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# Gluteal muscle activation and strength in Egyptian nurses with low back pain

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Abstract---Background: nursing is characterized by high occupational stress and bad carrying habits that may lead to negative changes in posture. The aim of this study is to assess Gluteal muscles activation and strength in Egyptian nurses working in ICU and In-patient units complaining from chronic low back pain. Design: A cross-sectional study. Subjects One hundred thirty-four Male and female nurses was recruited for this study. Their work duration ranged from 3 to 10 years in the hospital, their work shifts extend for approximately 8 - 12 hours including patient handling, and their age ranged from 21 to 40 years old. Method: the gluteal muscles activation was measured by EMG and gluteal muscles strength was assessed by hand-held dynamometer. Results: MANOVA revealed that there were no significant differences between groups in all measures of muscle endurance. On the other hand, there was only a significant difference between groups in Gluteus Maximus Muscle activation in nondominant side (F = 16.639, p <.001\*) and Gluteus Med/Min Muscle activation in dominant side (F = 6.732, p =  $0.011^*$ ). Conclusion: The study documented changes in muscle activation in dominant and non-dominant sides which may be attributed to the nature of the nursing work in different departments of the hospital. The nature of their working tasks may be considered a risk factor for the

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development of low back pain later in life.

*Keywords*---back pain, Egyptian nurses, gluteal muscles, EMG, strength.

## Introduction

Poor strength and delayed firing of the hip extensor (gluteus Maximus) and abductor (gluteus medius) muscles has been observed in individuals with chronic LBP or lower extremity instability (Nadler et al., 2000). However, the strength of Gluteus Maximus muscle have many points to be investigated systematically. LBP is a common and prevalent complaint in nurses worldwide, with annual prevalence in Italy ranging from 33% to 86% (I Maul et al., 2003). A previous study reported that 43% had low-back pain symptoms, 30% had arm or neck complaints (mostly in the shoulder) and 16% had leg complaints (mostly in the knee) (Engels et al., 1996).

In Egypt, a study in Zagazig reported that LBP prevalence among working nurses was estimated to be 79.3%, with the highest rate reported in Intensive care unit (ICU) nurses (95%) and the lowest in the outpatient clinics nurses (64%) (El-soud et al., 2014). LBP in nurses was associated with prolonged standing, heavy lifting, frequent bending and stooping, twisting, sudden unexpected movements, exposure to vibration and tasks involving, pushing, and pulling associated with their work at hospital (El-ezaby & El-mowafy, 2015). Low-back pain (LBP) is pain localized in the back region bounded by the twelfth ribs, superiorly; the gluteal line, inferiorly; and the anterior axillary line, anteriorly (Depintor et al., 2016). It is an extremely common global health problem (Hoy et al., 2010) that causes disability in working populations (Coggon et al., 2013).

Physical factors associated with the development of LBP included manual lifting, bending, stooping, twisting, and other manual tasks. Nurses carried out less than 10 manual transfers per shift without using any assistance and usually with faulty posture (Lagerstrm et al., 1998). Low back pain in nurses is an occupational risk factor due to lifting or handling of patient. Study by Nourbakhsh, (2022) revealed that Gluteus Maximus activities changed in people with LBP such as athletes whom perform high demanding activities in which Gluteus Maximus muscle act as primary mover together with lower back extensor during lifting or as in handling of patients in nursing occupation. Therefore, we hypothesize that there were changes in Gluteal muscles pattern of recruitment in nurses complaining from LBP. The purpose of the current study is to assess Gluteal muscles activation and strength in Egyptian nurses working in ICU and In-patient unit complaining from chronic low back pain.

## Materials & Methods

One hundred thirty-four nurses were recruited for this study between February 2021 and February 2022. Participants were subdivided based on their working unit into two groups:

Group one: Sixty-seven ICU nurses with Chronic LBP.

Group two: Sixty-seven In-patient nurses with Chronic LBP.

All participants were enrolled in this study based on the following inclusion and exclusion criteria:

Inclusion criteria was male and female nurses, work duration from 3 to 10 years in the either ICU or In-patient unit, their work shifts extend for approximately 8 - 12 hours including patient handling, and age ranged between 21 to 40 years old complaining from LBP for at least three months up to five years.

Exclusion criteria nurse with a previous history of spinal or lower quadrant pain, surgery or diseases, trauma to the lower extremity over the past year, apparent skeletal spinal or lower extremity deformity, systematic disease that affects the neuro-muscular system such as diabetes, abdominal problem such as spastic colon, evidence of femoro-acetabular impingement assessed with the hip flexion/adduction/internal rotation test, any form of a mechanical disc herniation causing lower extremity symptoms assessed by the straight leg raising test, and any history of neurological conditions that affect functional activities.

Study design: Cross-sectional study

#### Assessment

#### Electromyography (EMG)

The activation of Gluteus Maximus, Medius, and Minimus muscles was assessed by EMG device, according to the testing protocol described previously (Marras et al., 1999). EMG has frequently been used to compare muscle activity levels. The activity of the gluteal muscles was assessed while nurses in a stooping position (reaching tasks) which is the most frequent position assumed during patient's handling. The electrodes were placed according to recommended guidelines in which the position of the first electrode to detect Gluteus Maximus muscle activation is on the origin of the muscle at greater trochanter and the second on belly of the muscle (one third of the distance from the second sacral vertebra). The nurse was asked to take a stooping position in front of the patient and the activation of gluteal muscles where recorded. The activation of the Gluteus Medius and Minimus muscles were measured while the electrode was placed one third of the distance from the greater trochanter and the iliac crest (Rainoldi et al., 2004). The gluteal muscles activation during maximal contraction was used to normalize their activation during stooping. The normalization was done by dividing activation of muscle during stooping position by their maximum contraction during standing (Neto et al., 2020).

#### Isometric muscle strength

A hand-held dynamometer Lafayette (Microfet, Draper, and UT) was used to determine isometric hip strength of both lower extremities for hip extensors and abductors. Hand-held dynamometer was fixed about two inches above the insertion of Achilles tendon while the participant is in prone position. The participant was asked to extend lower limb then hold after maximum contraction against hand-held dynamometer for Gluteus Maximus muscle strength as shown in figure (1a,b). The dynamometer was fixed above lateral malleolus by about two

inches while the participant is in side lying position. The participant was asked to abduct lower limb then hold after maximum contraction against hand-held dynamometer for Gluteus Medius and Minimus shown in the picture as shown in figure (1c).





Figure 1: Assessment of muscle strength of a.&b. Gluteus Maximus muscle c. Gluteus Medius and Minimus muscles.

## Statistical analysis

One way between subject MANOVA test was used to determine if there were significant differences in activation and strength of Gluteus Maximus, Medius and Minimus muscles between groups A (In-patient) and group B (ICU nurses). Chi-squared test was used to assess gender distribution in the two groups. The level of significance for all statistical tests was set at p < 0.05. All statistical analysis was conducted using the statistical package for social studies (SPSS) version 28 for windows (IBM SPSS, Chicago, IL, USA).

# Results

# **Subject characteristics**

Seventy-one nurses participated in groups A (mean age  $30.89 \pm 5.22$  years) and 63 nurses participated in group B (mean age  $30.13 \pm 4.838$  years). There was a significant difference between groups in gender distribution as shown in table 1. There was no significant difference between groups in age, weight, and Body Mass Index (BMI) (p > 0.05) as shown in table 1. On the other hand, a significant difference was observed between groups on height (p < 0.05) as shown in table 1

Table 1: Demographic characteristics for group A (in-patient nurses) and B (ICU nurses)

Group A (n = 71)	Group B (n = 63)	MD	p-value
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Age (years), mean ± SD	30.89 ± 5.22	30.13 ± 4.838	0.760	0.78			
Weight (Kg), mean ± SD	81.17 ± 8.191	78.68 ± 6.552	2.486	0.056			
Height (CM)	175.73 ± 6.607	173.27 ±	2.463	0.023*			
		5.620					
BMI (kg/m <sup>2</sup> )	26.224 ± 1.3724	26.200 ±	0.0235	0.930			
		1.6936					
Gender, n (%)							
Males	49(69%)	31 (49.2%)		0.02*			
Females	22 (31%)	32 (50.8%)					

SD, Standard deviation; MD: Mean difference p value; Probability value

#### The difference between gluteal muscle activation and strength

MANOVA revealed that there were no significant differences between groups in all measures of muscle strength as shown in table 2. On the other hand, there was only a significant difference between groups in Gluteus Maximus Muscle activation in non-dominant side (F = 16.639, p <.001\*) and Gluteus Med/Min Muscle activation in dominant side (F = 6.732, p = 0.011\*).

Table 2: Mean values of Gluteal muscle activation and strength in group A (Inpatient nurse) and B (ICU nurse)

Variable	Side	Group A (In-patien nurse) N = 71	ıt	Group B (ICU nurse) N = 63	MD	Univariate test		Multiple pairwise comparison test	
		$\overline{X} \pm SD$		$\overline{X} \pm SD$		F- value	p- value	Partial Eta Squared	p- value
Gluteus Maximus Muscle Contraction (%)	Dominant side	44.25 15.38	±	39. 49 ± 12.22	4.764	3.874	0.051	0.029	0.051
	Non-dominant side	40.40 8.07	±	35.02 ± 7.08	5.380*	16.639	<.001*	0.112	<.001*
Gluteus Med/Min Muscle contraction (%)	Dominant side	36.39 14.89	±	48.03 ± 34.36	-11.64*	6.732	0.011*	0.049	0.011*
	Non-dominant side	32.47 8.89	±	34.37 ± 10.26	-1.899	1.319	0.253	0.010	0.253
Gluteus Maximus Muscle Strength (P)	Dominant side	342.01 110.46	±	362.52 ± 133.76	- 20.513	.944	0.333	0.007	0.333
	Non-dominant side	357.49 120.38	±	346.94 ± 138.26	10.543	.223	0.638	0.002	0.638
Gluteus Med/Min Muscle Strength (P)	Dominant side	273.272 131.1	±	289.946 ± 144.14	- 16.674	0.492	0.484	0.004	0.484
	Non-dominant side	254.946 129	±	268.092 ± 143.62	- 13.146	0.312	0.578	0.002	0.578

SD, Standard deviation; MD, Mean difference; p value, Probability value; \* Significant differences between groups

Mean value of activation and strength of Gluteus Maximus, Medius and Minimus muscles between groups A (In-patient) and group B (ICU nurses) were presented at figure 2.

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Figure 2: Cluster Bar graph of mean values of Gluteus Max. Med/Min Muscle Activation and Strength between group A (In-patient nurse) and B (ICU nurse)

## Discussion

The purpose of the current study is to assess Gluteal muscles activation and strength in Egyptian nurses working in ICU and In-patient unit complaining from chronic low back pain. One of the main causes of back pain in nurses is patient lifting and handling during positioning the patient (Winkelmolen et al., 1994; Luoto et al., 1995; Marras et al., 1999). The major differences between In-patient and ICU nurses were supposed to be attributed to their different working environment and their related working tasks. Failure of the current work to find a significant difference between such groups in both activation and strength of the gluteal muscles may be due to the nature of work in the Egyptian hospital in which there were no fixed working department for nurses all over their working years. Furthermore, some job requirement may be demanded outside their working department all over a single shift or every multiple shifts according to the requirements of such work and the number of nursers available. Therefore, a controlled environment may be needed to closely assess the working tasks of nursers in different departments to be correlated with the activation and strength of Gluteal muscles to explore whether their working tasks considered a risk factor for the development of low back pain or not. The current findings come in parallel with many studies results concentrated on back pain in nurses and the possible risk factors (Sakakibara et al., 2013; Nadler et al., 2000; Yassi et al., 2013; Marras et al., 1999).

The current study illustrated the difference between both groups of nurses in Gluteal muscle activation and strength between dominant and non- dominant sides. The observed differences may be attributed to their pattern of posture and movement to accommodate with back pain while performing their working tasks. A comprehensive analysis by the dynamic EMG may be needed to correlate between the posture of nurses during their working tasks and the activation of all back and hip muscle.

The finding of the current study is in line with the results of the vivo trial revealed atrophy of Gluteus Maximus seen with LBP analyzed by computed tomography (CT) (Amabile et al., 2017). Other study used a standardized back and hip physical examination observed that Gluteus Medius weakness and tenderness are common symptoms in people with chronic non-specific LBP (Cooper et al., 2016). Furthermore, poor strength and delayed firing of the hip extensor (Gluteus Maximus) and abductor (Gluteus Medius) muscles have previously been noted in individuals with LBP (Nadler et al., 2002).

Other cross-sectional and prospective studies suggested that LBP is associated with reduced strength, atrophy, and excessive fatigability of the lumbar extensors (Grimmer et al., 1999; Steele et al., 2014). Furthermore, other study revealed that strength of the back extensor muscles had the highest association with LBP. Other factors such as the length of the back extensor muscles, and the strength of the hip flexor, hip adductor, and abdominal muscles (Nourbakhsh, 2022).

The current study examined Gluteal muscle activation and strength in Egyptian nurses working in ICU and In-patient units suffering from low back pain, but it had some limitations. First, EMG used surface electrode that may be affected by several sources of noise. Furthermore, Wide variations in the duration of pain complain from one month to five years. Lack of data related to working environment and the nurse's posture at work. Therefore, it is recommended for the future research to closely analyze nurse's working environment and facilities and to correlate it with several factors such as activation of lower back and hip muscles in addition to their strength and endurance.

## Conclusion

The current study observed changes in muscle activation in dominant and nondominant sides which may be attributed to the nature of the nursing work in different departments of the hospital. The nature of their working tasks may be considered a risk factor for the development of low back pain later in life.

## **Competing interests**

We did not receive any financial support from any institution or company Authors declare that there were no competing interests

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