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Is Hip Muscles Flexibility Associated with Low Back Pain Among First-Class Undergraduate Students?

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Abstract: Background and objective. Hip muscles lengthening is commonly associated with the normal function of the lumbar spine and lower extremities. Some evidence correlates hamstrings and iliopsoas tightness with low back pain (LBP). Undergraduates are more prone to LBP as they are involved in prolonged sitting and mal-posture. This study aims to assess the impact of hip muscles lengthening on LBP. **Methods:** A descriptive study of 70 students who were recruited from Zefat Academic College. Measurement of hamstrings and iliopsoas muscles lengthening as well as a constructive questionnaire were used. **Results:** The majority of participants (80% for the Hamstrings and 96% for the Iliopsoas) manifested normal muscle lengthening. Muscle flexibility was significantly higher among females. The logistic regression analyses revealed that hamstrings lengthening (right), and stress-related study, are significantly associated with LBP. **Conclusions:** The current study indicates that muscle length is female-dependent and right-left muscle length is symmetrical. Increased hamstrings length could be related to LBP.

Keywords: Low back pain; muscle flexibility; physical activities; students.

1. Introduction

Flexibility of muscles is considered an essential element of normal biomechanical function [1] and optimizing the performance of physical activities [2]. Reduced flexibility not only decreases the range of motion but can also lead to various other musculoskeletal problems [3].

Hip muscles such as the hamstrings are commonly linked with movement dysfunction at the lumbar spine complex and lower extremity and have been coupled with low back pain [4]. Evidence has also correlated a decrease in psoas lengthening to LBP due to the connection of this muscle to the pelvis and lumbar spine [5]. It has been postulated that psoas tightness may lead to lumbar hyperlordosis, predisposing to apophyseal facet impingement which may produce pain in the lower back [6]. In addition, hamstrings tightness was found to have a positive correlation with the severity of LBP [7].

Low back pain (LBP) is a widespread health problem that affects individuals of all ages and professions. It is one of the most common musculoskeletal disorders worldwide [8] leading to disability and economic burdens. Moreover, LBP profoundly impacts the quality of life, productivity, and mental health [8, 9]. LBP is considered a multifactorial reason? (etiology?) and involves various structures such as facet joints, intervertebral discs, and muscles. Although LBP increases in the elderly, its prevalence among adolescents (18-24 years) is higher (up to 40%) [10, 11].

Undergraduate students, particularly in health science, are at high risk for developing low back pain due to the demanding nature of the curriculum, prone to physical exposure at clinical practice, and prolonged sitting [12-14]. Although the importance of hip muscles flexibility for maintaining joint mobility and relieving musculoskeletal disorders [15-19], few studies have addressed the impact of these muscles on LBP. Additionally, the existing data regarding hip muscles` flexibility and LBP are ambiguous.

Hence, this study aims to characterize hip muscles flexibility among first-class undergraduate students and to reveal whether hip muscles lengthening is associated with LBP.

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2. Materials and Methods

A descriptive study was conducted in the 2023 and 2024 Academic years, at Zefat Academic College in the north of Israel. Seventy volunteers (13 males and 57 females) among first-class students (age range 18-49 years) were enrolled in this study. Participants were excluded if they were (1) pregnant, (2) underwent surgery in their spine or lower extremities, (3) had neuromuscular-skeletal diseases and (4) had anatomical deformities related to the spine and chest wall. A consent form, which included the purpose of the research and the right of the participant to withdraw at any time, was received from each participant. This study has recruited only the first class because this research is part of a prospective one that intends to follow up with the students for 1 to 2 years. This study was conducted according to the Helsinki Declaration and approved by the Departmental Research Ethics Committee, Zefat Academic College (no. 2-2024).

2.1. Instruments and Measures

Structured questionnaire. We used the modified validated Standardised Nordic Questionnaire [20] that sought information on sociodemographic characteristics, physical activities, and factors related to sedentary behavior and smoking habits [21,22] (Table 1). Students were also asked if they had suffered from LBP in the last week. Pain intensity was measured following the visual analog scale (VAS) [23]. Data about study-related stress was also recorded [21].

Table 1. Sample size characteristics **.**

	% (n) /or Mean ± SD
Male	19 (13)
Female	81 (57)
Mean age (year)	25 ± 6
Mean BMI (kg/m^2)	23.7 ± 4
Dominant right-hand–	90 (63)
Marital status:	
Single	79 (55)
Others	21 (15)
Smoking	11 (8)
General Chronic diseases	27 (19)
Constant medication use	17 (12)
Religion & faith:	
Secular	59 (41)
Traditional	14 (10)
Religion and orthodox	21 (15)
Others	6 (4)
Involved with aerobic physical activities (e.g., walking and swimming)	50 (35)
Involved with anaerobic exercise (e.g., Pilates and Yoga)	46 (32)
Sustained daily sitting:	
Up to 3 hours	51 (36)
> 3 to 5 hours	33 (23)
> 5 hours	16 (11)
Total daily sitting:	
Up to 6 hours	44 (31)
Between 6-8 hours	47 (33)
>8 hours	9 (6)
Study-related stress:	
Very high -Quite high	56 (39)

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Little- None	44 (31)
Low back pain in the last week	46 (32)
Hamstrings flexibility (degree) right	92.2 ± 17
Hamstrings flexibility (degree) left	91.8 ± 17
Hamstrings shortness	20 (14)
Iliopsoas flexibility (degree) right	11.6 ± 8
Iliopsoas flexibility (degree) left	12.4 ± 7
Iliopsoas shortness	4 (3)

Muscle flexibility. Hamstrings and iliopsoas length was evaluated through passive straight-leg raise [24] and the modified Thomas test [25], respectively. One of the authors (NR) measured the muscle length on both sides in which each side was evaluated three times and the mean value was then recorded. Hamstrings tightness was defined when the range of passive hip flexion was less than 80 degrees, whereas the inability of the hip to extend to a neutral position was considered iliopsoas tightness [26].

Body anthropometry. One of the authors (NR) evaluated each participant for height and weight using a digital device (Shekel, H150-5). The BMI value was calculated as the weight (kg) divided by height in meters squared (m^2).

2.2. Statistical Analyses

The data were analyzed using the SPSS software 25. The intra-class correlation coefficient was calculated to determine the intra-tester and inter-tester reliability of the measurements of muscles flexibility (repeated measurements of 15 individuals). All continuous parameters (e.g., age, weight, and muscle length) were checked for normal distribution when running the Kolmogorov-Smirnov test. An Independent t-test was used to check the association between muscle length and LBP, gender, and physical activities. Paired t-test was carried out to reveal the right-left muscle length asymmetry. Logistic regression analysis (backward LR) determined the variables associated with LBP (LBP - dependent variable, independent- age, BMI, muscle length, prolonged sitting, etc.). A significant difference was set at $P < 0.05$.

3. Results

The intra-tester and inter-tester reliability results (ICCs) for measuring the hamstrings and iliopsoas lengthening were very high: 0.995 to 0.985 and 0.992 to 0.942, respectively. The demographic and sedentary features of the participants are presented in Table 1. All participants' mean age and BMI values were 25 ± 6 years and 23.7 ±4, respectively. About 81% of the participants were females, and 11% were habitual smokers. Forty-six percent of the students suffered from LBP and 27% have chronic diseases. Half of the participants were involved in physical activities: 50% for aerobic training and 46% for anaerobic activity. Forty-nine percent of students spend time in a prolonged sedentary position (> 3 hours).

3.1. Muscles Length Characteristics

The majority of the participants have normal muscle length (80% for the Hamstrings and 96% for the Iliopsoas) (Table 1). Females manifested greater muscle flexibility for the hamstrings and iliopsoas than males, adapted for the same age and BMI ($P<0.05$) (Table 2). In addition, individuals who were engaged in anaerobic physical activity (e.g., Yoga) revealed significant muscle flexibility compared to those who did not practice this activity ($P<0.05$). A high correlation was reported between the flexibility of the hamstrings and iliopsoas muscles ($r= 0.692$; $P<0.001$). In contrast, no significant asymmetry was noted for hip muscles lengthening (hamstrings right-left: 92.1 ± 17 vs. 91.8 ± 17; $P=0.734$, and iliopsoas right-left: 11.5 ± 8 vs. 12.4 ± 7; $P= 0.08$). Notably, this trend was also established when the analysis was conducted separately for individuals with and without LBP.

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Table 2. Mean muscle lengthening (right and left) by gender and physical activities.

Muscle lengthening (degree ± SD)	**Gender**		**Aerobic activity**		**Anaerobic activity**	
	Males (n=13)	Females (n=57)	Yes (n=35)	NO (n=35)	Yes (n=32)	NO (n=38)
Right hamstrings	78.5 ± 13 vs. 95.2 ± 17 **P= 0.001**		91.4 ± 18 vs. 92.8 ±16 P= 0.736		97.7 ± 17 vs. 87.4 ±16 **P= 0.015**	
Left hamstrings	80.6 ± 10 vs. 94.4 ± 17 **P= 0.001**		91.6 ± 16 vs. 92 ± 18 P= 0.915		97.6 ± 18 vs. 87 ± 15 **P= 0.013**	
Right iliopsoas	5.7 ± 8 vs. 12.8 ± 7 **P= 0.012**		11.2 ± 10 vs. 11.9 ± 6 P= 0.719		14.4 ± 8 vs. 9.1 ± 7 **P= 0.007**	
Left iliopsoas	7.6 ± 8 vs. 13.5 ± 7 **P= 0.031**		12.2 ± 9 vs. 12.6 ± 6 P= 0.818		15.5 ± 7 vs. 9.7 ± 6 **P= 0.002**	

3.2. Muscle Flexibility and LBP

No significant difference was found in the mean age of subjects between the group of LBP and those without LBP (25 ± 5 vs. 24.5 ± 4, P=0.795). Participants with LBP displayed greater hip muscles flexibility than those without LBP, however, significant differences were noted only for the

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hamstrings muscles (Table 3). The logistic regression analyses showed that right hamstrings length (OR= 1.035, P= 0.033) and study-related stress (OR=3.836. P=0.013) increase the likelihood of LBP among undergraduate students (Table 4).

Table 3. Muscle lengthening and low back pain.

Muscle lengthening	**Low back pain** (n= 32)	**Without low back pain** (n= 38)
Right hamstrings (degree ± SD)	97 ± 16	88 ± 17
	P= 0.029	
Left hamstrings (degree ± SD)	96.5 ± 19	87.8 ± 15
	P= 0.042	
Right iliopsoas (degree ± SD)	13.5 ± 8	9.8 ± 8
	P= 0.066	
Left iliopsoas (degree ± SD)	14 ± 7	11 ± 8
	P= 0.115	

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Table 4. A logistic regression analysis for the variables associated with LBP among first-class students.

Variable	OR	95% CI	P value
BMI	0.893	0.784-1.018	0.090
Study-related stress	3.836	1.330-11.063	0.013
Hamstrings length Rt.	1.035	1.003-1.069	0.033

OR- odds ratios, CI- confidence intervals, BMI- body mass index.

4. Discussion

The results of this study indicate that hamstrings flexibility (OR= 1.035) and study-related stress (OR=3.836) increased the risk of LBP among first-class undergraduates. In addition, females manifested more muscle (hamstrings and iliopsoas) length than males.

The association between hip muscles flexibility and LBP is in agreement with many previous studies [27, 28] However, it is not apparent whether muscle tightness or increased muscle flexibility could lead to LBP. For example, Noormohammadpour and colleagues have previously reported that adolescent girls who had greater spinal forward bending and increased hip joint range of motion (ROM) for internal rotation were factors associated with LBP [29]. Partial support could also be attained from some evidence [29-32] which reported that joint hypermobility was related to LBP. Indeed, joint hypermobility was not examined in the current study and no cut-off for the extreme range of hamstrings flexibility was recorded. Yet, the association between increased hamstrings flexibility and LBP could be attributed to the fact that augmentation of the joint range of motion could lead to soft tissue strain and wearing of the joint surfaces. On the contrary, it has been reported that decreased lumbar and hamstrings flexibility was attributed to LBP [28, 33]. In addition, there is emerging evidence to support conservative treatment for improving hip mobility in non-specific LBP [34-36]. A meta-analysis study (2017), has reported that restricted hamstrings flexibility as well as decreased lumbar motion and lordosis were found to increase the risk of developing LBP [37]. On the other hand, Shakya et al. [38], Mistry et al. [39], and Stutchfield, and Coleman (2006) [40] reported no association between LBP and hamstrings tightness among students. A recent systematic review (2019), also documented insufficient evidence to support an association between limited hip ROM and non-specific LBP [41]. The later authors suggested viewing this conclusion cautiously due to the low-quality supportive evidence. We attributed this discrepancy to the following reasons: (1) the diversity of the muscle flexibility measurements, (2) the lack of border limit to discriminate between a normal and extreme range of flexibility/or lengthening, and (3) the assortment of the study sample (e.g., students, athletics). Therefore, one could assume that both increased and decreased hamstrings flexibility at the extremes of the range could alter the kinematics around the lumbopelvic girdle leading to LBP. We also suggest that clinicians should be aware when they perform stretching for hamstrings muscle tightness in subjects with LBP.

Our results rule out any relationship between the length of iliopsoas and LBP. Supporting evidence was also obtained from the study of Volpato et al. [42] and Nourbakhsh et al. [5].

The association between study-related stress and LBP has been well-documented in other cohort studies on the healthcare populations [14, 43, 44]. For example, a recent systematic review and meta-analysis study confirmed that biopsychosocial factors (e.g., anxiety and mental pressure) were strongly related to LBP among nursing and medical students [44]. We believe that academic institutions may consider developing and implementing proper strategies to mitigate the risk factors in these students.

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When comparing muscle flexibility and gender of the same age, it is apparent from our data and others [38, 39, 45-48] that females are more flexible than males. Notably, the effect of gender on joint ROM and muscle length was considered joint and motion-specific [49].

The current study also revealed a low prevalence of hip muscle tightness (20% for the hamstrings and 4% for iliopsoas) that contradicts others [38, 50]. One study has reported a medium prevalence of hamstrings tightness (40.19%) among physiotherapy students in Nepal [38]. Thakur and Rose (2020) [50] examined 80 healthy college students (40 males and 40 females) and showed a great prevalence (90% to 96%) of hamstrings tightness (severe to tight) among males and females. Hip muscle tightness can be caused due to sustained sedentary behavior /and or inactive individuals. Nevertheless, all subjects in the current study are in their first year of academic education (contrary to other studies) and we assume that a longer time is needed for the influence of sedentary behavior on muscle flexibility. A high percentage (46%) of the students were involved in anaerobic activity, which positively correlated with muscle flexibility. In addition, the diversity of the methodology for measuring muscle lengthening may affect the outcomes.

Regarding muscle length symmetry, our data agree with that of others who reported no significant differences between muscle flexibility of the right and left extremities [51-54], but challenge the study of Stutchfield and Coleman [40].

Limitations of the study. Small sample size from a single Academic Centre. The self-reported questionnaire could include some biases (e.g., recall and socioeconomic). The duration of pain (e.g., acute or chronic) was not described and an unequal ratio of males and females was reported.

5. Conclusions

The current study indicates that the majority of first-year undergraduates manifest normal hip muscle lengthening (hamstrings -80%, iliopsoas- 96%). Muscle length is gender-dependent, lacking significant differences between the right and left sides. Increased hamstrings flexibility and stress-related study were considered predictive factors for LBP. We also believe that further study is needed to shed light on the extreme ranges of hamstrings muscle length.

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Informed Consent Statement: Informed and written consent was obtained from all subjects involved in the current study.

Data Availability Statement: Datasets are available to download on request. Requests should be directed to the corresponding author.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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