published: 1 Oktober 2026
doi: 10.21070/midwiferia.v12i2.1910

Development and Preliminary User Acceptance of a Maternity Support Belt Prototype Among Third-Trimester Pregnant Women

Karolin Adhisty[1*], Mutia Nadra Maulida[2], Firnaliza Rizona[3], Destri Kurnia Utami[4]
[1,2]Universitas Sriwijaya
Email: karolin.adhisty@fk.unsri.ac.id

OPEN ACCESS
ISSN 2548-2246 (online)
ISSN 2442-9139 (print)
Edited by: Nurul Azizah
**Correspondence: Karolin Adhisty*
karolin.adhisty@fk.unsri.ac.id
Received: 15 Sept 2026
Accepted: 30 Sept 2026
Published: 1 Okt 2026

Citation: Karolin Adhisty (2026) Development and Preliminary User Acceptance of a Maternity Support Belt Prototype Among Third-Trimester Pregnant Women

Midwiferia Jurnal Kebidanan. 12:2. doi: 10.21070/midwiferia.v12i2.1910

ABSTRACT

Introduction *Low back pain is a musculoskeletal problem that can occur during pregnancy, and this condition can interfere with daily activitie. Maternity support belts is used as a conservative management to help prevent this. This study aimed to develop a prototype of a maternity support belt and assess its initial user acceptance among women in their third trimester of pregnancy.* ***Methods*** *The development process followed five initial stages of Research and Development (R&D): needs analysis and literature review, product planning, prototype development, limited-scale testing, and major product revision. The limited-scale testing involved five pregnant women (aged 25–35) in their third trimester with low-risk pregnancies in Sakatiga Village, Indonesia, between October and November 2025. Participants used the prototype for 15 minute, after which their acceptance scores were measured. Initial acceptance was evaluated using a questionnaire based on Technology Acceptance Model (TAM).* ***Results*** *The results showed percentage scores of 99% for Perceived Usefulness (POU), 99% for Perceived Ease of Use (PEU), and 100% for Attitude Toward Using (AOT). The questionnaire consisted of 11 items, with responses measured on a Likert scale; scores were calculated as a percentage of the total possible score for each indicator.* ***Conclusion*** *In conclusion, a maternity support belt prototype was developed, and initial questionnaire scores among the test group were high. These findings reflect only the perception of initial acceptance; they do not prove that device can prevent or reduce pain, improve quality of life, or guarantee clinical safety and effectiveness.*

Keywords: low back pain**,** maternity support belt, pregnancy, prototype development, user acceptance

INTRODUCTION

Pregnancy involves physiological and biomechanical changes that can contribute to musculoskeletal symptoms, including low back pain (LBP) and pelvic girdle pain (PGP) [1], [2], [3]. Musculoskeletal problems arise due to joint laxity, triggered by an increase in the hormones relaxing and progesterone. This factor leads to fluid retention, which can exert pressure on soft tissues during pregnancy, thereby making pregnant women susceptible to musculoskeletal injuries, lower back pain being one such example [2], [4], [5]. The relaxation of pelvic ligaments is a necessary physical change during pregnancy and childbirth, beginning as early as the tenth week. The levels of the hormones responsible for this stabilize by the second trimester and can be detected through serological testing prior to labor [4]. Although these conditions are interrelated, they are distinct phenomena and should not be conflated as a single, homogeneous condition. The resulting symptoms can interfere with mobility, sleep quality, and daily activities, particularly as the pregnancy progresses [2], [4], [6].

As the uterus grows, body mass distribution and posture change, with the greatest concentration of load shifting to the lumbar region (lower back) and the pelvis. Although an increase in lumbar lordosis can occur during pregnancy, it should not be assumed to be the sole cause of low back pain (LBP) to the exclusion of other contributing factors [7], [8], [9]. LBP specifically refers to pain located in the lower back, whereas pelvic girdle pain (PGP) refers to pain localized around the pelvic girdle. Distinguishing between these two conditions and their respective locations is crucial when designing and evaluating pregnancy support aids [7], [9], [10], [11], [12]. Maternity support garments and belts have been investigated as non-pharmacological options for managing discomfort during pregnancy. A systematic review and meta-analysis of seven studies indicated a reduction in pain through the use of pelvic belts; however, the confidence intervals in these studies included values suggesting that the effect may be minimal [13], [14]. The authors rated the certainty of this evidence as low to very low [15]. These findings indicate a need for further evaluation, rather than claims that the belt can definitively prevent or treat pain.

This study focuses on the initial development of a pregnancy support belt prototype intended for women in their third trimester. The research team designed a prototype to provide support around the abdominal and waist areas for pregnant women, incorporating

a massage component at the waist. This design is based on an assessment of pregnant women's needs for supportive garments, as well as existing literature on pregnancy support aids [13], [16]. Although the massage component is one of the design features, evidence regarding the effectiveness of this massage function for lower back pain in general cannot be taken as proof that this specific device is effective during pregnancy [17]. Given the uncertainty in the scientific clinical evidence reviewed, early product development must be able to distinguish between design feasibility and user acceptance, as well as clinical success on the other hand. While limited, small-scale testing can provide an initial indication of perceived utility and ease of use, it cannot determine whether a product is capable of reducing pain, improving lumbar function, or ensuring long-term safety.

Therefore, this study aims to develop a prototype of a maternity support belt and report preliminary scores from a user acceptance questionnaire administered to five women in their third trimester of pregnancy. This study is not designed with a sufficient statistical basis to evaluate changes in pain intensity, disability, or the quality of life of the mothers during pregnancy.

METHODS

This study used a research and development approach (R&D) consist of 10 step [18]. This research is divided into 2 phases; this research completes the first phase to the fifth stage. The process consisted of five stages: (1) needs analysis and literature review, (2) product planning, (3) prototype development, (4) limited testing, and (5) major product revision. The research design covered only these initial five steps; subsequent stages namely field testing and dissemination were not included in this report.

The limited testing was conducted between October and November 2025, in collaboration with DND Technology as a developer of a tool based on a design previously created by a researcher, and took place in Sakatiga Village, Indonesia. This report described the process as a limited evaluation of user response. The initial acceptance results presented in this report consisted of usability questionnaire scores based on the Technology Acceptance Model (TAM).

Five pregnant women participated in the limited test. The reported inclusion criteria were:

a. Pregnancy in the third trimester

b. Maternal age of 25-35 years

c. a Low-risk pregnancy

A low-risk pregnancy is a condition in which the mother has no pre-existing medical issues, nor are there any complications affecting the mother or the fetus; the pregnancy support device is tested by mothers who meet these criteria for a duration of 15 minutes to help prevent potential health complications and 5 minute for using a masssage tools. Initial pre-eliminary uses 5 respondents to determine the initial acceptance of this tool, this method is in accordance with the Tessmer model which tolerates initial respondents to try the tool as many as 5 people [19].

The study team reported using a questionnaire described as based on the Technology Acceptance Model (TAM) [20], with three labels: POU, PEU, and AOT. This research report defines POU as ease of use, PEU as usefulness, and AOT as acceptance/attitude The reported percentage was calculated as: P (%) = (actual score / maximum possible score) × 100.

The percentage of the results is interpreted as the criteria score per reported section, divided by the maximum score obtained, then multiplied by 100. This interpretation is provisional until the number of questions, answer choices, and scoring key are verified.

This study received ethical approval from the Faculty of Medicine, Universitas Sriwijaya (approval number 402-2025) on October 21, 2025. The research procedure began with an explanation of the study's objectives, the completion of an informed consent form by participants, and the setup of equipment by the researchers. The researchers ensured that the collection of documentation prioritized the privacy of the respondents at all times.

RESULT

The reported development process consists of five stages: needs analysis and literature review, product planning, prototype development, limited testing, and major product revision. This prototype is designed to provide support to the abdominal and lumbar

regions, featuring a lumbar support/massager component positioned over the L1–L5 area. The design was developed as an initial-stage prototype following a needs analysis and literature review. The complete specification comprises a maternity support belt and a massager. The maternity support belt measures 42 cm in length, with an upper fastening strap that is 21 cm long.

Table 1. Characteristic Responden

Respondent	Age	Education	Occupation	Obstetric history
R1	30	Bachelor	Enterpreneur	Multiparous
R2	29	Bachelor	Housewife	Primipara
R3	32	Junior High School	Housewife	Multiparous
R4	28	Senior High School	Housewife	Multiparous
R5	28	Senior High School	Housewife	Primipara

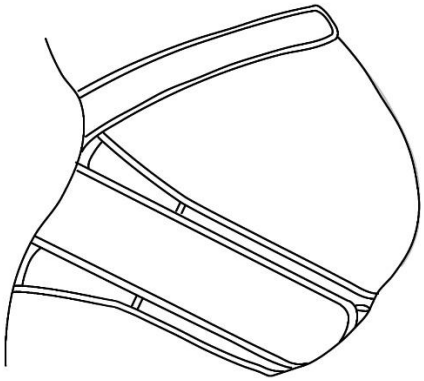
Table 1 explains the characteristics of respondents consisting of age, education, occupation and pregnancy history. It can be seen that all respondents have a history of low-risk pregnancy and have a variety of pregnancy histories with 3 multiparas and 2 primiparas.

Table 2. Components of the maternity support belt

No.	Component	Quantity
1	DC Motor	4 Units
2	Passive circuit	1 Set
3	Active circuit	1 Set
4	12V 3A DC adapter	2 Units
5	Elastic fabric	1 Piece
6	Songket fabric	2 Meters
7	Zipper	1 Piece
8	3D-Printer motor housings	8 Units
9	Heater	1 unit
10	Red LED	10 Units
11	Switch	4 Units
12	Timer control	1 Unit
13	Jumper wires	1 Set
14	Sound-dampening foam	1 Piece
15	Plastic frame	1 Unit

Table 3 describes the components of the maternity support belt, which consist of three parts: a pregnancy support belt, a massager, and an adhesive fastener.

Figure 1. 3D Model of maternity support belt



This figure shows how to use a maternity support belt from the side. The position of the support device must be right at the hip position at L1-L5. The massage device can be removed and reattached as needed. It operates at a rotational speed of approximately 3,000 RPM, with a massage pressure of 1 kPa. This pressure level is set as a safe limit to prevent injury to the pregnant woman

Figure 2. Prototype of Maternity Support Belt



This figure displays several components of the maternity support belt prototype, which consists of three main parts: the maternity support belt, the massage, and the fastener strap.

The next step involves conducting limited testing with five respondents to evaluate usability, utilizing the Technology Acceptance Model (TAM) questionnaire to assess their initial acceptance. The TAM questionnaire comprises four questions for the

Perceived Usefulness (POU) domain, four questions for the Perceived Ease of Use (PEU) domain, and three questions for the Attitude Toward Using (AOT) domain.

The score for each item is calculated based on its respective domain, resulting in a percentage derived from the number of criteria within that domain and the total calculated value for that domain.

Table 3. Preliminary user acceptance questionnaire (n=5)

Domain	ΣSK	ΣSH	P (%)
POU	100	99	99
PEU	100	99	99
AOT	100	100	100

The calculation results in Table 3 show that the initial acceptance rate among the respondents is 99–100%.

DISCUSSION

This study developed a prototype of a maternity support belt equipped with a massage unit for the lumbar region. Initial testing of the prototype conducted on a limited group among five women in their third trimester showed a positive level of acceptance, achieving 99% of the maximum possible score for ease of use and utility, and 100% for acceptance. These scores reflect user perceptions following limited-scope usage. The results cannot be considered evidence of any impact on pain, disability, or the respondents' quality of life factors that were not measured in this study nor can they confirm the level of comfort during prolonged wear. The design’s contribution lies in its lumbar massage mechanism, which distinguishes it from other maternity support belts.

The interpretation of these findings should take into account the broader evidence regarding the use of maternity support belts. Meta-analysis and systematic reviews of previous study, examining pain and disability have yield confidence intervals that include zero, with the certainty of the evidence rated as low to very low [9]; Other research has also found non-significant evidence that maternity support belts can reduce lower back pain (LBP) or pelvic girdle pain (PGP) during pregnancy [6], [7], [21], [22], [23]. Given the significant variation across studies, in terms of belts characteristics, duration of use, and daily wearing patterns [9], while the high level of acceptability observed in this study serves as a necessary starting point for further development, the device is not yet

sufficiently established for practical application.

The principal finding of this early-stage study is that a maternity support belt prototype was developed and the study team reported high questionnaire scores across three acceptance-related domains in a sample of five pregnant women. The contribution is preliminary product development and an initial description of user-reported acceptance, not evidence that the prototype prevents or reduces LBP.

Other findings from previous research on the effect of belts on balance have been inconsistent [10], [11]; therefore, this prototype was not designed to improve body stability for pregnant women. The massage feature is based on evidence derived from use by non-pregnant adults, with benefits that are short-term and supported by a low to very low level of certainty [24], [25]. The Technology Acceptance Model (TAM) was developed for the field of information technology, where perceptions of usefulness and ease of use are the primary determinants of acceptance [16], [20]. In the healthcare sector, this model is typically applied to health information technologies tailored to specific healthcare contexts [13]. Furthermore, TAM measures perceived acceptance, not satisfaction or comfort. Consequently, the term "satisfaction" is not used to describe the results of this study.

CONCLUSIONS

A prototype of a maternity support belt equipped with a lumbar massage unit has been developed through the first five stages of a research and development (R&D) cycle. This prototype showed a positive initial level of acceptance among five women in their third trimester of pregnancy, achieving 99% of the maximum possible score for ease of use and perceived utility, and 100% for acceptance. This limited trial does not prove that the prototype can prevent or reduce lower back pain, improve function or quality of life, or guarantee user safety; these questions require further investigation through larger-scale, controlled studies.

ACKNOWLEDGMENT

The authors thank Universitas Sriwijaya for funding this research under the Early-Career Lecturer Research Scheme (Rector’s Decree No. 0027/UN9/SK.LPPM.PT/2025, 17 September 2025), the participants and Sakatiga Village for their cooperation, and DND

Technology

AUTHOR CONTRIBUTIONS

KA conceived and designed the study, obtained ethical approval and funding, supervised all stages of the research, and served as corresponding author. MNM was responsible for data collection during the limited testing phase, data curation, and formal analysis of the Technology Acceptance Model (TAM) questionnaire results. FR contributed to development of the research methodology, validated the data analysis, and critically reviewed and edited the manuscript. DKU coordinated project administration and fieldwork in collaboration with DND Technology and Sakatiga Village, and contributed to reviewing and editing the manuscript. All authors read and approved the final version of the manuscript.

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