JO, Brandon C. Evaluating maternal recovery from labor and delivery: bone and levator ani injuries. Am J Obstet Gynecol. 2015;213(2):188.e1-188.e11.
5. Chu SR, Boyer EH, Beynnon B, Segal NA. Pregnancy Results in Lasting Changes in Knee Joint Laxity. PM R. 2019;11(2):117-124.
6. Inoue-Hirakawa T, Ito A, Iguchi S, et al. The effect of simulated gestational weight gain on balance, gait, and fear of falling. Nagoya J Med Sci. 2021;83(1):41-49.
7. Waugh CM, Scott A. Case Studies in Physiology: Adaptation of load-bearing tendons during pregnancy. J Appl Physiol (1985). 2022;132(5):1280-1289.
8. Fontaine AE, Przysucha E, Klarner T. Impact of Gestational Period and Weight on Individual, Task and Environmental Constraints on Balance in Pregnant Women. American Journal of Medical and Clinical Sciences. 2022;7(4)
9. Krkeljas Z. Changes in gait and posture as factors of dynamic stability during walking in pregnancy. Hum Mov Sci. 2018;58:315-320.
10. Flores D, Connolly CP, Campbell N, Catena RD. Walking balance on a treadmill changes during pregnancy. Gait Posture. 2018;66:146-150.
11. Haywood M, Getchell N. Life span motor development. Human kinetics.
12. Health Canada. (2016, September 22). Canadian Guidelines for Body Weight Classification in Adults - Quick Reference Tool for Professionals. Canada.ca. 2019. https://www.canada.ca/en/health-canada/services/food-nutrition/healthy-eating/healthy-weights/canadian-guidelines-body-weight-classification-adults/quick-reference-tool-professionals.html
13. Rienhoff R, Tirp J, Strauß B, Baker J, Schorer J. The 'Quiet Eye' and Motor Performance: A Systematic Review Based on Newell's Constraints-Led Model. Sports Med. 2016;46(4):589-603.