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Effect of General Physical Activity on the Flexibility of Lumbar Spine and Lower Limbs in Healthy Undergraduates: A Cross-Sectional Study

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Abstract

Physical inactivity is a leading risk factor for global mortality with flexibility being the key factor for determining an individual's health status. This study explored the impact of physical activity on the flexibility of lumbar spine and lower extremities in undergraduates. It further explored the association between the flexibility of lumbar spine and lower limbs in individuals who shared the same amount of physical activity. The sample of 70 undergraduates was chosen from the University of Peradeniya, Sri Lanka using stratified random sampling method. 35 students from each gender were divided into three categories (low, moderate, and high) based on their physical activity level evaluated using International Physical Activity Questionnaire-short form (IPAQ-SF). Modified Schober test was used to measure the flexibility of lumbar spine while Sit-and-Reach and Groin Flexibility tests were used to measure the flexibility of lower limbs. The results showed a weak significant correlation between physical activity and flexibility of lower limbs ($r=0.236$, $p=0.048$), but no significant correlation between physical activity and flexibility of lumbar spine ($r=-0.179$, $p=0.701$). It explored a moderate positive significant correlation between the flexibility of lumbar spine and lower limbs ($r= 0.536$, $p=0.008$) in subjects who were low in physical activity but not in subjects who were moderately and highly physically active. Furthermore, the study indicated the males to be more flexible in both lumbar spine (22.3) and lower limbs (7.7) compared to the corresponding values of females (21.4 and 6.7) respectively. Therefore, it is important to take measures to alleviate the physical inactivity in young adults with low physical activity to improve the general status of health by preventing the influence of flexibility of one region on another.

Keywords: Body flexibility, General physical activity, Lower limbs, Upper limbs, Young adults.

Introduction

Although our daily lives have been revolutionized with improvement in technology, such advancements are believed to have negatively influenced the physical and mental health of people as well (Kardefelt-Winther, 2017). In particular, young adults: students and undergraduates, who spend a large part of a day glued either to a screen or to a chair are at higher risk of developing serious health consequences due to being physically less active (Vandelanotte et al., 2009). Therefore, this study aimed to explore the importance of being physically active and how it would influence the flexibility of lumbar spine and lower limbs in young adults. Exploring the amount of physical activity performed by the individuals and identifying to which extent it influences the flexibility of the different regions of the body, would enable the students to understand their physical health status better and it would pave a path to address the deviations promptly if there were any.

As far as physical activity is concerned, World Health Organization (WHO) (2010) defined it as "any bodily movement produced by skeletal muscles that requires energy expenditure" and it includes all the common activities people perform as a part of their activities of daily living (ADL). Studies showed that youth who are physically active are more likely to report good physical and mental health status (Uusitupa et al., 2000) with a better quality of life (Warburton, 2006). On the other hand, flexibility is defined as "the intrinsic property of body tissues which determines the range of motion achievable without injury at a joint or group of joints" (Pate, Oria & Pillsburg, 2012). A considerable number of studies have investigated a positive correlation between flexibility and injury prevention (McHugh & Cosgrave, 2010) and improved performances (Kay & Blazevich, 2012) as well.

Even though the literature consists of evidence correlating the flexibility to general health, it failed to accurately point out how the flexibility is influenced by general physical activities of daily living of a healthy individual. Besides that, flexibility measures often were included in a study because of their association with a different objective that is being measured (i.e., back pain) rather than being assessed directly. Therefore, the need of exploring the effect of general physical activity on the flexibility of a healthy individual is vital.

Therefore, this study aimed to (i) explore any impacts of general physical activity level of the young individuals on the flexibility of their lumbar spine and lower limbs, (ii) find the association between the flexibility of lumbar spine and the flexibility of the lower limbs among the subjects who share the same physical activity level and (iii) assess the impact of gender on flexibility.

Materials and Methods

Sample size and sampling procedure

It was a cross sectional study using the stratified random sampling method, targeting the total population of students (649) from the Faculty of Allied Health Sciences (FAHS) of University of Peradeniya (UOP). At 90% confidence level with 10% margin of error the minimum sample size required was calculated

as 70 assuming the population proportion is 0.50. The sample represents males and females equally as gender is the first strata. Sample subjects were informed individually and recruited for the study to make each stratum have 35 participants. Subjects with apparent factors that may restrict mobility (i.e., back pain, leg pain, recent surgery, fracture) were excluded.

Methodology

Upon obtaining a written consent, the general physical activity level of each participant was assessed by self-administering International Physical Activity Questionnaire – Short Form (2016) (IPAQ – SF) to divide them into three categories: low, moderate and high, based on their general physical activity level. The flexibility of lumbar spine was measured using Modified Schober Test and the subjects who reached the threshold flexibility distance (21cm) were considered flexible in lumbar spine (Rezvani et al., 2012). On the other hand, the flexibility of lower limbs was measured using both Sit-and-Reach and Groin Flexibility tests. Subjects were divided into 7 levels of flexibility (7-high, 1-low) according to Sit-and-Reach test (Wood, 2012) and 5 levels of flexibility (5-high, 1-low) according to Groin Flexibility test (Wood, 2008).

The sum of the above mentioned levels from both tests (Sit-and-Reach and Groin Flexibility) were used to group the subjects into final three categories: good, average, and poor, according to the flexibility of their lower limbs. During all the flexibility measurements, each procedure was repeated thrice, and the final average score was calculated. In addition to that, the subjects were not asked to undergo a warm-up stretching program prior to the flexibility measurement to alleviate the effect of stretching on the flexibility.

Statistical analysis

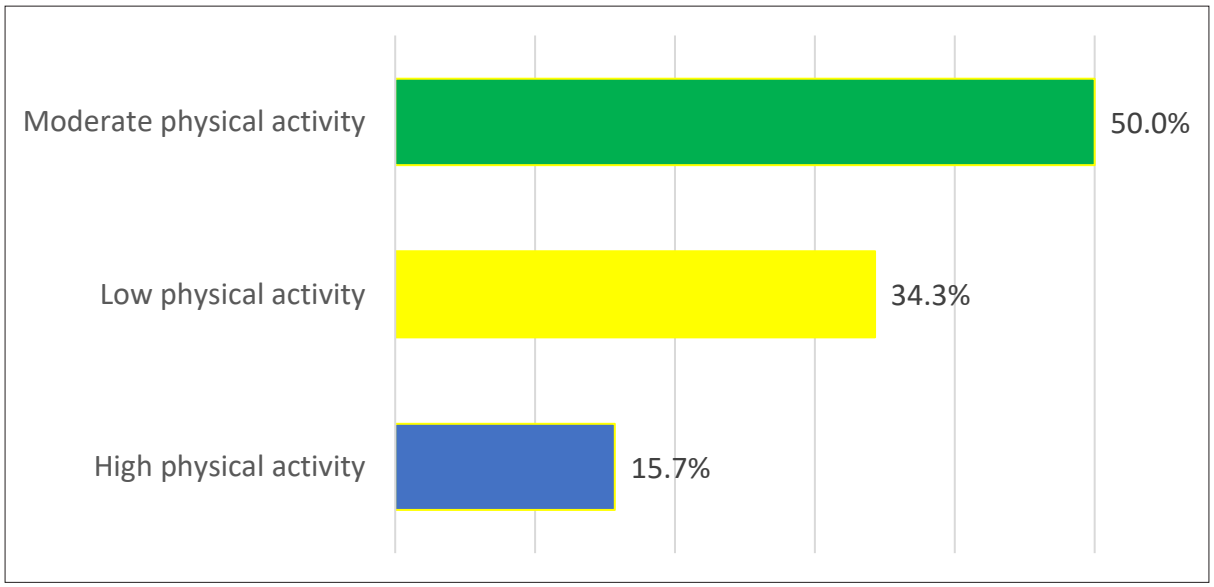
In addition to the basic statistics of different variables, correlation analysis was carried out to find the strength and direction of linearity of between two variables. Furthermore, Chi-square test was used to address the association between two factors and t-test was used to find the significant difference between two means.

Results and Discussion

General distribution of the subjects

Distribution of the subjects according to their physical activity level (Fig. 1) measured using the IPAQ indicated that 50% of the students were moderately physically active while 34.3% were low in physical activity and 15.7% of them were highly physically active. It was also found that the distribution of the flexibility of the lumbar spine and the lower limbs were normally distributed.

Figure 1.
Distribution of the physical activity irrespective of gender.



Impact of physical activity level on the flexibility of lumbar spine and the flexibility of lower limbs

Observed correlations among variables were shown in Table 1.

Table 1.
Impact of physical activity level on the flexibility of lumbar spine and lower limbs.

Variable 1	Variable 2	Correlation coefficient	p-value
Physical activity level	Flexibility of lumbar spine	- 0.179	0.701
Physical activity level	Flexibility of lower limbs	0.236	0.048

Results in Table 1 indicate that there was no significant association between the physical activity level and the flexibility of the lumbar spine in the subjects (r=-0179, p=0.701). The observed correlation coefficient (r=0.236, p=0.048) showed a weak significant positive correlation between the physical activity level and the flexibility of the lower limbs irrespective of gender. As per the results of the study, general physical activity level of individuals was found to have no impact on the flexibility of the lumbar spine. Literally, no large-scale studies were designed specifically to assess the relationship between physical activity and lumbar spine flexibility in the available literature except for a few studies that indirectly measured it.

Arab and Nourbakhsh (2014) postulated that lumbar lordosis is not affected by either different physical activity levels or different work settings. On the other hand, Gordon and

Bloxham (2016) in a systemic review showed that aerobic exercise can help in reducing low back pain by minimizing the stiffness of the lumbar spine through improved blood supply to the back. Yet this indirect measure cannot be considered accurate since the low back pain could have also been caused by reasons other than lack of flexibility of lumbar spine at times, such as reduced endurance and weakness of the musculature around the lumbar spine (Arab & Nourbakhsh, 2014).

Unlike the flexibility of lumbar spine, the flexibility of lower limbs was found to have a weak positive correlation with the physical activity level of healthy individuals. It is in consensus with many studies that suggested, sedentary lifestyle can be the leading cause for developing tightness in hamstrings that could result in reduced flexibility in lower limbs among healthy individuals (Vandelanotte et al., 2009; Qamar et al., 2017). Conversely, there is negligible evidence that does not support the finding of this study as well. In fact, Arab and Nourbakhsh (2014) have mentioned that hamstring muscle length is not affected by different work setting and lifestyles.

The major reason for divergent results on the impact of physical activity level on the flexibility of both lumbar spine and lower limbs, is the different choices of outcome measures that have been chosen to measure the lifestyle, physical activity level and the flexibility of different areas of the body. Unlike the present study that has used linear tests for their time efficiency and convenience of administration (Castro-Piñero et al., 2009), many studies used either Straight Leg Raise (SLR) or popliteal angle test (Youdas at el., 2005; Marshal et al., 2014) for the measurement of hamstring tightness while different questionnaires validated for different populations were considered for the measurement of physical activity. The present study used IPAQ questionnaire which has been the most widely used, self-reported measurement tool that could be adapted according to different cultures across various populations in the world (Craig et al., 2003).

In addition to that, the choice of subjects could have influenced the outcome as well. It can be emphasized by the differences observed in genetic, environmental factors, different body anthropometries observed for different ethnicities and geographic locations, and patterns of physical activity.

Association between the flexibility of lumbar spine and the flexibility of lower limbs among the subjects who share the same physical activity level

As shown in Table 2, no significant correlation was found between the flexibility of lumbar spine and the flexibility of lower limbs in subjects who were highly ($r=0.203$, $p=0.549$) and moderately ($r=0.160$, $p=0.366$) physically active. On the contrary, in subjects who were categorized in low physical activity level showed a moderate positive significant correlation ($r=0.536$, $p=0.008$) between the flexibility of lumbar spine and lower limbs.

Table 2.
Correlation between the flexibility of lumbar spine and the flexibility of lower limbs among the subjects within three physical activity levels.

Physical Activity Level	Correlation Coefficient	P-Value
High	0.203	0.540
Moderate	0.160	0.366
Low	0.536	0.008

In the literature, even though the integration of flexibility of two different regions demands more extensive approaches and multivariate analysis, a comparison can still be possible. As far as the subjects who were highly and moderately physically active were concerned, no significant correlation was found between the flexibility of lumbar spine and lower limbs. This finding is supported by Stutchfield and Coleman (2006) who showed no association between hamstring flexibility and lumbar flexion. In addition to that, Home and Thomas (2010) also found no significant correlation between lumbar excursion and hamstring tightness during forward bending tasks. However, on the opposite note, Carregaro & Gil Coury (2009) observed increased trunk movements in subjects with reduced hamstring flexibility.

The contentious result of these studies might be due to the inconsistency of previous researchers when defining the flexibility of lumbar spine. Some might have considered only the motion of lumbar spine while others might have considered the combined motion of pelvis and lumbar spine. Apart from that, the choice of different test measures for measuring the different areas of the body must have played an important role in the results too.

The most important finding of this study is the moderate positive correlation that was found between the flexibility of the lumbar spine and lower limbs in people who were low in physical activity levels but not in subjects with high and moderate level of physical activity. To our knowledge, no studies have explained this relationship previously. It indicated that, even though physical activity does not have an effect on the flexibility of the lumbar spine, the flexibility of the lumbar spine can still be influenced moderately by the flexibility of the lower limbs in people who are categorized as low physical activity level. Therefore, maintaining the general physical activity in the moderately or highly active status can prevent the influence on the flexibility of one region of the body on another. Thus, physical inactivity in young adults should be considered as a major concern to ensure the optimal status of health.

Impact of gender on the flexibility of lumbar spine and the flexibility of lower limbs

The mean lumbar spine flexibility for males measured with the modified Schober test was 22.26 cm while for females, it was 21.4 cm. A two-sample t-test revealed that there is a significant difference in the mean lumbar spine flexibility between males and females ($p=0.005$). The 95% confidence interval

for the mean difference in lumbar spine flexibility between males and females is between 0.262 cm and 1.456 cm confirming with 95% confidence that the corresponding true (population) difference can vary between 0.262 cm and 2.456 cm.

Furthermore, the mean lower limb flexibility score measured using the sum of the scores obtained from both Sit-and-Reach and Groin Flexibility tests, for males is 7.46 cm while for females, it is 6.66 cm. Based on the two-sample t-tests it was also confirmed with 95% confidence that there is a significant difference (p=0.017) between the two means. Thus, it can also be concluded with 95% confidence that the true mean difference can vary between 0.149 cm and 1.451 cm.

This study found that the flexibility of both lumbar spine and lower limbs were higher in males than their female counterparts in contrast to many studies that addressed the flexibility in favor to female gender. With the flexibility of the lower limb, studies performed in adults showed that females tend to have longer muscle length (Youdas et al., 2005) and higher extensibility (Marshall & Siegler, 2014) in hamstring muscles and lesser musculotendinous stiffness of calf muscles as well (Hoge et al., 2010). Yet, the flexibility of hamstring muscle alone cannot be considered for the flexibility of lower limbs since the hip adductor muscle stiffness has also become a major concern in adults (Sedaghati et al., 2013). Since the current study considered both hamstring and hip adductors for the flexibility of lower limbs, this deviation in the results compared to previous studies is expected. Moreover, this study found no significant difference (p=0.605) in physical activity between the two genders. Hence, the amount of physical activity cannot be considered to attribute to increased flexibility in males. On the other hand, regarding the flexibility of the lumbar spine, the lumbar spine is found to have a greater flexion angle in males compared to females (Sullivan, Dicknison & Troup, 1994), which is in consonance with the finding of this study that measured the flexion angle of the lumbar spine with modified Schober test. However, it is suggested that, for a more comprehensive outcome for the flexibility of lumbar spine and lower limbs of an individual, each joint with each set of muscles working on the joint should be evaluated for tightness, separately.

Having evaluated all the aspects of the study, it is important to acknowledge the methodological limitations as well. Merging the scores of flexibility of hamstring and hip adductors to indicate the lower limb flexibility needs mathematical and statistical modelling aspects. In addition to that, the IPAQ-SF questionnaire used to assess the physical activity level does not include the time spent in sitting or lying without doing any activities. Inclusion of such sedentary sitting time might have influenced the outcome of the study.

Conclusions

This study showed that the flexibility of the lumbar spine is influenced by the flexibility of the lower limbs in undergraduates with low level of general physical activity. Therefore, improving the physical activity level in young adults would positively affect the overall flexibility of the body and health of an individual. Thus, the corresponding stakeholders should take the responsibility to improve the physical activity among young adults, and undergraduates for a healthier and better future.

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