

**EVALUATION OF THE NON-PHARMACOLOGICAL METHODS
OF CONTROLLING PAIN DURING CHILDBIRTH;
USING ANALYTICAL EVALUATION MODELS**

**DISSERTATION SUBMITTED TO THE INSTITUTE OF GRADUATE STUDIES
NEAR EAST UNIVERSITY**

BY

EFE, PRECIOUS ONAKPOJERUO

**PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN BIOMEDICAL ENGINEERING**

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EVALUATION OF THE VARIOUS METHODS OF CONTROLLING PAIN DURING CHILDBIRTH USING ANALYTICAL EVALUATION MODELS
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USING ANALYTICAL EVALUATION MODELS**

**A THESIS SUBMITTED TO THE INSTITUTE OF GRADUATE STUDIES
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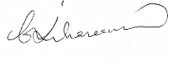




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Approval

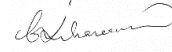
We certify that we have read the thesis submitted by **Efe, Precious Onakpojeruo** titled **“Evaluation of the Non-pharmacological Methods of Controlling Pain During Childbirth; Using Analytical Evaluation Models”** and that in our combined opinion it is fully adequate, in scope, and in quality, as a thesis for the degree of Master of Sciences in Biomedical Engineering.

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I hereby certify that all data in this publication was gathered and presented in compliance with ethical standards and scholarly guidelines. I also affirm that I have properly cited and referenced all information and findings that are not unique to this work, as required by these rules and conduct.

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Efe Precious Onakpojeruo

Abstract

“Evaluation of the Non-pharmacological Methods of Controlling Pain During Childbirth; Using Analytical Evaluation Models”

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August 2022,

Background of Study: Pain is an experience capable of causing tissue damage, it is associated with discomfort and unpleasant emotional and sensory experiences. Childbirth is usually accompanied by severe pain, fear, and anxiety, these factors can stimulate the sympathetic system to increase the release of catecholamines (adrenaline and nor-adrenaline) which can lead to the disruption of the secretion of oxytocin and slow contractions, stop it or even make it irregular. Pain during labor is regarded as one of the most severe forms of pain that can ever be experienced hence, the need for supportive approaches that are effective enough for the reduction of pain during labor. The nonpharmacologic approaches are very effective and more satisfactory methods for controlling pain during labor. Research has shown that women prefer these nonpharmacologic approaches due to the dangers that are associated with the usual pharmacologic approaches and their effects on mothers and neonates during and after delivery.

Objective/Method: The aim of this research is to evaluate and compare the various nonpharmacological approaches to reducing pain during childbirth, and to rank them according to their levels of preference based on selected criteria and assigned weights of importance using one of the multi-criteria decision-making (MCDM) technique called, the fuzzy preference ranking organization method for enrichment of evaluations (PROMETHEE).

Result: The results of this study using the fuzzy PROMETHEE technique indicated that the most effective nonpharmacologic approach for reducing pain was Acupressure with a net flow of 0.0640, followed by Hydrotherapy (Sterile water injection) with a net flow of 0.0252, followed by Acupuncture with a net flow of 0.0201, and then Hypnobirthing with a net flow of 0.0179. The least preferred approach for reducing pain during labor from this evaluation is Transcutaneous Electrical Nerve Stimulation (TENS) with a negative net flow of -0.0457 based on the chosen criteria/parameters of the alternatives and the importance weights given by the experts.

Conclusion: The outcome of this decision-making technique on the treatment approach to reduce pain during labor will help concerned parties such as pregnant mothers, gynecologists, midwives, healthcare supportive units, and hospital management to make an effective decision when the need arises. The fuzzy PROMETHEE technique was proposed to solve the problems associated with identifying the preferred approach for reducing pain during childbirth.

Keywords: childbirth, fuzzy PROMETHEE, neonates, non-pharmacologic-approach, pain reduction

ÖZ

Evaluation of The Various Methods of Controlling Pain During Child Birth Using Analytical Evaluation Models

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Çalışmanın Arka Planı: Ağrı, doku hasarına neden olabilen bir deneyimdir, rahatsızlık ve hoş olmayan duygusal ve duygusal deneyimlerle ilişkilidir. Doğuma genellikle şiddetli ağrı, korku ve kaygı eşlik eder, bu faktörler sempatik sistemi katekolaminlerin (adrenalin ve no-adrenalin) salınımını artırmak için uyarabilir, bu da oksitosin salgısının bozulmasına ve kasılmaların yavaşlamasına neden olabilir, doğumu durdurabilir. hatta düzensiz hale getirir. Doğum sırasında ağrı, yaşanabilecek en şiddetli ağrı biçimlerinden biri olarak kabul edildiğinden, doğum sırasında ağrının azaltılması için yeterince etkili destekleyici yaklaşımlara ihtiyaç duyulmaktadır. Nonfarmakolojik yaklaşımlar, doğum eylemi sırasında ağrıyı kontrol etmek için çok etkili ve daha tatmin edici yöntemlerdir. Araştırmalar, normal farmakolojik yaklaşımlarla ilişkili tehlikeler ve doğum sırasında ve sonrasında anneler ve yenidoğanlar üzerindeki etkileri nedeniyle kadınların bu farmakolojik olmayan yaklaşımları tercih ettiğini göstermiştir.

Amaç/Yöntem: Bu araştırmanın amacı, doğum sırasında ağrıyı azaltmaya yönelik çeşitli farmakolojik olmayan yaklaşımları değerlendirmek ve karşılaştırmak ve çok kriterli karar kullanarak seçilen kriterlere ve atanan önem ağırlıklarına göre tercih düzeylerine göre sıralamaktır. yapma (MCDM) tekniği olarak adlandırılan, değerlendirmelerin zenginleştirilmesi için bulanık tercih sıralama organizasyon yöntemi (PROMETHEE).

Sonuç: Bulanık PROMETHEE tekniğini kullanan bu çalışmanın sonuçları, ağrıyı azaltmak için en etkili farmakolojik olmayan yaklaşımın 0.0640 net akışla Akupresür, ardından 0.0252 net akışla Hidroterapi (Steril su enjeksiyonu) ve ardından Akupunktur olduğunu göstermiştir. 0.0201 net akışla ve ardından 0.0179 net akışla Hipnodoğum. Değerlendirmemize göre doğum eylemi sırasında ağrıyı azaltmak için en az tercih edilen yaklaşım, -0,0457 negatif net akışa sahip Transkutanöz Elektriksel Sinir Stimülasyonudur (TENS) alternatiflerin seçilen kriterleri/parametreleri ve uzmanlar tarafından verilen önem ağırlıklarına göre

Sonuç: Bu karar verme tekniğinin doğum eyleminde ağrıyı azaltmaya yönelik tedavi yaklaşımına ilişkin sonuçları, gebe anneler, kadın doğum uzmanları, ebeler, sağlık destek birimleri ve hastane

yönetimi gibi ilgili tarafların ihtiyaç anında etkin karar vermelerine yardımcı olacaktır. Bulanık PROMETHEE tekniđi, doğum sırasında ağrıyı azaltmak için tercih edilen yaklaşımın belirlenmesiyle ilgili sorunları çözmek için önerildi.

Anahtar Kelimeler: doğum, bulanık PROMETHEE, yenidoğanlar, farmakolojik olmayan yaklaşım, ağrı azaltma

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CHAPTER I

1. Introduction

1.1. Background of Study

Pain is an experience capable of causing tissue damage, and it is associated with discomfort and unpleasant emotional and sensory experiences [1]. Childbirth is usually accompanied by severe pain, fear, and anxiety, and this can stimulate the sympathetic system and increase the release of catecholamines (adrenaline and nor-adrenaline) [2], [3]. The release of adrenalin can lead to the disruption of the normal secretion of oxytocin which can make contractions slow down or stop altogether or even make irregular [2]–[4]. Pain during labor is regarded as one of the most severe forms of pain that can ever be experienced [2]–[4], hence, the need for supportive approaches that are effective enough for the reduction of pain during labor. Two approaches are known to reduce pain during labor (Pharmacologic and Non-Pharmacologic approaches) [5], [6]. The known standard and widely used approach for reducing pain during childbirth is the pharmacologic approach [5], [6]. This standard is the neuraxial blockade administered through injection or inhalation, which is usually known to be accompanied by adverse side effects [5], [6]. They include general anesthesia, epidurals, spinal, peripheral nerve blocks, sedation, or a combination technique of analgesic agents [7]. Analgesic agents administered during labor can have effects on the neonates or the mother [7] usually as a result of an excess medication or increased odds of analgesic agents during childbirth experience or other underlying medically related issues not properly optimized before administering anesthetic agents [7]. Due to these underlying possible effects, many women would like to avoid the pharmacological approach of pain relief in labor and subscribe to the non-pharmacologic approach. This non-pharmacologic approach is said to be the most preferred and effective method of reducing pain during labor [7]. This is because it possesses beneficial measures for both nursing mothers and their neonates without side effects that could be related to increased odds of analgesic properties [8]. This non-pharmacologic approach is more satisfactory as it is known to increase competence and birth control [8], [9]. Different studies have been carried out regarding this subject however, the efficiency and effectiveness of the non-pharmacologic approaches for reducing pain during labor have not been presented clearly enough to gain a universal acceptance. Lack of proper research study or inappropriate classification and evaluation of the available non-pharmacologic approaches

may be the reasons why these nonpharmacological approaches are not generally known and practiced [10]–[12]. To overcome this challenge, [13], [14] proposed three mechanisms that are activated during childbirth to address their mode of action instead of the available approach methods [13], [14]. The first mechanism is by creating and stimulating a none painful or mild pain input somewhere in the body to close the sensation of painful input to the body, from getting to the nervous system. It is a form of diverting attention from major pain stimulation to a none painful stimulation. Such approaches are; light massages, water immersion, position/ambulation, birthing ball, vibration, and wall packs [15], [16]. The second mechanism is by creating a major pain somewhere in the body to act on the sensory components when contraction is taking place. The process is called the Diffuse Noxious Inhibitory Control (DNIC) mechanism [17], such approaches are; Massage/reflexology, acupressure, acupuncture, hydrotherapy, etc. [17], [18]. And the third mechanism is involved with attention deviation by acting on the mind. Such approaches are; prenatal education, relaxation, breathing exercise, meditation, yoga, hypnosis, music therapy, aromatherapy, and a continuous support system [14]. In an attempt to circumvent the challenges regarding the most preferred non-pharmacological approach to reducing pain during childbirth, [19] in their research asserted that nonpharmacologic approaches combined with a continuous support system are very effective in reducing pain during labor compared to pharmacologic approaches [19].

In this context, the evaluation and selection of the most effective non-pharmacological approach to reducing pain during labor can be done using a multi-criteria decision-making (MCDM) technique based on human knowledge. The fuzzy Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE) decision-making technique is a concept that is based on the evaluation of complex multiple criteria. The benefit of being simple to execute is based on the evaluation of vague and multiple criteria systems for making decisions [20]. The fuzzy PROMETHEE technique has never been applied to determine and identify the preferred non-pharmacological methods of reducing pain during labor in any existing study. Although a comparison of nonpharmacological approaches to reducing pain during labor has been done in different studies in searched literature, none has applied fuzzy PROMETHEE to compare and evaluate nonpharmacological approaches for reducing pain during labor. Thus, this thesis research proposed the use of fuzzy PROMETHEE to evaluate and compare non-pharmacological approaches to reducing pain during childbirth and rank them based on certain parameters and assigned importance weight to criteria in order to understand the features and strengths of the alternatives.

1.2. Thesis Problems:

- The efficiency and effectiveness of the non-pharmacologic approaches for reducing pain during labor have not been presented clearly enough to gain universal acceptance. The lack of proper research study and evaluation of the available non-pharmacologic approaches may be the reason why these nonpharmacological approaches are not generally known and practiced.
- The conventional pharmacological techniques used for reducing pain during labor have been linked to higher rates of further medical interventions as well as greater risks of deleterious consequences on the mother and infant. Professional recommendations assert that non-pharmacological options be considered before pharmacological ones because painkillers frequently cross the placenta. Hence there is a need to compare and evaluate various non-pharmacological pain management approaches to identify the most effective and most preferred option for mothers.

1.3. Aims of the research:

- To evaluate, compare, and rank the efficacy of the non-pharmacological methods of pain management during childbirth, based on the mechanisms of action, physical parameters, preference functions, and assigned weights of importance to criteria basically using the MCDM model called Fuzzy PROMETHEE technique.
- To determine the respective effects of the non-pharmacological approaches of reducing pain, on labor, the duration, maternal satisfaction, maternal and neonatal outcomes, etc.
- To compare the confusion regarding the selection of the most effective non-pharmacologic approach for reducing pain during labor, subjecting the arguments to the following criteria (pain score, anxiety level during birth, patient satisfaction, complications at birth, duration of birth (first phase and second phase), Cesarean levels, episiotomy, perineal tear, need for oxytocin at birth, Apgar score, neonatal fetal heart rate results) and making mutual comparison among existing nonpharmacological approaches and thereafter, determining and identifying the most effective approach based on available evidence, clinical practices, and expert's opinion.

1.4. Significance of the research:

- No applications of the fuzzy PROMETHEE methodology for the determination of the most preferred nonpharmacological approach for reducing pain during labor have been proposed in the existing literature.
- The research will give a clearer understanding of the nonpharmacological approach to reducing pain during labor.
- The findings of this research will enable researchers to identify the optimal approach for controlling pain during labor.
- The findings of this research will circumvent the confusing arguments regarding the most effective, safe, and efficient method of reducing pain during childbirth and produce a deplorable standard for implementing this technique in future studies.
- The findings of this research will enable mothers, relatives, clinicians, and the general public to understand decision-making processes and to take part in the intelligent, systematic, and professional process of making decisions regarding choosing the most effective or preferred methods of reducing pain during labor based on chosen alternatives and criteria.
- The outcome of this research study will help concerned parties such as pregnant mothers, gynecologists, midwives, healthcare supportive units, and hospital management to make a rational decision regarding the preferred approach of reducing pains during labor when the need arises.

1.5 Limitations of the Research

- Expert opinion is at all times needed for appropriate assigning of importance weights to criteria and ranking alternatives when deploying fuzzy PROMETHEE. This process is the major challenge in multi-criteria decision-making studies.

CHAPTER II

2. Literature Review

2.1. Non-Pharmacologic Approaches for Treating Labor Pain

Non-pharmacological approaches for reducing labor pain are simply methods void of the administration of anesthetic agents for killing pain during labor [12], [13], [19]. They can either be used in isolation or by combining them for efficient results [12], [13], [19]. The non-pharmacological approaches for reducing pain during childbirth include;

A. Acupuncture Approach

Acupuncture is a therapeutic measure that helps to manage pain during labor. It is the practice of inserting sterile needles into the skin [21]. The penetrated needles act as stimulators to the connective tissues of pain, thereby acting on the nerves and muscles to trigger the body's natural painkillers [21]. This is done by accordingly increasing blood flow [21]. This practice is usually painless and effective within 30 minutes of needle insertion [21]. Acupuncture increases the satisfaction of mothers, reduces the use of pharmacological analgesic properties, and relieves pain accordingly during labor [21]. The efficacy of the usage of acupuncture to reduce pain during labor was tested in a randomized controlled trial by [21] involving about 607 healthy women in labor who received acupuncture as the desired pain reduction method. The pain relief level was evaluated, and the birth experience (before, during, and after labor) was evaluated including the labor time, the pattern of delivery, the umbilical cord pH value, the Apgar score, postpartum hemorrhage, and the satisfaction level of mothers were all evaluated. It was concluded from the study that acupuncture is a good pain-reducing approach during labor and it can serve as a supplement to existing pain-reducing approaches during childbirth [21]. A recent study [22] on acupuncture also showed that acupuncture was administered by professionals during labor and the level of satisfaction was very high [22]. The midwives [22] who organized an orientation meeting on the safe use of acupuncture during childbirth found out that women who were indicated for acupuncture as a means of reducing pain during labor did not request epidurals as the acupuncture approach was sufficient enough to give birth satisfaction. The use of acupuncture treatment appeared to have a significant reduction in pain during labor [22]. A randomized controlled trial by [23] included 144 healthy women in the active phase and marked them as a control to evaluate the

efficacy of reducing pain during labor using the acupuncture method. Pain rate was recorded, and it was concluded that acupuncture reduced the effect of pain, reduced labor duration, and increased satisfaction. The women in the study agreed to use acupuncture again in subsequent pregnancies as no adverse effects were recorded [23]. A study by [24] compared acupuncture to other methods of reducing pain during labor, and it was concluded from the study that acupuncture could reduce pain, reduce labor time, and give birth satisfaction both to mothers and the supporting healthcare units. No side effects on the mothers and their neonates were recorded. The feedback was reported using the following criteria; pain, anxiety, Apgar record, infant weight, hemorrhage, use of analgesics, patient satisfaction, complications at birth, augmentation of labor with oxytocin, delivery time, and, birth outcome[24].

B. Acupressure Approach

Acupressure works with the principle of acupuncture but without the use of sterile needles [25]. It uses the mechanism of creating a second pain anywhere in the body around the acupoints such as the large intestine (LI4), liver 3 (LR.3), spleen 6 (SP-6), etc. by applying pressure usually by palms, elbows, fingers, or feet during contraction, and acts on the sensory discriminative components of pain by promoting blood flow and releasing muscle tensions [17], [25]. This simple practice provides pain relief during labor and helps to shorten delivery time [25]. The effects of acupressure for pain management during labor were evaluated by [25] published and unpublished randomized trials from the Cochrane library, MEDLINE, etc. were reviewed in the study. Acupressure was compared to usual care and other non-pharmacological pain management methods. Data reporting 3960 nulliparous and multiparous women were included in the study summing up to 28 trials. Results showed that 15 trials indicated acupressure reported a slight reduction in the intensity of pain during labor when compared to usual care [25]. A study [26] reported a single-blinded study on the effects of acupressure on pain management and labor duration. A total of 100 women were included in the study and divided into two groups; 50 for acupressure and the other 50 as control. Acupressure was performed for good 35 times for the acupressure group, with a target at the Sp6 points of the legs. For the control, a normal delivery method was deployed. The pain was evaluated five times during the process of delivery, and the labor time was calculated in the three stages of parturition, it was proven from the results that the acupressure group had a shorter delivery time compared to the control group. (the first phase was 225min and 320min) and (the second phase was 15 and 20min). SP6 acupressure is, therefore, a recommended approach for reducing pain during labor and it shortens birth

duration time respectively [26]. Similarly, [27] reported a study in India on the efficacy of acupressure in reducing pain during labor. Patients were assigned to 3 respective groups namely, the acupressure SP6 group, touch group, and control group. Seventy-one (71) were assigned to receive acupressure treatment at the spleen 6 (SP6) point during contractions on both legs over a period of 30-minute and were classed as the acupressure group, another seventy-one (71) women were grouped as (touch group) were given a light touch treatment at SP6 point on both legs at the same period, and lastly, seventy (70) women were administered usual care and labeled control group, thus making sample size totaling 212 women. visual analog scale (VAS) was used to collect the data on pain experienced by the women. From the study, it was concluded that acupressure reduces pain during labor in nulliparous women and reduces birth duration time when compared to the touch group and the control group [27].

C. Hydrotherapy (Sterile Water Injection) Approach

Sterile water immersion during labor is referred to as hydrotherapy [28]. It can be used in any of the three phases of labor, the early phase, the active phase, and the delivery phase [28]. Hydrotherapy from a recent research study has been observed as a comfort approach to providing relaxation to ease anxiety and pain management during labor [28] Hydrotherapy is an inexpensive, effective and safe treatment measure for comforting women undergoing labor [28]. Studies have shown that hydrotherapy diminishes stress, and hormones, ease muscle tension and reduces pain sensation by increasing the natural pain relievers of the body called endorphins[29]. A study by [28] conducted to determine if sterile water injection is effective in general pain management during labor and if it reduces the rate of cesarean section, concluded that a significant decrease in general labor pain was observed. Another study by [29] aimed at evaluating the effectiveness of the use of hydrotherapy in reducing pain and determining possible adverse effects in infants born in water, concluded that hydrotherapy reduces pain during labor significantly and there are no adverse effects observed in infants born underwater. A meta-analysis of combined research work from the Cochrane library, on the effects of water immersion during labor using 11 different randomized controlled trials including 3146 women as samples, proved that patients who used water immersion during labor were less likely to request epidurals or any analgesic agents [30]. Another research study was conducted by [31] using 7 randomized trials of usual care compared to water immersion in labor before regular land birth, including over 2,600 women. six out of the seven trials were considered and proven to reduce pain, and it was concluded in 1 trial that hydrotherapy reduced anxiety within a few minutes of being in sterile water, increased

satisfaction that's equivalent to usual care, satisfactory cervical dilation, and neonatal outcome [31].

D. The Transcutaneous Electrical Nerve Stimulation (TENS) Approach

TENS is a mechanical method of reducing pain during labor. Two electrodes connected to a machine deliver pulses of electrical current to the body when stuck to the skin and it is said to reduce pain during labor [12]. In a published study on the effectiveness of TENS in managing labor pain, investigators discovered there were only slight differences in pain scaling between the compared groups. Although there was no report of severe pain when using the TENS approach [12]. Another research study carried out using 9 trials involving a total of 1076 women, when compared with the standard care, shows no significant difference between them. There was no result showing the interference of TENS in any of the outcomes therefore it was concluded that the use of TENS has no impact on labor and no effect on mothers or neonates and there is no evidence that TENS reduces the use of epidurals [32].

E. Sacral Massage, Reflexology and Music

Massage reflexology and Music-therapy during labor are said to increase tolerance to pain, increase parturition and uterus, reduce anxiety, and shorten labor duration [33] Music therapy helps to manage pain during labor. It gives tolerance to labor pain, increases relaxation, decreases anxiety, shortens labor duration, and increases parturition[33]. A study conducted by [33] included 30 women ready for child delivery. The study aimed to investigate and compare the efficacy of music therapy in pain management during labor. The women included in the study were grouped into two (the music therapy group and the control group). Results proved that the music therapy group listened to relaxing music during labor and had a music effect on their labor experience by significantly decreasing the sensation of pain. When compared to the control group without music there was an opposite report. Which proved that music therapy was effective for pain management. A study from the Cochrane library examined the effectiveness of massage therapy and reflexology for pain management during labor, 6 trials reported that massage reduces pain during labor but no report on reflexology [34]. In another trial, Labor pain was reduced when massage and music therapy were compared with standard care. When all trials were compared with usual care they found that anxiety level was reduced. The research concluded that Massage, reflexology, and music therapy have a major role in managing pain sensation and reducing anxiety during labor [34]. An updated meta-analysis of combined research work from the Cochrane library reviewed 14

trials from a sample of 1055 women. 10 trials were used from the 14 trials and when massage and reflexology were compared to usual care, more satisfaction was found with massage than other approaches [35]. A trial that compared music therapy approach with usual care found insufficient evidence concerning the reduction of pain intensity. In conclusion, massage, reflexology, and music were reported to reduce pain intensity, increase birth satisfaction, decrease cesarean section and increase birth control [35].

F. Hypnobirthing

Hypnosis is a state of consciousness in a person whereby the person hypnotized loses the power of voluntary action but is responsive to directions or suggestions [36]. The process of hypnosis has been studied and observed to be a therapeutic measure for behavioral modification, reduction of pain during labor, and increased satisfaction during birth [36], [37]. Therefore, Hypnobirthing is the use of self-hypnosis techniques to reduce pain and anxiety during labor [36], [37]. An antenatal hypnobirthing training conducted for pregnant women was found to be very beneficial during labor [36], [37]. In a randomized controlled trial research study evaluated by [38], on Self-hypnosis for coping with labor pain involving 1222 nulliparous women [38]. Patients were divided into 3 groups, hypnobirthing, relaxation methods, and a standard care group. There was no obvious difference in self-reported pain levels when compared with standard care [38]. In another randomized control trial involving 3326 patients, when evaluated by [39], hypnobirthing was compared with standard care and found to have reduced pain during birth as there was more epidural analgesia in standard medical care [39]. Another research by [40], involving 2916 women, compared self-hypnosis with usual care. It was concluded from the study that women indicated for the self-hypnosis approach were less likely to be administered analgesia [40]. Hypnobirthing is therefore a recommended nonpharmacologic approach to increase birth satisfaction, reduce pain during labor and reduce labor duration.

G. Aromatherapy

The use of plants or oils for therapeutic purposes and to increase well-being is called aromatherapy [41]. Aromatherapy has been studied by researchers to be an effective approach to reducing pain during labor, reducing birth duration time, reducing anxiety, and increasing satisfaction during labor [42]. Eight randomized controlled trials and one quasi-experimental study by [42] evaluated the effectiveness of aromatherapy on pain management and anxiety control [42]. VAS was used to measure the intensity of pain from 0 to 10 and

they measured anxiety levels using an anxiety inventory questionnaire with possible scores between 20 and 80. The aromatic oils discussed in the study were; rose (*Rosa damascena*), bitter orange (*C. Aurantium*), lavender (*L. Angustifolia*), geranium (*Pelargonium graveolens*), and sweet orange (*Citrus sinensis*). One trial had patients in the control group select from lavender, geranium rose, citrus, and jasmine, based on their choice of interest. Another trial with 2 control groups assigned patients to jasmine (*Jasminum officinale*) or salvia (*Salvia officinalis*). It was found from the study that aromatherapy reduced pain in latent (cervical dilatation of 3 to 4 cm), early active (cervical dilatation 5 to 7 cm), and late active (cervical dilatation 8 to 10 cm) of first-stage labor compared with control. Aromatherapy was also proven to reduce patients' anxiety during labor compared with control [42]. A systematic review by [43], evaluated 5 databases (SCOPUS, PubMed, Google Scholar, Web of Science, and Scientific Information Database). 33 studies met the inclusion criteria, and the following aromatherapy oil and their effects on pain and anxiety were evaluated; Lavender (*Lavandula spp*), Rosa damascene or Damascus rose, Jasmine Officinale, Geranium (*Pelargonium graveolens*), Chamomile, Peppermint (*Mentha piperita*), sweet orange aromatherapy, Bitter orange (*Citrus aurantium*), Frankincense (*Boswellia thurifera*), Clove (*Eugenia aromatica*) and Mandarin orange (*Citrus reticulata*). It was evident from the study that aromatherapy can be used as a complementary approach or an alternative modality to mitigate anxiety and pain during labor and to increase satisfaction during labor [43].

H. Exercise, Breathing Exercise, and Attention Diversion

Distraction during labor is an important process of reducing pain during labor, it helps attention to be diverted from labor pain by engaging patients with stimulants from the surroundings [44]. It has been known that pregnant women do exercises like walking around, climbing stairs, sitting in a chair, watching television, talking to visitors, playing games and cards, using their phones, and listening to music during labor to get away from pain [44]. A study by [45], identified the effects of breathing exercises in reducing pain during labor, using the VAS, and the results showed that breathing exercise during pregnancy is an effective approach to managing pain sensation and shortening birth duration [45]. Another comparison was done by [46], on the effect of antenatal exercises on 200 primiparous women. Results proved that regular antenatal exercises result in better outcomes of delivery [46].

I. Birthing Ball

A birth ball is one of the nonpharmacological pain management approaches [47]. The birth ball is also known as a fit ball. It is a large ball with an approximate diameter of 55cm or 65cm. women lean or sit on it while carrying out exercise [47]. The birth ball has a soft surface that enables women to sit and lean comfortably on it during exercise. A birth ball has been observed to reduce physical pain and improve pelvic dimensions. A study by [48] critically evaluated birthing balls' impact on pain management. Results from the meta-analysis revealed a significant reduction in pain. A study by [49] evaluated the effects of the birthing ball on anxiety and labor pain reduction. The study used a quasi-experimental analysis to evaluate 30 women. The T-test data processing method was deployed to evaluate the data of the study. Results from the study showed that birthing balls used during labor reduces significantly anxiety in maternity and pain intensity [49]. Another study by [47] with the aim of evaluating the efficacy of a birthing ball for managing pain during labor, asserted the recommendation of the use of a birthing ball for managing pain sensation during labor.

J. Prenatal Education

[50] conducted a qualitative study on 11 pregnant women who participated actively in a prenatal/antenatal education exercise. 10 women that were regular in attendance were selected as the sample. The prenatal education involved antenatal meetings aimed at providing physical exercises and information on pain management techniques during labor. The anatomical and the physiology associated with maternal delivery were disclosed and relief techniques were extensively thought out. The pregnant women that participated in the orientation without missing out on any meeting days reported satisfaction with the nonpharmacologic approaches deployed. They were able to maintain birth control, and they were responsive to the instructions of the various nonpharmacological approaches used respectively. They reported that pain was reduced during labor, anxiety was cleared completely, and high birth satisfaction was achieved [50]. Women who did not participate in prenatal education when asked reported difficulties in maintaining birth control, and an extremely high level of anxiety that led to a lack of birth control. They also reported dissatisfaction with labor. A similar experience was reported in [51]. Therefore, prenatal education is very important for pregnant women, in all three stages of pregnancy; from the first trimester, through the second trimester to the third trimester which is the fetal period.

CHAPTER III

3. Methodology

3.1. Study Design:

3.1.1. Sources of Literature

We performed a search on 5 databases (SCOPUS, PubMed, Google Scholar, Web of Science, and Scientific Information Database (SID)) using the keywords Pharmacologic and Nonpharmacologic methods of reducing pain during labor. Results within 15 years were retrieved up to July 2022. The search revealed over 1,730,000 results.

3.1.2. Criteria for Research Inclusions:

Criteria for research inclusions were peer-reviewed meta-analyses, systematic reviews, full-length, randomized controlled trials (RCTs), single/double-blinded reviews, and quasi-experimental trials that evaluated the effects of Non-pharmacological approaches on pain during labor. We identified 3642 studies that met our criteria for inclusion but referenced our evaluation from 51 core studies based on peer-reviewed meta-analyses, systematic reviews, full-length, randomized controlled trials (RCTs), single/double-blinded reviews, and quasi-experimental trials.

3.1.3. Criteria for Elimination

Studies that are published in other languages that are not English were eliminated. Article comments, letters to editors, and commentaries were all eliminated.

3.2. Multicriteria Decision Making (MCDM) Models

MCDM technique focuses on the choices made when choosing between options according to the intended study criteria [52]. The MCDM technique considers a theoretical approach to handling decision-making problems, which is focused on choosing actions that include solving various types of problems to successfully inform, clarify, justify, and analyze decisions [53]. The PROMETHEE is an MCDM technique that supports decision-makers in making precise analytical studies [54] especially if data is qualitative and vague, to help

provide the best alternatives in a situation of uncertainty [53], [55]. Fuzzy logic in this situation enables decision-makers to effectively interpret vague data[55].

3.2.1. Fuzzy PROMETHEE and its Applications

The fuzzy and PROMETHEE models are two heterogeneous models from MCDM, that relies on the assessment of capricious cases. Both of them have various applications in the fields of engineering, mathematics, sociology, medicine, etc. [53]. The fuzzy PROMETHEE technique creates room for uncertainty [56]. It is a form of human reasoning that approaches ambiguous data with intermediate possibilities [57]. It gives an acceptable form of reasoning even without providing accurate and precise reasoning which is helpful in solving the problems of uncertainty. Fuzzy systems create a middle ground between distorted values of YES and NO. Due to the involvement of sentimental possibilities in human reasoning between YES and NO or between True and False, unlike computers. Lofti Zadeh [58] invented the Fuzzy ideology from Boolean Logic to create possible facts in between YES and NO e.g. [58] Absolutely Incorrect, Incorrect, Slightly Incorrect, Correct, Slightly Correct, Absolutely Correct, or Certainly Yes, Possibly Yes, Cannot Say, Yes, NO, Cannot Say, Possibly NO, Certainly NO [58].

Fuzzy PROMETHEE works with sentiments and possibilities of input to get a distinct output [57]. Fuzzy PROMETHEE is therefore a recommendable data inputting system that considers data with various sizes and capacities ranging from micro to large networked control systems [57]. Zadeh 1996 concluded that fuzzy logic is a preferred system over Bayesian logic also known as predictable logic [58]. Due to the versatility and the applicability nature of the fuzzy PROMETHEE technique, many studies have deployed its usage in comparing and evaluating alternatives based on assigned parameters and criteria to arrive at a reliable and useful conclusion and results. In a study by [52], fuzzy PROMETHEE was deployed by the authors to evaluate the treatment options for covid-19. It was concluded from the study that the fuzzy PROMETHEE technique is a reliable technique for evaluating options in the presence of uncertainty. Another study by [59] compared the efficacy of AuNPs with other nanomedicines in cancer targeting using the fuzzy PROMETHEE. The study concluded that the fuzzy PROMETHEE technique is an applicable and suitable technique for comparing, evaluating, and ranking different sets of alternatives for a scientifically reliable result [59]. Finally, [60] evaluated the treatment approaches for spinal cord tumors by deploying the fuzzy PROMETHEE method and concluded that the technique is reliable to get accurate and precise results when comparing, ranking, and evaluating a set of alternatives.

This research study deployed the fuzzy PROMETHEE technique to rank, evaluate, and compare the various nonpharmacologic approaches for reducing pain during labor which include; Acupuncture, Acupressure, Hydrotherapy, TENS, Sacral Massage, Hypnobirthing, Exercise, Reflexology, Attention diversion, Aromatherapy, Music therapy, Breathing exercises, Birthing ball, and prenatal education. In defining the criteria used for selection, the triangular linguistic fuzzy scale was used to evaluate the linguistic values in the study. As shown in Table 1 below. A triangular fuzzy scale is represented with 3 specific points (a, b, and c) where “a” is the initial point (left extreme), “b” is the peak point of the triangle which contains the maximum membership degree, and “c” is the right bound of the triangle (right extreme) [52], [55], [58].

The linguistic fuzzy scale similar to what has been explained above represents the linguistic terms of very high (VH), high (H), moderate (M), low (L), and very low (VL), with their accompanying scaling of fuzzy data. The significant importance of the nonpharmacologic approaches employed during maternal delivery has been explained with the triangular linguistic fuzzy scale. The following factors were considered when choosing the analysis criteria: pain rate, mother satisfaction, Apgar score, complications at birth, parturition, reduction of the cesarean session, decrease episiotomy/perineal tear, decreased birth duration, oxytocin, anxiety at birth, and cost. These factors were chosen after extensive literature research and experts’ opinions. As observed in Table 2, the parameters were then normalized to create a triangular linguistic fuzzy scale that displays the importance weight of each criterion and the Min/Max preference. The fuzzy values were also defuzzified using the Yager index. Using the Gaussian preference functions, the visual PROMETHEE program was then implemented.

Table 1 Triangular Linguistic Fuzzy Scale of Weights, Criteria, and Parameters

Linguistic Scale for ranking	Triangular Fuzzy Scale	Importance Ratings of Criteria
Very High (VH)	(0.75, 1, 1)	pain rate, mother satisfaction, Apgar score,
High (H)	(0.50, 0.75, 1)	complications at birth, parturition, cesarean session, decrease episiotomy/perineal tear, decreased birth duration, oxytocin
Medium (M)	(0.25, 0.50, 0.75)	anxiety at birth,
Low (L)	(0, 0.25, 0.50)	cost.
Very Low (VL)	(0, 0, 0.25)	

3.3. Determining Weights of Importance to Parameters

This section describes the rationale for allocating the weight of importance to each criterion based on expert knowledge and literature searches to identify the parameters used in this study.

Pain Rate: The level of pain experienced by women during labor varies substantially due to a variety of physical and psychological reasons [10]. Pain rate is a very important criterion in comparing approaches that reduce pain during labor and therefore assigned 0.92 weight of importance. Pain rate can be measured using a visual analog scale [1], [10]. An alternative that gives a minimal pain reduction rate is considered very important to the decision-maker.

Anxiety at Birth: Childbirth is usually accompanied by severe pain, fear, and anxiety [2], [3]. The alternative, that decreases anxiety rate is considered favorable to pregnant women. Minimal anxiety level is required when comparing the alternatives.

Mother Satisfaction: The non-pharmacologic approaches discussed in this study have been studied to be satisfactory to mothers during childbirth. Research has it that these approaches are known to increase competence and birth control [8], [9]. The mother's satisfaction with a particular approach would determine the continuous usage of the approach. Therefore, it is considered very important when comparing alternatives and assigned a 0.92 weight of importance. In this case, maximum satisfaction is required. The alternative that gives the maximum satisfaction in ranking is considered efficient.

Complications at Birth: Some nonpharmacological methods of reducing pain during labor have been observed in reviewed studies to have a different forms of complications that may require the further use of pharmacological methods of augmenting the pain reduction processes. Approaches such as TENS [12], breathing exercise [45], attention diversion [44], etc. may require a combination of analgesic agents for efficacy. An alternative that would give a reduced complication effect when put in use is regarded as a more preferred approach to reducing pain during labor.

Decreased Birth Duration: The efficacy of any approach for reducing pain during labor is dependent on the reduction in the birthing time. Any approach that reduces birth duration is

considered advantageous. Minimal time is required in this regard for the purpose of comparing alternatives.

Parturition: Parturition is simply the delivery process that involves the events that occur from the fetus stage till the termination stage of giving birth to a neonate [61]. It involves three stages; the dilation of the cervix, the delivery of the baby, and the shedding of the placenta [61]. A pain-reducing approach that tends to increase and ease the parturition process is beneficial and satisfactory to the mother. Therefore, maximization is required for this criterion. When parturition is increased by an approach, it is regarded as a favorable alternative [33]. Increased parturition is required and maximum parturition is selected for ranking alternatives.

Decrease Episiotomy/Perineal Tear: The procedure undertaken to widen the vagina opening to ease delivery processes is known as episiotomy [62]. The performance of episiotomy should be discouraged as there is great evidence that episiotomy leads to adverse effects and long-term risks of sexual problems, long-term pain, and health consequences [60]. When a nonpharmacologic approach deployed during labor is not efficient enough for delivery, episiotomy, therefore, serves as an augmenting procedure [62]. In this regard, the alternative that decreases the use of episiotomy or discourages the use of episiotomy during labor is regarded as a favorable alternative and therefore ranked with preference. The same explanation goes for perineal tears.

Cesarean Session: This is an operation that involves an incision of the abdomen to ease the delivery process [63]. This is done when delivery through the vagina would put the mother and neonates at great risk [63]. A nonpharmacologic approach that decreases cesarean delivery is considered efficient when comparing alternatives.

Oxytocin: Childbirth is a very painful process full of worries. This alone can stimulate the sympathetic system and increase the release of catecholamines [2], [3]. The release of catecholamines can lead to the disruption of the secretion of oxytocin which can make contractions slow down or even make them irregular or ultimately stop the process [2]–[4]. Oxytocin is the birth hormone that stimulates contraction during childbirth [2]–[4]. Lack of increased secretion of this hormone would require inducing the hormone to reduce maternal risks. An approach without an external inducing requirement of oxytocin is a more favorable

alternative. Maximum secretion of oxytocin is required and the approach that gives maximum secretion of oxytocin earns a high-ranking preference for our comparison. To compare our alternatives with this criterion, VL is used to represent the absence of oxytocin, while L, M, H, and VH denote the quantity of oxytocin secretion. The higher the secretion, the better the approach.

Apgar Score: This is the score used to evaluate the outcome of labor at 1-minute and 5 minutes intervals [64]. It scales the conditions of the newborn infant from 0, 1, 2, for the following characteristics; heart rate, the color of the baby, sole and foot response to stimuli, respiration, and muscle tone [64]. If the Apgar score is high, then the baby's condition is better with 7, to 10 being a perfect score [64]. A maximum Apgar score is required for this criterion. The alternative with the highest Apgar score for neonates is considered very important for making decisions in this regard.

Cost: A cost-effective approach is considered favorable in making decisions in this regard.

Table 2. Data set of Criteria and alternatives with corresponding parameters (very high (VH), high (H), moderate (M), low (L), very low (VL))

Alternatives /Criteria	Reference s	Pain rate	Anxiety at birth	Mother satisfaction	Complications at birth	Decreased Birth duration	Parturition	Decrease Episiotomy/Perineal tear	Reduction of Cesarean session	Oxytocin	Apgar score	Cost
Weight of importance		0.92	0.50	0.92	0.75	0.75	0.75	0.75	0.75	0.75	0.92	0.25
MIN/MAX		Min	Min	Max	Min	Max	Max	Max	Max	Max	Max	Min
UNIT		Impact	Impact	Impact	Impact	Yes/No	Impact	Yes/No	Yes/No	Impact	Impact	Impact
Acupuncture	[7], [13], [21]–[27]	L	L	H	VL	Yes	M	Yes	Yes	H	H	M

Acupressure	[13], [17], [19], [20], [23]– [27]	VL	VL	VH	VL	Yes	H	Yes	Yes	VH	VH	M
Hydrotherapy (Sterile Water Injections)	[24], [28]– [31]	M	VL	H	VL	Yes	H	Yes	No	VH	H	M
TENS	[6], [12], [13], [16], [32]	M	H	L	M	No	M	No	No	L	L	H
Sacral Massage	[7], [24], [33]– [35]	M	M	M	L	No	M	Yes	No	M	M	L
Music therapy	[7], [24], [33]– [35]	M	L	H	L	Yes	H	Yes	Yes	H	M	VL
Hypnobirthing	[7], [8], [13], [29], [34], [36]– [40]	M	VL	H	L	Yes	H	Yes	Yes	H	M	L
Exercise	[34], [35], [45], [46]	M	M	M	M	Yes	H	Yes	Yes	H	M	VL
Reflexology	[7], [24], [33]– [35]	M	M	L	M	Yes	M	Yes	No	M	M	L

Attention diversion	[34], [35], [44]– [46]	M	L	H	L	Yes	M	Yes	No	M	H	VL
Aromatherapy	[41]– [43]	M	L	H	L	No	M	Yes	Yes	M	H	M
breathing exercises	[34], [35], [44]– [46]	M	H	M	M	No	M	Yes	No	M	M	VL
Birthing ball	[46]– [49]	M	H	H	L	Yes	H	Yes	Yes	H	H	L
Prenatal education	[49]– [51]	VL	VL	VH	VL	Yes	VH	Yes	Yes	VH	VH	M

CHAPTER IV

Results and Discussion

The PROMETHEE preference net flow Table 3 shows the complete ranking results for the various non-pharmacological approaches to reducing pain during labor considered in this study. The resulting ranking after simulation using the fuzzy-PROMETHEE technique indicates that Acupressure ranks first with a net flow of 0.0640. It is, therefore, the most preferred and more effective approach for reducing pain during labor, decreasing anxiety rate, giving mothers satisfaction after birth, giving an absence of complications, short delivery time, increasing parturition, decreasing the chances of episiotomy and perineal tear, reduces cesarean delivery, increases oxytocin during birth, gives a high Apgar score to babies from 1 minute to 5-minute interval of checking Apgar score, and it is also cost-effective and therefore an affordable approach that can be adopted by pregnant mothers.

Hydrotherapy (Sterile water injection) ranks second on the preference ranking flow with a net flow of 0.0252 followed by Acupuncture with a net flow of 0.0201, and then Hypnobirthing with a net flow of 0.0179 based on the designated weight of importance to the criteria and evaluated parameters for comparison.

The ranking result shows that TENS with a negative net flow of -0.0457, is the least preferred approach for reducing pain during labor, and this is based on the evaluated parameters, mechanism of action, and assigned importance weight of criteria. See Table 3 below

Table 3: PROMETHEE Preference Net Flow with The Deactivation of Prenatal Education Alternative

Rank	Alternatives	Phi	Phi+	Phi-
1	Acupressure	0,0640	0,0640	0,0000
2	Hydrotherapy	0,0252	0,0295	0,0043
3	Acupuncture	0,0201	0,0259	0,0058
4	Hypnobirthing	0,0179	0,0221	0,0042
5	Music therapy	0,0106	0,0156	0,0051
6	Attention diversion	0,0051	0,0127	0,0076
7	Aromatherapy	-0,0004	0,0110	0,0114
8	Birthing ball	-0,0036	0,0117	0,0153

9	Exercise	-0,0129	0,0065	0,0194
10	Sacral Massage	-0,0162	0,0036	0,0198
11	breathing exercises	-0,0316	0,0010	0,0326
12	Reflexology	-0,0325	0,0025	0,0351
13	TENS	-0,0457	0,0000	0,0457

Figure 1 displays the positive (+) and negative (-) attributes of evaluated approaches for reducing pain during labor based on the designated weights of importance. As seen from Figure 1, the Acupressure approach has been observed to have a wider positive standing for efficiency on the following criteria used for comparison in this study; pain rate, mother satisfaction, anxiety at birth, complications at birth, parturition, decreased birth duration, Apgar score, reduction of the cesarean session, oxytocin, episiotomy/perineal tear, and cost. And it has no negative standing for any of the criteria. This shows the efficacy of this approach in reducing pain during labor.

Next to acupressure, is the Hydrotherapy (sterile water injection) approach which has a wider positive standing for efficacy for the following criteria; complications at birth, pain rate, mother satisfaction, anxiety at birth, decreased birth duration, reduction of the cesarean session, decrease episiotomy/perineal tear, and cost. And a narrow negative standing for Apgar score, reduction of the cesarean session, and pain rate on the graph. In reverse to this, TENS has a wider negative standing for less efficacy on the following criteria; pain rate, parturition, decreased birth duration, complications at birth, anxiety at birth, and mother satisfaction. And a narrow positive standing showing strength for the following criteria; decrease in episiotomy/perineal tear, reduction of the cesarean session, oxytocin, Apgar score, and cost. This illustration is applicable to the rest approaches as seen in Figure 1 below.

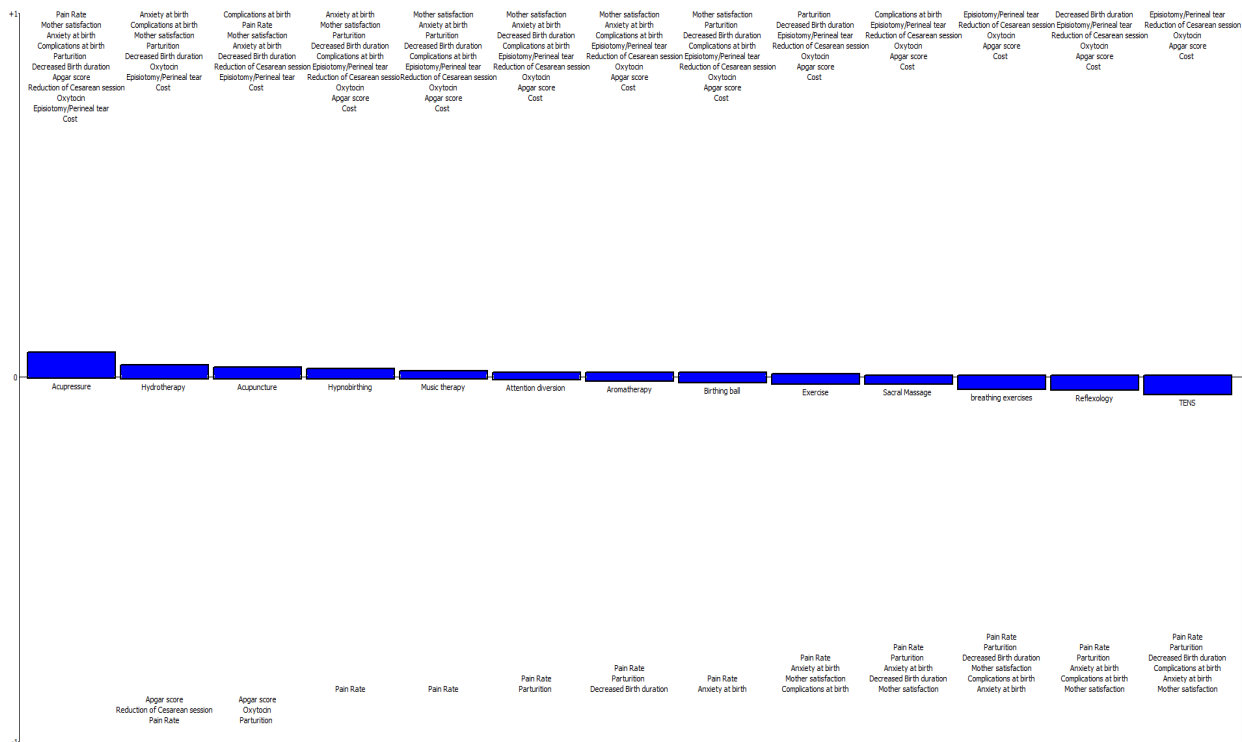


Figure 1. Positive (+) and Negative (-) PROMETHEE Ranking Results with The Deactivation of Prenatal Education, Alternative.

The wider the alternative is seen on the positive side of the graph, the more efficient it is to the criteria on the positive side of the graph. Ditto the lower the alternative is seen on the negative side of the graph, the less efficient it is to the criteria for comparison.

Table 4 shows a sensitivity report with the activation of prenatal education as an alternative for comparison.

Table 4: PROMETHEE Preference Net Flow with The Activation of Prenatal Education Alternative

Rank	Alternatives	Phi	Phi+	Phi-
1	Prenatal education	0,0674	0,0674	0,0000
2	Acupressure	0,0587	0,0591	0,0004
3	Hydrotherapy	0,0203	0,0273	0,0070
4	Acupuncture	0,0159	0,0239	0,0080
5	Hypnobirthing	0,0135	0,0204	0,0069
6	Music therapy	0,0065	0,0144	0,0079

7	Attention diversion	0,0004	0,0117	0,0113
8	Aromatherapy	-0,0051	0,0102	0,0152
9	Birthing ball	-0,0083	0,0108	0,0191
10	Exercise	-0,0182	0,0060	0,0242
11	Sacral Massage	-0,0217	0,0033	0,0249
12	breathing exercises	-0,0378	0,0010	0,0388
13	Reflexology	-0,0391	0,0023	0,0414
14	TENS	-0,0526	0,0000	0,0526

The PROMETHEE preference net flow in Table 4 above shows the complete ranking results for the various non-pharmacological approaches to reducing pain during labor with the activation of an important criterion (prenatal education). The resulting ranking after simulation using the fuzzy-PROMETHEE technique indicates that Prenatal education ranks first with an outranking net flow of 0.0674.

It is imperative to know that prenatal education is very important for pregnant women, in all three stages of pregnancy; from the first trimester, through the second trimester to the third trimester which is the fetal period. Prenatal education is involved with antenatal meetings aimed at providing physical exercises and information on pain management techniques during labor. From our evaluation and comparison with the activation of prenatal education as an approach to reducing pain during labor, it was proven that prenatal education is the most preferred and more effective approach for reducing pain during labor. A study by [50] proved that pregnant women who attended antenatal meetings during the three stages of pregnancy reported a significant decrease in labor pain, decrease in anxiety rate, got satisfaction after birth, reported absence of complications, short delivery time, increased parturition, decreased chances of episiotomy/perineal tear, reduced cesarean delivery, increases oxytocin secretion during birth, and high Apgar score for babies. They were able to implement all they have learned and followed instructions that guide the use of nonpharmacologic approaches deployed during labor. The results from searched literature are similar to the result from our simulation using the fuzzy PROMETHEE program.

Acupressure ranks second after prenatal education on the preference ranking flow with a net flow of 0.0587 followed by Hydrotherapy (Sterile water injection) with a net flow of 0.0203, and then Acupuncture with a net flow of 0.0159.

The ranking result with the activation of prenatal education alternative shows that TENS with a negative net flow of -0,0526, is the least preferred approach for reducing pain during labor based on the evaluated parameters, mechanism of action, and assigned importance weight of criteria as shown in Table 4 above.

It is of vital effects to note that although Acupressure ranks first with the deactivation of prenatal education alternative in Table 3, and Prenatal education tops the list when it is activated for comparison as seen in Table 4, the results are based on the evaluated parameters, criteria, and assigned importance weights to criteria. Preferred approaches for reducing pain during labor for me, may be different from another decision-maker, depending on the alternatives available for evaluation and criteria with their designated weights of importance for comparison, as seen with the activation and deactivation of prenatal education alternative. More also, two different approaches may be combined for efficacy.

The findings procured from this study, do not give a general-standard approach for reducing pain during labor, but it only shows the applicability of the fuzzy PROMETHEE technique. As a result, the conclusions reached by anybody making decisions in this regard, are not universal since different people making decisions concerning the subject matter, may arrive at contradictory opinions depending on the approaches and criteria they have chosen. When choosing the criteria and determining the weights criteria, an expert's advice is crucial for the analysis.

Similar to Figure 1, Figure 2 represents the positive (+) and negative (-) areas of each approach. It is worthy of note that the criteria on the positive (+) and negative (-) sides of the graph in Figures 1 and 2 are immutable, except for the deactivation of the prenatal education alternative in figure 1 and the activation of the prenatal education alternative in Figure 2. Their order of preference on the graph changes with respect to the assigned weights of importance to criteria.

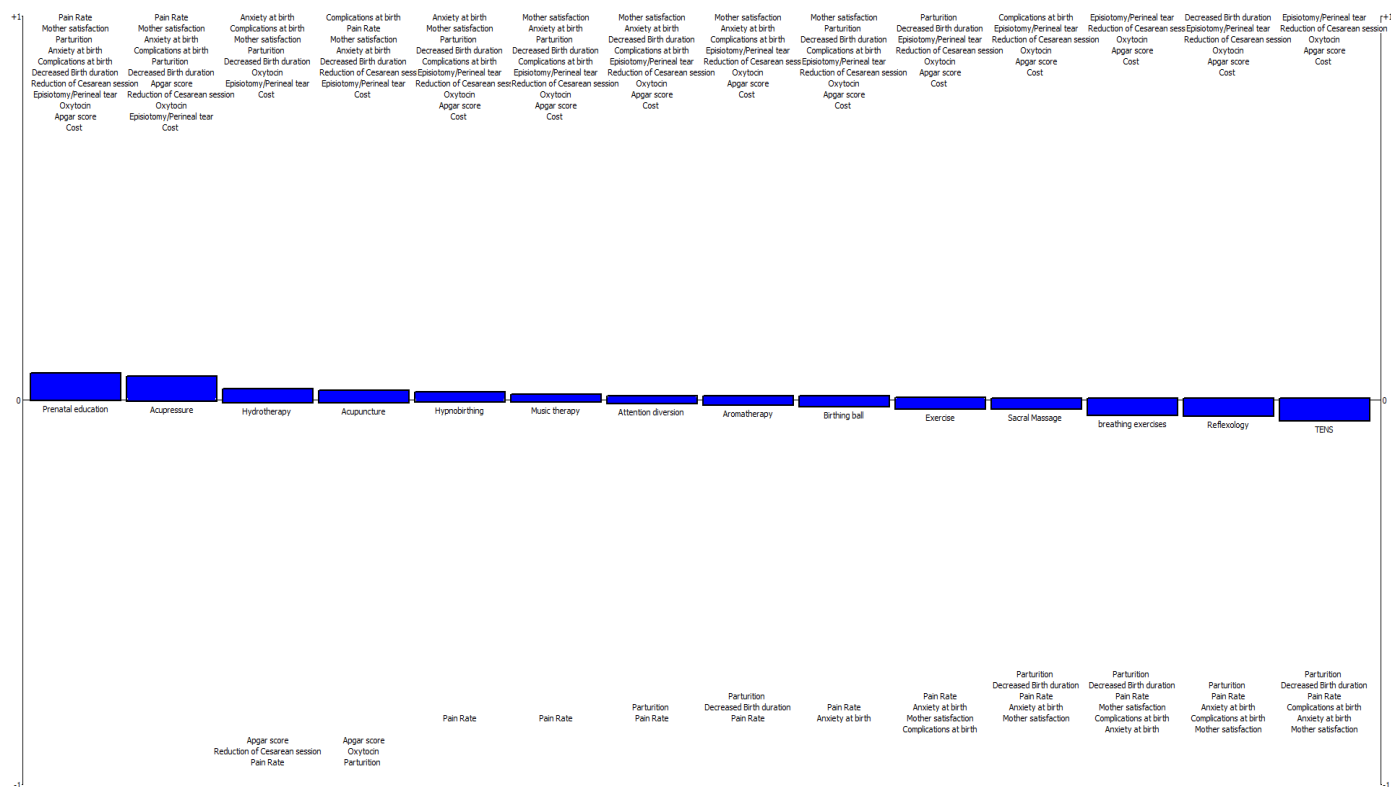


Figure 2. Positive(+) and Negative(-) Ranking Results with The Activation of Prenatal Education, Alternative.

From Figure 2, it is evident that prenatal education, acupressure, hydrotherapy, and other alternatives are all having net flows to the positive side of the graph. The weights assigned to individual criteria played significantly positive to all alternatives. Prenatal education, acupressure, hydrotherapy, etc. The assigned weights to each criterion affect each alternative in the following manner;

Prenatal education: pain rate, mother satisfaction, parturition, anxiety at birth, complications at birth, decreased birth duration, Apgar score, reduction of the cesarean session, oxytocin, episiotomy/perineal tear, and cost have a net flow to the positive side of the graph with no criteria to the negative side.

Acupressure: pain rate, mother satisfaction, parturition, anxiety at birth, complications at birth, decreased birth duration, Apgar score, reduction of the cesarean session, oxytocin, episiotomy/perineal tear, and cost have a net flow to the positive side of the graph with no criteria to the negative side.

Hydrotherapy: anxiety at birth, complications at birth, mother satisfaction, parturition, decreased birth duration, oxytocin, episiotomy/perineal tear, and cost have a net flow to the positive side of the graph while Apgar score, reduction of the cesarean session, and pain rate

is underplaying at the negative side of the graph. Therefore, the net flow is not affected much by these criteria. The same explanation applies to the other alternatives. All criteria play an important role in either pushing the overall phi value to the positive side or the negative side.

Figure 3 shows the PROMETHEE network chart and the distance each approach has from one another. The gap between each alternative shows the efficacy in performance difference that one has over the other.

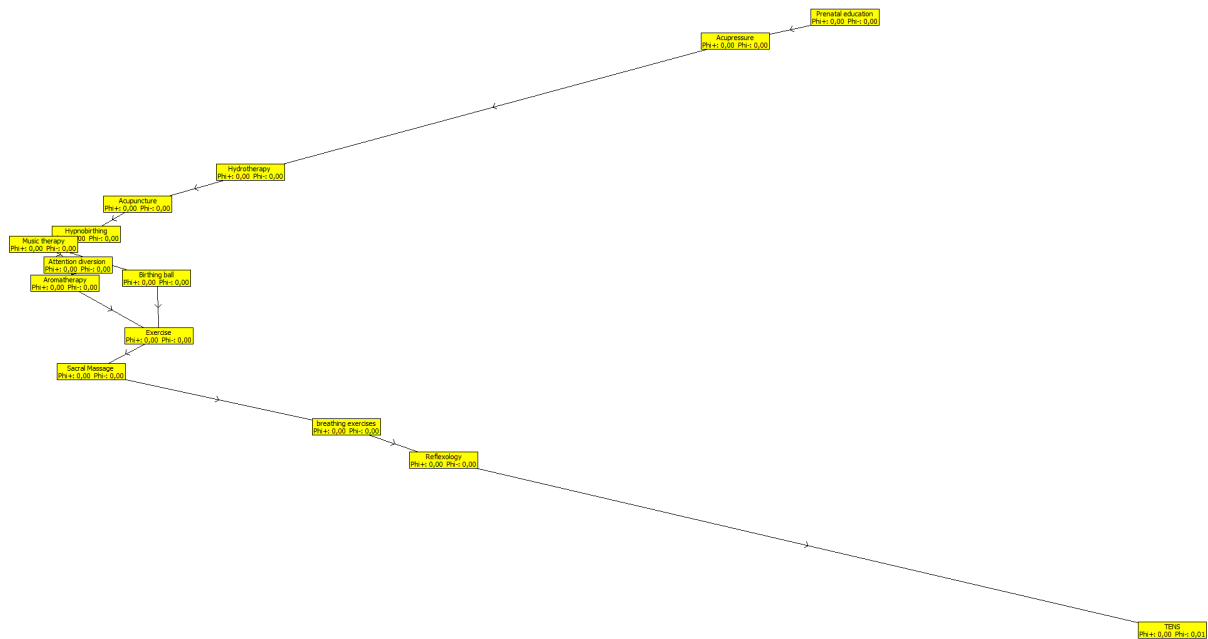


Figure 3: PROMETHEE network flow

With the fuzzy PROMETHEE technique, concerned parties such as pregnant mothers, gynecologists, midwives, healthcare supportive units, and hospital management would be able to make an unarguable decision regarding the preferred approach of reducing pain during labor when the need arises.

CHAPTER V

Conclusion

This study has shown that the fuzzy PROMETHEE technique can be deployed to rank, compare, and evaluate the non-pharmacological approaches to reducing pain during labor and to identify and determine the most preferred and effective approach for reducing pain, anxiety, etc. when the choice of using non-pharmacologic methods of delivery arises. The alternatives, criteria, and weights of importance that influence the ranking, evaluation, and comparison were decided upon by the experts in this field. The Fuzzy PROMETHEE technique can be deployed to determine and identify the most efficient approach for reducing pain during labor among others. With this technique, non-pharmacological approaches for reducing pain during labor can be ranked with a level of efficacy, evaluated and compared intelligently and systematically by deploying important related parameters, and as many criteria as deemed necessary based on the choices of the decision-maker. The results from our study using the fuzzy PROMETHEE technique indicated that the most effective nonpharmacologic approach for reducing pain was Acupressure with an outranking net flow of 0.0640, followed by Hydrotherapy (Sterile water injection) with a net flow of 0.0252, followed by Acupuncture with a net flow of 0.0201, and then Hypnobirthing with a net flow of 0.0179. The least preferred approach for reducing pain during labor from our evaluation is TENS with a negative net flow of -0.0457.

With the easy-to-implement characteristic of the fuzzy PROMETHEE technique, we deduced from the study that, the technique application is ranked with a significant efficacy when compared to other MCDM methods [65]. Fuzzy data that are not crisp are included in this study, these fuzzy data processes have too many range parameters, vague, and qualitative values, to be set properly with other MCDM methods. However, the fuzzy PROMETHEE technique is capable of handling this kind of fuzzy data very well. By deploying the fuzzy PROMETHEE technique for ranking, comparing, and evaluating the approaches to reducing pain during labor, this study has circumvented the confusing arguments regarding the most effective, safe, and efficient method of reducing pain during childbirth and produced a deplorable standard for implementing this technique in future studies.

The efficiency and effectiveness of non-pharmacologic approaches have remained unclear, and there is still no general acceptance of the most effective and preferred non-pharmacologic approach to reducing pain during childbirth. but with the help of this study, concerned parties such as pregnant mothers, gynecologists, midwives, healthcare supportive units, and hospital management would be able to make an intelligent decision regarding the preferred approach of reducing pain during labor when the need arises. Expert opinion is at all times needed for appropriate assigning of importance weights to criteria and grading alternatives when deploying fuzzy PROMETHEE. This process is the major challenge in multi-criteria decision-making studies.

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SKILLS

Laboratory Analysis	5years
Decision Analyst	2years
Machine Learning	1year
Deep Learning	1year
Python	1year
Data Science	1year
3D printing	1year
Forex market analysis	7years
Research Writing	7years
Leadership	10years
Organizational skill	10years

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PROFESSIONAL SUMMARY

Passionate Biomedical Engineer, Machine Learning Engineer, Data Analyst, Research Assistant, Lecturer Assistant, Laboratory Analyst/Technician, Scientist, Professional Forex Market Analyst, and Content creator with extensive knowledge of Machine/Deep Learning Models and Decision-Making Analytical Evaluation Models for disease diagnosis/treatment approaches. I have years of experience in all my professional skills, and I am excited to implement my skills to solve real-life problems.

PROFESSIONAL EXPERIENCE

- Jan 2022 – Present **Research Assistant (Biomedical Engineer, Decision Analyst)**
Operational Research Center in Healthcare, Near East University
Nicosia, Turkish Republic of Northern Cyprus
- Key Responsibilities**
- Incorporate Multi-Criteria Decision-Making (MCDM) technique with Artificial Intelligence for medical disease diagnosis and treatments.
 - Application of Fuzzy PROMETHEE and MCDM for decision-making in healthcare.
 - Apply AI ensemble paradigms for predictions
 - Apply AI to medical disease diagnosis and treatment.
- Projects**
- Brain Tumor Cancer Diagnosis Based on Supervised Learning and Analytical Evaluation Models
 - Comparative Analysis of the Pharmacological Treatments of Venous Insufficiency Using Fuzzy-PROMETHEE
 - Diagnosis of Parkinson's disease using supervised learning and MCDM model
 - An AI-based comparison for liver disease diagnostic alternatives
 - Diagnosis of Parkinson's diseases using supervised learning and multicriteria decision-making models
 - Liver disease screening based on supervised learning models and the Fuzzy PROMETHEE technique
 - Comparative Analysis of Different Anesthesia for Surgical Operations Using Analytical Evaluation Models
 - Emerging AI and Cloud Computing Paradigms Applied to Healthcare
 - Dissolve Oxygen Prediction Using Ensemble Paradigms
 - AI-based decision analysis for brain tumor diagnosis
 - Evaluation of The Various Methods of Controlling Pain During Childbirth Using Analytical Evaluation Models
 - Global Climate Change and Its Effects on Nature and Human Life Using Fuzzy-PROMETHEE To Evaluate the Top-10 Countries That Contribute to Climate Change the Most and The Top-10 Countries Most Vulnerable to Climate Change
 - Hydrogel-Based Drug Delivery Nanoparticles in Comparison with Other Conventional Treatment Methods for Cancer Tumor
 - Fuzzy PROMETHEE-Based Evaluation of Bone Cancer Treatment Techniques
 - Evaluation of the Treatment Alternatives for Herniated Disc Using MCDM Simulation Methods
- Sept 2021 – Present **Lecturer Assistant (Biomedical Engineering)**
Biomedical Engineering Department, Near East University Nicosia.
- Oct 2021 – Jan 2022 **Laboratory Analyst (Laboratory Technician)**
Biogram Tibbi Laboratuvari, Lefkosa TRNC
- Key Responsibilities**
- Covid-19 PCR/Antigen Testing
 - Sending Covid-19 test results to the Government database
- Nov 2021 – Jan 2022 **Sales Manager Pawn Shop Company**
- Sept 2019 – Present **Chinese/Nigeria English Teacher**
Native Camp Online Teaching Platform
- April 2018 – Present **Independent Business Owner**
IM Academy New York City.
- Key Responsibilities**
- Convincing investors and subscribers
 - Actively involved in Forex Education, dispensing of trade signals, and account management services.
- Sept 2018 – Nov 2020 **Laboratory Analyst/Technician and Quality Control Officer**
Daily Need Industries Nig. Ltd., Lagos Nigeria
National Youth Service to the Federal Republic of Nigeria.
- Key Responsibilities**
- Examine and ensure the quality of drugs produced
 - Laboratory evaluation for produced drugs
 - Documentation
- Jan 2017 – Sept 2017 **Laboratory Assistant**
Group Christian Medical Center, Warri Nigeria
One-year mandatory internship.
- Jun 2012 – Sept 2015 **Computer Café Manager**
Fastlink Computers Innovation and Communication Inc. Bomadi Nigeria
- Key Responsibilities**
- Computer tutor
 - Computer café manager
 - Computer Hardware Engineer

EDUCATION

2022	Ph.D. in view
2021-2022	Master of Science in Biomedical Engineering (Grade: 4.00/4.00) Near East University, Nicosia Cyprus
2014 – 2018	Bachelor of Science in Medical Biochemistry and Genetics (Grade: 4.00/5.00) Delta State University Abraka, Nigeria
2014 – 2015	Wisdom Foundation for Leadership
2012 – 2014	Fastlink Computers Innovation and Communication School Inc. Bomadi Nigeria

PUBLICATIONS**JOURNALS:****CONFERENCES ATTENDED:**

1. EURO 2022 ESPOO, FINLAND
2. Conference FOR Medical Students at Near East University 2022
3. International Conference on Artificial Intelligence in Everything 2022 Near East University
4. **Association of Southern European Economic Theorists (ASSET 2022)**

PUBLISHED ARTICLES

1. Evaluation of The Treatment Alternatives for Spinal Cord Tumors Using Analytical Evaluation Models
2. Comparative evaluation of 3D printing filaments, used in additive manufacturing of biomedical tools; Using fuzzy PROMETHEE

PAPERS UNDER PEER-REVIEW

1. Comparative Analysis of the Pharmacological Treatments of Venous Insufficiency Using Fuzzy-PROMETHEE
2. Comparative Analysis of Different Anesthesia for Surgical Operations Using Analytical Evaluation Models
3. *Emerging AI and Cloud Computing Paradigms Applied to Healthcare*
4. fuzzy-based comparison of hydrogel-based drug delivery nanoparticles with conventional treatment approaches for cancer

EXTRA-CURRICULAR ACTIVITIES

Nov 2018 – Oct 2019	President of National Association of Adventist Corps Members, (Lagos State Zone) Nigeria
June 2016 – July 2018	President of National Association of Adventist Students, (Delta State Zone) Nigeria.
Sept 2017 – Sept 2018	President of National Association of Medical Biochemistry & Genetics Students (NAMBS) Delta State Chapter, Nigeria
2012 – 2014	President of Alumni Association of Our Lady's Catholic Secondary School Bomadi, Nigeria