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Comparison between Two Baby Carrying Techniques on Lower Trunk and Neck Muscles Activity

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Abstract

Background: Infant carrying is essential for caretakers, particularly with the use of baby carriers. A baby carrier, designed for infants aged one to twenty-four months, facilitates parents and caregivers in carrying out their daily tasks while ensuring the safety and comfort of the baby **[1]**.

Aim of Study: This study aimed to compare between two baby carrying techniques on lower trunk and neck muscles activity.

Patients and Methods: This study involved the participation of 34 normal female individuals. The age range of the individuals varied from 23 to 32 years old. The age of the mannequin is five months. The weight of the mannequin is seven kilograms, and the weight of the mannequin dummy is also seven kilograms. Position one involved measuring the maximum voluntary isometric contraction of the upper trapezius and erector spine muscles on the right dominant side using EMG. In position two, muscle activity of the upper trapezius and erector spine was recorded while carrying an infant mannequin in the arms. In position three, muscle activity of the upper trapezius and erector spine was recorded while carrying an infant mannequin in a front baby carrier **[2]**. This study started on January 2024 up to March 2024.

Results: The results indicated significant disparities in muscle activity between holding an infant mannequin in the arms and using a front baby carrier. Specifically, there was reduced muscle activity in the right upper trapezius and right erector spine muscles when holding the mannequin in the arms, while high muscle activity was observed in the same muscles when using the front baby carrier. With a significance level of $p<0.05$.

Conclusion: Based on the results, it can be concluded that carrying a baby in one's arms is more effective than using a baby carrier. Carrying a baby in a carrier leads to higher muscle activity in the right upper trapezius and right erector muscles, whereas carrying a baby in one's arms results in less muscle activity in these muscles.

Key Words: *Electromyography – Baby carrier and Amplitude.*

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Introduction

THERE are numerous methods for carrying kids, some of which have cultural significance while others are simply current trends **[3]**.

Caregivers frequently utilize baby carriers to transport infants until they reach around thirty six months of age, since this affords both physical proximity and security for the infant in relation to the caregiver. Baby wearing refers to the practice of maintaining a newborn in close proximity to a mother's body, either with or without the use of a supporting device **[4]**. The most prevalent methods for carrying a baby in Egypt include using a front baby carrier or holding the baby within one's arms.

Front type includes a back support that is adjustable to fit the caregiver's body shape. They have padded shoulder straps and a padded waist belt. These three features to be comfortable and to give good waist support.

Design of baby carrier (front baby carrier) mostly focused on baby's needs Front load to wearer at front position produced postural changes similar to a pregnant women placing the center of gravity of the human body at the front of the stomach, increasing the curvature of the head and lumbar bones, increasing the level of stiffness of the torso and increasing the amount of extension of the lumbar spine, which can be a factor in increasing the amount of load onto the waist.

Regarding posture orientation, the front load causes a shift in the center of mass of the upper body towards the front, which leads to an increase in the activity of the back muscles that are necessary for maintaining an upright body position. Conversely, carrying a burden on the back can result in a notable alteration in neck movement while walking. These changes in range of motion and walking pattern have the potential to negatively impact those who carry the load for extended periods, potentially leading to physical health issues such as back pain.

Electromyography (EMG) enables the investigation of muscle activity. It enables the assessment of muscular performance and activity, aiding in pre- and post-surgical decision making. Additionally, it records the therapy and protocol training regimens, aiding patients in muscle training. Enables the examination and enhancement of sports activities. Additionally, it can identify muscle reaction in investigations related to ergonomics. The predominant techniques of carrying a baby in Egypt are using a front baby carrier or holding the baby in one's arms. This study aimed to examine the impact of both methods on muscle activation using electromyography (EMG) in order to determine the most suitable approach for carrying infants **[5]**.

Subject, Material and Methods

Study design:

Study was designed as a single group repeated measures design. (one shot the comparative study).

Participants:

A total of thirty-four female subjects were involved in this investigation. The participants' ages spanned from 23 to 32 years old. The study commenced in December 2023 and lasted for a duration of two months, concluding in February 2024. The protocols of the present study underwent thorough examination, and the patients were chosen at random from the outpatient clinic of the Rheumatology and Rehabilitation Department at Kasr El-Aini Hospitals. Prior to participation, all patients were obligated to provide written consent after obtaining approval from the ethics committee of the Faculty of Physical Therapy, Cairo University, Egypt.

Inclusion criteria:

- Age of females ranged from 23 to 32.
- Healthy females participated in this study had no severe lumbar deviations.
- No previous baby carrier wearing experience.
- Their body mass index BMI ranged from 18-30kg/m^2. Age of the mannequin is 5 monthes, weight of the mannequin 7kg and height 66cm. The weight and age of the mannequin referring to the males and females babies in 2006 World Health Organization child sex standard table.

Criteria for exclusion:

Participants were removed based on the following criteria:

Women who have used medicines, undergone hormone therapy, or received injections that may have had an impact on their postural stability in the past 3 months. Women who experienced problems or pain in their upper and lower extremities within the past 6 months. Previous experience with wearing baby carriers has resulted in females reporting discomfort in their knees, ankles, necks, and backs, as well as experiencing serious chronic illnesses.

The sample size calculation:

The sample size was calculated using the G*Power software (version 3.0.10). *t*-test difference between two dependent means (matched pairs) was selected. Considering a power of 0.80, α level of 0.05 (2 tailed) and effect size of 0. 5, a generated sample size is 34 subjects.

Instrumentation:

Measurement equipment and tools:

Weight-Height scale:

Weight-height scale was used to measure the weight and height of each female to calculate BMI, and to fill data. Body mass index was calculated according to formula:

$$\text{BMI} = \text{Weight / height squared } (\text{kg/m}^2).$$

Chicco baby carrier:

Chicco Baby Carrier was Ultra soft, small (Dimensions 6.18 x 9.13 x 10.43 inches) and lightweight (Weight 1.2 pounds) carrier. It was made of Cotton-Polyester, The flexible fabric of the baby carrier allowed good support of the newborn's natural C-back curve position. It had 3 belts – 2 shoulder belts and one waist belt for lumbar support these straps are padded and adjustable for comfort. This carrier was easy to use, with just a few adjustable buckles the infant can be quickly put on and off. It was suitable for newborn to 12-months baby. It's perfect for the early months when, like all newborns, because the baby needs lots of closeness. Minimum recommended weight of the carrier is about eight Pounds and Maximum recommend weight is about 25 pounds.

The mannequin infant used for this study had seven Kg which matches the infant's age five month. Weights were added into the baby mannequin and dispersed equally. This weight was particular chosen as it corresponds to the age at which the infants are usually carried by the mother. The baby mannequin was used instead of the actual baby for two reasons: Firstly, to control the errors arising from the baby's movements. Secondly, carrying an infant was not significantly different from carrying a mannequin.

Infant mannequin:

The mannequin infant utilized in this study had a weight of 7 kilograms, which corresponds to the age of a 5-month-old infant. The infant mannequin was equipped with weights that were evenly distributed.

Electromyography (EMG):

Is a diagnostic technique used to measure and record the electrical activity of muscles Electromyography (EMG) is a method used to assess and document the electrical signals generated by skeletal muscles. This procedure involves the use of a device called an electromyography apparatus, which produces a recording known as an electromyogram. Electromyography is a dependable and accurate method for detecting the electrical potential produced by muscle cells during their electrical or neurological stimulation. The signals can be examined to identify irregularities, level of activation, or sequence of recruitment, or to assess the biomechanics of human or animal movement. Electromyography is valid and reliable tool to detect the electric potential generated by muscle cells. Surface electromyography (EMG) is a legitimate non-medical technique employed by various specialists, such as physiotherapists and kinesiologists, to evaluate muscle activation [10].

The experiment utilized the Natus EMG instrument model 2016, specifically the Viking Quest System with software V7.4, manufactured by Nicolet Biomedical in Madison, Wisconsin, USA.

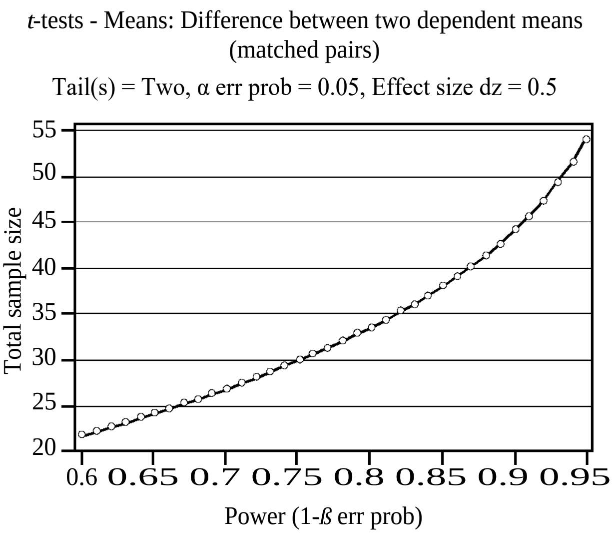

Fig. (1): Sample size calculation.

Procedures of the study:

Each participant was provided with a comprehensive explanation of the protocol, followed by the assignment of a written consent form to each individual. A data recording sheet was utilized to document information on each female, including personal history and past history.

The muscle activation of the upper trapezius and erector spinae was measured using surface electromyography (SEMG).

Prior to attaching the surface electrode, body hair was eliminated at the designated spot and rubbing alcohol was utilized to disinfect and reduce the potential for error produced by skin resistance. The surface electromyography (EMG) sensor was affixed to the dominant side of the right muscles in order to capture EMG data for the right upper trapezius muscle. The surface electrode was positioned at the midpoint of the line connecting the spinous process of the C7 vertebra and the outermost point of the acromion. A surface electrode was positioned on the right side of the erector spinae muscle, namely at the L3 level, 2cm away from the spinal processes, and running parallel to the lumbar spine. EMG muscle activity amplitude was measured for participants in three distinct positions as outlined:

During the first unloaded position, the female participant was directed to sit and place a EMG surface electrode on the upper trapezius muscle on the right side of her neck. The person was then provided resistance three times for 30 seconds and taught to shrug her shoulder against the resistance. A surface electrode was positioned on the right side of the erector spinae muscle in the lumbar region. The participant's lower trunk was subjected to resistance three times for a duration of 30 seconds. They were then told to do back extension against the resistance while in a prone posture, in order to quantify the maximum voluntary isometric contraction.

Loaded Position two occupied by an individual who is holding a mannequin of a newborn in their arms. The participant was directed to grasp the mannequin at the front of the trunk using their right arm, allowing the mannequin's head to rest on their right shoulder. The participant's left arm was used to support the mannequin's trunk and head. EMG surface electrodes were placed on the right side of the participant's upper trapezius muscle in the cervical region. Resistance was then applied to the participant's shoulder to induce a shrugging motion. Applying surface electrodes to the right side of the lumbar erector spine while maintaining a stationary standing position for a duration of 30 seconds.

Loaded Position three involves females carrying an infant mannequin in a baby carrier that is worn on the front of the body using a harness-style with two padded shoulder straps. The individuals stand in a static position for 30 seconds while their muscle activity amplitude is measured by providing resistance to shoulder shrugging. This measurement is done using surface electromyography (SEMG) for the right upper trapezius muscle. Additionally, resistance is given in back extension to measure muscle activity for the right erector muscle, also using SEMG.

Statistical analysis:

Statistical analysis was conducted using SPSS for windows, version 23 (SPSS, Inc., Chicago, IL). The current test involved one independent variable was the (conditions); within subject factor which had two levels (Holding an infant mannequin in arms and Holding an infant mannequin in the baby carrier). In addition, this test involved two tested dependent variables (EMG of upper trapezius and Erector spine). Accordingly, repeated measure MANOVA was used to compare the tested variables of interest at different tested conditions. Within subject MANOVA was performed on the examined sample with the alpha level 0.05.

Results

EMG of upper trapezius:

As presented in Table (1) and illustrated in Fig. (2), the mean ± SD values of EMG of upper trapezius in the "Holding an infant mannequin in arms" and "Holding an infant mannequin in the baby carrier" were 1.97±0.18 and 2.45±0.18 respectively. The univariate tests of repeated measure MANOVA revealed that there were significant differences in the mean values of EMG of upper trapezius between both conditions (F-value=162.281, *p*-value =0.0001*). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there were significant differences between (Holding an infant mannequin in arms Vs. Holding an infant mannequin in the baby carrier) with ($p<0.05$) in favour to Holding an infant mannequin in the baby carrier.

EMG of Erector spinea:

As presented in Table (2) and illustrated in Fig. (3), the mean ± SD values of EMG of Erector spine in the " Holding an infant mannequin in arms" and " Holding an infant mannequin in the baby carrier" were 0.92±0.37 and 1.28±0.40 respectively. The univariate tests of repeated measure MANOVA revealed that there were significant differences in the mean values of EMG of Erector spine between both conditions (F-value=69.402, *p*-value=0.0001*). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there were significant differences between (Holding an infant mannequin in arms Vs. Holding an infant mannequin in the baby carrier) with ($p<0.05$) in favor to Holding an infant mannequin in the baby carrier.

Table (1): Descriptive statistics and repeated measure MANOVA for the EMG for Upper trapezius between both conditions.

Mean ± SD	Holding an infant mannequin in arms	Holding an infant mannequin in the baby carrier
EMG for Upper trapezius	1.97±0.18	2.45±0.18
The univariate tests for the mean of EMG for Upper trapezius between both conditions		
	F-value	*p*-value
EMG for Upper trapezius	162.281	0.0001 *
Multiple pairwise comparison tests (Post hoc tests) for the EMG for Upper trapezius between both condition		
EMG for Upper trapezius	Holding an infant mannequin in arms VS. Holding an infant mannequin in the baby carrier	
	p-value	Partial Eta square
	0.0001*	0.831

*Significant at alpha level <0.05.

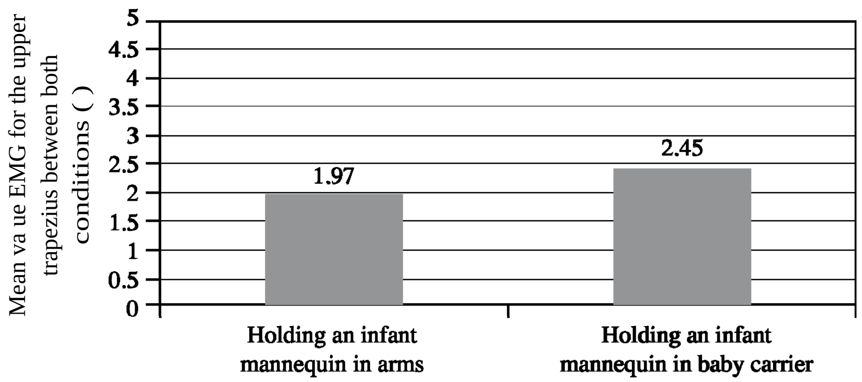

Fig. (2): Mean values of the EMG for Upper trapezius between both conditions.

Table (2): Descriptive statistics and repeated measure MANOVA for the EMG for Erector spine between both conditions.

Mean ± SD	Holding an infant mannequin in arms	Holding an infant mannequin in the baby carrier
EMG for Erector spine	0.92±0.37	1.28±0.40
The univariate tests for the mean of EMG for Erector spine between both conditions		
	F-value	*p*-value
EMG for Erector spine	69.402	0.0001 *
Multiple pairwise comparison tests (Post hoc tests) for the EMG for Erector spine between both condition		
EMG for Erector spine	Holding an infant mannequin in arms VS. Holding an infant mannequin in the baby carrier	
	p-value	Partial Eta square
	0.0001*	0.678

*Significant at alpha level <0.05.

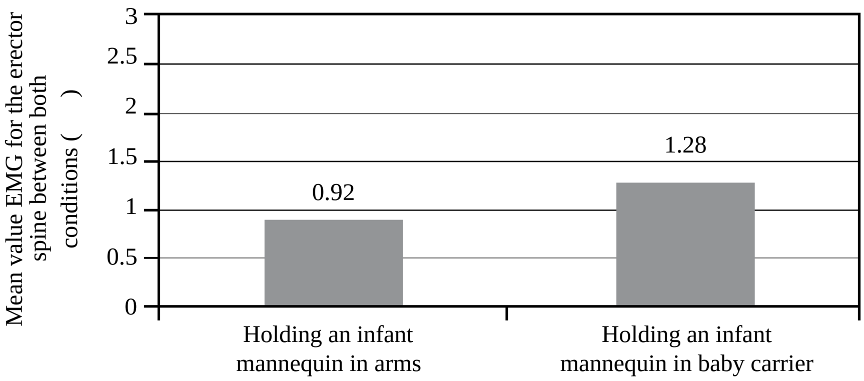

Fig. (3): Mean values of the EMG for Erector spinae between both conditions.

Discussion

The objective of this study was to assess the impact of carrying a baby in one's arms on the muscles of the lower back and neck, specifically focusing on the activity levels of the lumbar and cervical muscles during static standing. Electromyography was used to measure muscle activity amplitude.

The findings indicated that electromyography (EMG) measurements revealed the least amount of muscle activity (amplitude) in the erector muscles while using the approach of carrying an infant mannequin within the arms. Conversely, the baby carrier method resulted in increased muscle activity in the erector muscles.

The EMG analysis revealed that the upper trapezius muscle exhibited the least amount of muscular activity (amplitude) when carrying an infant mannequin using the "in arms" approach, while the upper trapezius muscle showed higher muscle activity when using the baby carrier method.

These results can be attributed to the weight's height, which affects the movement of the spine. This is supported by the current study. The results are consistent with Ojukwu et al., 2023, who used three hip belts of varying widths (2 inch, 4 inch, and 6 inch) attached to the front of an infant carrier during three different carrying tasks. Surface electromyography (EMG) was used to measure the activity of the right and left components of the Erector spine and Multifidis muscles during each 5-minute session. The asymmetry ratios of the normalized electromyography (EMG) data for the right and left components of each muscle were computed. The use of various hip-belt dimensions did not result in statistically significant variations (p<0.05) in the electrical activity of the back muscles, nor in their asymmetry ratios. Nevertheless, slight disparities in the normalized EMG readings indicated that the 4-inch belt resulted in the most muscular activity in three out of the four muscles examined.

The current results align with a study conducted by Lee Sang-Yeol in 2009, which found that using the carrier belt at the front reduces muscle activation in the neck area, while using the belt at the back increases muscle activity in the neck area. The findings of this study demonstrated that wearing the anterior slope of the neck in the back resulted in higher activity of the neck muscles when standing in a neutral position, which aligns with previous evidence [12].

These outcomes may be ascribed to the practice of holding the object close to the body rather than away from it, which minimizes the bending moment on the lumbar spine. This hypothesis is validated by the current investigation. The results are consistent with previous findings.

In the study conducted by Chang et al., in 2010, it was found that the activation of the neck paraspinalis muscle greatly increased when using a baby carrier with arms. Additionally, there was a significant rise in the activation of the erector spinae muscle when using an anterior baby carrier. These findings suggest that the muscle activation was altered by the use of arm assistance and the positioning of the infant carrier. Hence, the correlation between muscular activation and musculoskeletal harm might be regarded as the act of carrying a baby while walking [13].

The results were consistent with Ojukwu et al.'s findings in 2023, indicating that there were no significant variations in the electromyography (EMG) activity of the erector spine muscles during the rising of infants in-arms when awake. Curiously, the erector spinae had the greatest muscular activity while using a front baby carrier during wakefulness [14].

The findings of the present study contradict the findings of Schmid et al. (2019) who investigated the effects of unloaded walking and carrying a dummy in front. They found that these activities were mostly related with an increase in lumbar lordosis and higher activation of the erector spinae muscles, rather than carrying a baby in a baby carrier. Carrying situations involving a carrier resulted in elevated paraspinal muscle activity when walking [15]. Carrying Positions preferred by mothers:

The practice of using soft carriers to carry babies has been employed for centuries and continues to be used now. It is advisable to adjust the height of the baby carrier to the pelvic level. This helps distribute the weight evenly to the lower extremities and ensures that the baby is in an optimal body position. This position promotes the healthy development of the spine and motor skills, and helps prevent hip disorders in newborns.

Woven wraps facilitate easier fabric manipulation, making them easier to handle and tie. Additionally, they promote appropriate hip growth. Exerts a beneficial influence on both the offspring and the caregivers [16].

Conclusion:

This study found that carrying a baby in one's arms is more effective than using a baby carrier, as carrying the baby in one's arms resulted in lower muscle activity in the upper trapezius and erector muscles. In contrast, carrying the baby in a baby carrier led to higher muscle activity in these muscles, according to statistical analysis.

Recommendations:

1- Additional studies are required to investigate the impact of varying evaluation durations and application approaches.
2- Further research is advised to examine the impact of Electromyography assessment on patients in various situations.
3- Since the weight of the infant doll was kept constant in this study, we should investigate the impact of varying weights of infants (dolls) on these muscles.
4- Additional research is required to elucidate the complete intricacies of muscle activation in additional muscles, beyond the upper trapezius and erector spinae.

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مقارنة بين تقنيتين لحمل الطفل على النشاط العضلى لأسفل الجذع والرقبة

تستخدم العديد من النساء ومقدمى الرعاية حامل الطفل كطريقة لحمل الاطفال خلال القيام بالأنشطه الحيوية اليومية بينما تستخدم أخريات طريقة الحمل بين الذراعين اثناء القيام بالأنشطة اليومية. استهدفت هذه الدراسة تقييم وفحص النشاط العضلى لعضلات أسفل الجذع وعضلات أعلى الرقبة خلال طريقتى حمل الطفل سواءا بين الذراعين او باستخدام حامل الطفل وتم تقييم النشاط العضلى باستخدام جهاز التخطيط الكهربى للعضلات خاصة على العضلة شبه المنحرفة العلوية والعضلة المنتصبة القطنية. تبين من خلال الدراسة ان النشاط العضلى لتلك العضلات أكبر خلال استخدام حامل الطفل أكثر من طريقة الحمل بين الذراعين وبالتالى يكون الحمل بين الذراعين كطريقة حمل للأطفال أفضل من طريقة استخدام حامل الطفل حيث يحتاج نشاط عضلى أقل وتأثيراته محدودة كارهاق ومضاعفات على العضلات.

الهدف من البحث:

أجرى هذا البحث من أجل:

١- دراسة تأثير استخدام طريقة حمل الطفل بين الذراعين على النشاط العضلى لعضلات أسفل الجذع وعضلات أعلى الرقبة باستخدام جهاز التخطيط الكهربى للعضلات أثناء الوقوف فى وضع ثابت.

٢- دراسة تأثير استخدام طريقة حمل الطفل باستخدام حامل الطفل الامامى على النشاط العضلى لعضلات أعلى الرقبة وعضلات أسفل الجذع باستخدام جهاز التخطيط الكهربى للعضلات أثناء الوقوف فى وضع ثابت.

٣- المقارنة بين تقنيتين لحمل الاطفال (طريقة حامل الطفل وطريقة بين الذراعين) على النشاط العضلى لعضلات اسفل الجذع وعضلات أعلى الرقبة أثناء الوقوف فى وضع ثابت.

مواد وأساليب البحث: اشترك فى هذه الدراسة ٣٤ أنثى طبيعية تتراوح أعمارهن من ٢٣ حتى ٣٢ عاما وهن غير حوامل ولا يعانين من مشاكل لها علاقة بالعظام أو الجهاز العضلى الهيكلى ولا ألام اسفل الظهر ولا مشاكل عصبية. ولم يسبق لهن خبرة فى ارتداء حامل الطفل. يتراوح مؤشر كتلة الجسم لهم من ١٨ حتى ٣٠ كجم/م٢. سن الطفل ٥ شهور. وزن الطفل (الدمية ٧ كيلوجرام). تم اختيار الاناث بشكل عشوائى من العيادة الخارجية بقسم الروماتيزم والتأهيل بمستشفيات القصر العينى وتم الاختيار على أساس دراسة مقارنة مرة واحدة. (الوضع الأول بدون تحميل): الأنثى تم توجيهها لتقف بشكل مستقيم وتم وضع القطب الكهربى السطحى على الجانب الايمن من عضلة الرقبة (العضلة شبه المنحرفة العلوية) وأيضا على جانب العضلة القطنية (المنتصبة) لكى نقيس قوة أقصى انقباض عضلى ارادى ثابت فى المكان للعضلات المستهدفة. الوضع ٢ (بالتحميل): تحمل الاناث الدمية عن طريق الذراعين أثناء الوقوف بشكل مستقيم لمدة ٣٠ ثانية مع مقاومة هز الكتفين لكى نقيس النشاط العضلى باستخدام القطب الكهربى السطحى لجهاز التخطيط الكهربى للعضلات وذلك للعضلة شبه المنحرفة العلوية وبعد ذلك يتم اعطاء مقاومة لفرد الظهر كى نقيس النشاط العضلى للعضلة المنتصبة القطنية. الوضع ٣ (بالتحميل): تحمل الاناث الدمية من خلال حامل الطفل عن طريق اسلوب الحمل الامامى بواسطة رباطين مثبتين على الكتفين ويتم الوقوف فى وضع مستقيم لمدة ٣٠ ثانية كى يتم قياس النشاط العضلى مع اعطاء مقاومة لهز الكتفين ويتم القياس بواسطة القطب الكهربى السطحى لجهاز التخطيط الكهربى للعضلات وذلك للعضلة شبه المنحرفة العلوية وبعد ذلك يتم اعطاء مقاومة لفرد الظهر وقياس النشاط العضلى للعضلة المنتصبة القطنية.

النتائج: أظهرت النتائج أن هناك اختلافات ذات دلالة احصائية فى كلتا العضلتين (شبه المنحرفة العلوية والمنتصبة القطنية) اثناء طريقة حمل الطفل بين الذراعين (أقل نشاط عضلى) وطريقة حامل الطفل (أكبر نشاط عضلى). نتيجة لذلك يعتبر حمل الطفل بين الذراعين فعال أكثر من ارتداء حامل الطفل. ذلك لأن طريقة حامل الطفل أظهرت نشاط عضلى أكبر للعضلة شبه المنحرفة العلوية والعضلة المنتصبة القطنية فى حين أظهرت نشاط عضلى أقل فى العضلة شبه المنحرفة العلوية والعضلة المنتصبة القطنية اثناء طريقة حمل بين الذراعين.

لذا أثبتت الدراسة أن حمل الطفل بين الذراعين فعال أكثر من ارتداء حامل الطفل. ذلك لأن طريقة حامل الطفل أظهرت نشاط عضلى أكبر للعضلة شبه المنحرفة العلوية والعضلة المنتصبة القطنية فى حين أظهرت نشاط عضلى أقل فى العضلة شبه المنحرفة العلوية والعضلة المنتصبة القطنية اثناء طريقة حمل بين الذراعين.

وقد أجريت تلك الدراسة خلال الفتره من يناير ٢٠٢٤ حتى مارس ٢٠٢٤ فى القاهره .