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Research Article

ADVERSE NEURAL MECHANICAL TENSION–A COMPARISON BETWEEN YOUNG HEALTHY INDIVIDUALS ON THE BASIS OF PHYSICAL ACTIVITY

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ABSTRACT

Background: It has been suggested that restoration of altered neurodynamics can lead to reduction in pain and improvement in physical function. Therefore a relationship should exist between neurodynamics and physical activity (PA). So the aim of present study was to find out the prevalence and magnitude of relationship of neurodynamics with physical activity in young and healthy individuals.
Methods: This cross-sectional study included 50 young healthy subjects (age of 20.62±2.13yrs) with normal neurological status. Inclinometric measurements were taken and compared at first onset of symptoms (P1) and at maximally tolerated symptoms (P2) during straight-leg raise (SLR) tests with ankle in plantar grade. Total PA score (TPAS) was calculated by using International Physical Activity Questionnaire of last '7days'. The level of significance was set at $p \leq 0.05$.
Results: Males (Mn) were more physically active than females (t=1.62). In whole sample (Nn) fair positive correlation was there between left P2 and TPAS (r=0.38). In females (Fn) there was a fair positive correlation of TPAS to P2 of right leg (r=0.41). P2 was significantly higher than P1 in both right (t=18.76) and left (t=19.75) lower extremities in in Nn , Fn and Mn. Extremely significant positive correlation was there between all P1 and P2 in Nn , Fn and Mn.
Conclusion: Neurodynamics has also a fair positive correlation to PA in general population to non-dominant leg while in females to dominant leg. Increase in PA can increase the neural mobility of lower limb in young and healthy adults.

INTRODUCTION

Adverse mechanical neural tension (AMNT) and physical activity (PA) has attracted various researchers as source of variety of signs and symptoms during the past few decades. (Butler, 1989; Shacklock, 1995; Bauman *et al.*, 2005; Pivarnik *et al.*, 2006 and California State Parks, 2005) Butler, 1989 stated that biomechanically the nervous system is comprised of intrinsic and extrinsic mechanisms to adapt a wide variety of ranges, speeds and many combinations of movements to prevent injury and impairment. These include development of tension or pressure within the system and movement relative to its mechanical interface. Butler considered it as a source of both local and remote origin of signs and symptoms of mechanical disorders of nervous system and also stated that setup of a mechanical tension. Mechanical tensions simultaneously setup a clinical paradox where electrodiagnostic procedures describe no obvious pathology but patient still have the signs and symptoms of nervous system. (Butler, 1989) electrodiagnostic procedures describe no obvious pathology but patient still have the signs and symptoms of nervous system (Butler, 1989). Similarly Shacklock, 1995 stated that joint angulations and anatomical destination of nerve are the possible cause of neural mechanical responses. According to him healthy mechanics of the nervous system enable pain-free posture and movement but in the presence of any pathomechanics symptoms may be provoked during daily activities. Two elements arise here. First the nervous system can be damaged even when there is no obvious direct injury to nerves and second mechanical interface is an important aspect of healthy neural biomechanics. Bogduk (1980) described an existence of correlation between nerve fiber diameter and metabolic activity as large diameter mechanoreceptors with high metabolic demands are first and most severely affected by ischemia and become a source of pain (Butler, 1989). But in contrast Borges and Leitao, (2012) examined nerve physiology in athletes and suggested that nerves get benefits from physical exercise predominantly in lower limb.

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Literature has shown that the altered AMNT of any cause can affect the person's physical capabilities or physical function making them disable depending on the extent of involvement. Altered AMNT can reduce the functional level of a person by altering their PA of daily living and occupational or sports specific in affected patient population and restoration of neural mechanics results in improvement of physical function (Joshua *et al.*, 2006; Richard and Wane, 2008; Nee *et al.*, 2012). PA can be defined as movement that increases heart rate and breathing or any bodily movement produced by skeletal muscles that requires energy expenditure. (Canadian Physical Activity Guidelines, Canadian Society for Exercise Physiology, 2011)**.** It is an important aspect of health and a measure to control non communicated diseases (cardiovascular diseases, diabetes and cancer etc) in developing countries which face rapid economic and social development, urbanization and industrialization (Bauman *et al.*, 2005; Pivarnik *et al.*, 2006 and California State Parks, 2005). Does AMNT and PA are interconnected in normal healthy population? This is still unclear therefore it is needed to know the relationship of AMNT and PA so that neural mechanics can be either maintained or its alteration can be controlled to avoid disablements and enhancing physical functioning or health.

AMNT can be analyzed and best experienced by reference to neurodynamic procedures e.g. Straight Leg Raise (SLR). SLR is an most reliable neurodynamic tool which can add considerable caudal movement of lumbosacral nerve roots in relation to intervertebral foramina, cranial movement of tibial nerve distally in relation to its mechanical interface and a tension point posterior to the knee where the nerve/interface movement remains constant (Butler, 1989; Szlezak *et al.,* 2011; Boyd *et al.,* 2010).

PA can be analyzed through self-report methods. As a consequence, there are a large number of self-report approaches in use, including questionnaires, diaries and log books, with great variation in reliability and validity. Their reliance on recalling activity from memory can be problematic, especially for children and young people. Despite these limitations, self-report tools remain the most cost-effective, practical and extremely useful for providing information about type and context of physical activity which is not available through more direct assessment methods for public health evaluations (Biddle *et al.,* 2011). International Physical Activity Questionnaire (IPAQ) with four short and four long versions of the questionnaire was developed as an instrument for cross-national monitoring of physical activity and inactivity. The long version (31 items) was designed to collect detailed information within the domains of household and yard work activities, occupational activity, self-powered transport, and leisure-time physical activity as well as sedentary activity and the short version (9 items) provided information on the time spent walking, in vigorous- and moderate intensity activity and in sedentary activity. An additional question asked about the pace of walking and cycling. Strength of IPAQ is that it is self-administrated, can be used by adults aged 18–65 yr, tested in both developed and developing countries, and demonstrated acceptable reliability and validity properties across both, especially in the urban samples. The reliabilities of the long and short forms were comparable indicated that the short form IPAQ "last 7 d" was feasible to administer, and there was no difference between the reliability and validity of the short and long IPAQ forms for population prevalence studies (Craig *et al.,* 2013). The objective of study is to know AMNT in healthy individuals using SLR and compare it with PA of the participants using IPAQ '7d'.

MATERIALS AND METHODS

Present study was a cross sectional study with correlation design. The samples were selected from Guru Jambheshwar University of Science and Technology, Hisar. The inclusion criteria for the present study include healthy young adults with normal neurological status; age between 18 years and 30 years; meet flexibility requirements of isolated hip flexion ≥90°, full knee extension, ankle dorsiflexion ≥0° and plantar flexion ≥30° (Boyd *et al.,* 2010). The exclusion criteria for the present study include spinal or lower-limb surgery; a history of sciatica or trauma to the nerves of the lower extremity; regional pain syndrome; chemotherapy in the past year; infection or inflammatory disease affecting the spine or CNS; recent injury; spinal fractures; structural deformities such as spondylolisthesis and spondylolysis; complex chemical dependence or alcohol abuse; pregnancy; any psychological or psychiatric disorder; any communication disorder; any systemic impairments such as cardiovascular disease, cerebrovascular disease, respiratory disorder and metabolic or GIT disorder. Outcome variables used for the present study were Short form IPAQ '7d' to measure PA; SLR to measure AMNT. The following instruments were used pen, paper, exercise couch, digital inclinometer, stopwatch, straps, asthesiometer and digital weighing machine.

Procedure

The study took place in a private air-conditioned room with the temperature thermostat set at 23^0 to standardize treatment conditions. After fulfilling the selection criteria a total of 50 young healthy subjects with normal neurological status (25 males and 25 females) were selected for the study. Informed consent was taken from all subjects and the whole study protocol was approved by Departmental Ethical Committee. The purpose and need of the study was explained to the participants and they were asked to fill IPAQ '7d' after that SLR measured.

Protocol

IPAQ (Craig *et al.,* 2013)

Participants were instructed to refer to all domains of physical activity including 9 items. On the basis of the answers MET minutes per week of the participants was calculated SLR (Szlezak *et al.,* 2011 and Boyd *et al.,* 2010). Participants were positioned in supine on the treatment couch in a standardized position, with the non-tested leg strapped to the plinth mid way between the greater trochanter and head of fibula. The tested lower limb was maintained in full available knee extension and the ankle in plantar grade with the help of static ankle foot orthosis. This standardized positioning of limb whilst "preloading" neural structures in the posterior chain. Maintaining this knee position, the subject's hip was slowly moved passively into flexion while manually avoiding hip rotation, abduction, or adduction. During this passive hip flexion movement, the subject pressed the hand held trigger to identify the moment they first felt the onset of any symptoms (P1) and when their symptoms became too intense to continue and they felt they could not tolerate any further movement (P2). The SLR test was stopped at P2 and this position was held for 5 seconds before the limb was returned to resting on the plinth. Hip flexion range of motion (ROM) was measured in degrees relative to the horizontal with a digital inclinometer secured to lateral thigh (5 cm above patella) with straps. (Yeomans and Liebenson, 1996) Two-minute rests were given between each SLR trial and their lowest AMNT were recorded in order to analyze lowest possible healthy AMNT within the healthy individuals to set a constant to compare with pathological AMNT in patients.

Statistics

Data analysis was performed using software package SPSS 21 version for windows. Mean and standard deviation of age, height, weight, BMI, IPAQ '7d' and SLR were calculated. Matched t-test was used to compare SLR range of motions (P1 and P2) of right leg and left leg respectively. Independent t-test was used to compare gender difference within the variables. Pearson's Correlation co-efficient (r) was used to assess correlation between variables. The amplitude of relationships was determined as little to no relationship = 0.00 to 0.25, fair = 0.26 to 0.50, moderate to good = 0.51 to 0.75 and good to excellent = 0.76 to 1.00 (Portney LG and Watkins MP, 2008). Significance level was set at $p \leq 0.05$.

RESULTS

The descriptive characteristics of the participants are described in Table1. On examination there was no significant difference between females (F_n) and males (M_n) in age, height, weight, BMI, SLR ROM and sitting; except IPAQ '7d' (t=1.623 at $p \geq 0.009$) (refer Table2). Males were more physically active.

SLR

On examining the means for SLR ROM of whole sample (N_n); there was significant difference between the P1 and P2 of both right (t=18.758 at $p \geq 0.001$) and left (t=19.751 at $p \geq 0.001$) legs. Similar results were there in F_n and M_n. There was significant difference between the P1 and P2 of both right leg (t=13.168 at $p \geq 0.001$) and of left leg (t=13.2 at $p \geq 0.001$) in F_n (refer Table3). In M_n P2 was significantly more than P1 of right leg (t=14.479 at $p \geq 0.001$) and of left leg (t=16.116 at $p \geq 0.001$) (refer Table4). That means maximal onset of AMNT was significantly higher than their first onset of AMNT and is independent of gender and side tested. In N_n an excellent significant correlation was found between SLR ROM of both legs (P1 and P2 of right leg r=0.892, P1 and P2 of left leg r=0.904, right P1 and left P1 r=0.887, right P1 and left P2 r=0.840, right P2 and left P1 r=0.813 and right P2 and left P2 r=0.896 at $p \geq 0.001$ respectively). Similar results were found in both F_n and M_n (refer Table3and4). That means SLR ROM of both legs is extremely correlated or say interconnected and is independent of gender and side tested. Along with this age of the N_n has some fair significant positive correlation to maximal onset of AMNT of right lower limb (r=0.285) at $p \geq 0.045$.

IPAQ

On comparing IPAQ '7d' to SLR ROM there was no significant correlation between IPAQ '7d' and SLR of right leg in N_n but here a fair positive correlation does exist between left P2 and IPAQ '7d' (r=0.379) significant at $p \geq 0.007$. That means in N_n physical activity has a fair positive relationship to maximal onset of AMNT of left lower limb. But in F_n there was a fair positive correlation of IPAQ '7'd'to P2 of right leg (r=0.406 at $p \geq 0.044$) (refer Table3). That means in F_n physical activity has a positive relationship to maximal onset of AMNT of right lower limb. But in M_n neither of them was correlated (refer Table 4). However all the participants were right lower limb dominant. Along with this a significant fair negative correlation exists between sitting and IPAQ '7d' (r=-0.32) at $p \geq 0.024$ in N_n. That means physical activity has a negative relationship with sitting minutes per week.

BMI, Height and Weight

Neither IPAQ '7d' nor SLR had any significant correlation to BMI, height or weight in N_n, F_n or M_n.

Table 1. Showing Descriptive statistic of different variables (N=50)

	Mean	Pearson correlation	SLR range of motion				IPAQ '7d' (MET.minute/week)
			Right P1	Right P2	Left P1	Left P2	
Age (yrs)	20.62±2.13	r	.226	.285*	.176	.230	.056
		Sig.	.114	.045	.222	.108	.700
Height (cm)	162.45±8.62	r	-.217	-.064	-.161	-.024	.172
		Sig.	.130	.658	.264	.870	.233
Weight (kg)	55.28±10.85	r	-.043	.074	-.130	.006	.194
		Sig.	.769	.610	.368	.970	.178
BMI (kg/cm^2)	20.8556±3.01	r	.100	.140	-.057	.021	.108
		Sig.	.491	.333	.693	.882	.454
Right P1	62.14±14.41	r	1	.892**	.887**	.840**	.173
		Sig.		.000	.000	.000	.229
Right P2	80.14±14.75	r	.892**	1	.813**	.896**	.237
		Sig.	.000		.000	.000	.098
Left P1	63.06±14.67	r	.887**	.813**	1	.904**	.271
		Sig.	.000	.000		.000	.057
Left P2	80.78±14.29	r	.840**	.896**	.904**	1	.379**
		Sig.	.000	.000	.000		.007
IPAQ '7d'	2050.71±1919.4	r	.173	.237	.271	.379**	1
(MET.minute/week)	1	Sig.	.229	.098	.057	.007	
Sitting (minutes/week)	3007.2±793.09	r	.059	-.063	.000	-.076	-.320*
		Sig.	.683	.663	.998	.601	.024

*. Correlation is significant at the 0.05 level
**. Correlation is significant at the 0.01 level

Table 2. Showing group analysis of males and females

	Sex	N	Mean	T	Sig.
Age (yrs)	Male	25	20.32±2.09	-.997	.865
	Female	25	20.92±2.16		
Height (cm)	Male	25	169.10±5.35	8.608	.732
	Female	25	155.80±5.58		
Weight (kg)	Male	25	60.80±10.95	4.151	.092
	Female	25	49.76±7.54		
BMI (kg/cm^2)	Male	25	21.22±3.40	.860	.278
	Female	25	20.49±2.56		
Right P1	Male	25	60.92±15.81	-.595	.619
	Female	25	63.36±13.07		
Right P2	Male	25	81.04±17.06	.428	.179
	Female	25	79.24±12.30		
Left P1	Male	25	62.56±16.09	-.239	.901
	Female	25	63.56±13.42		
Left P2	Male	25	82.40±15.80	.799	.571
	Female	25	79.16±12.73		
IPAQ '7d'	Male	25	2484.12±2436.04	1.623	.009
(MET.minute/week)	Female	25	1617.30±1093.71		
Sitting (minutes/week)	Male	25	2839.20±730.28	-1.518	.522
	Female	25	3175.20±831.91		

Table 3. Showing correlations of different variables within females (n=25)

	Pearson Correlation	SLR range of motion				IPAQ '7d' (MET.minute/week)
		Right P1	Right P2	Left P1	Left P2	
Age (yrs)	r	.138	.280	.191	.246	.232
	Sig.	.509	.175	.359	.236	.265
Height (cm)	r	-.318	-.261	-.280	-.210	-.023
	Sig.	.121	.208	.175	.313	.913
Weight (kg)	r	-.134	-.146	-.172	-.189	-.125
	Sig.	.525	.486	.410	.366	.552
BMI (kg/cm^2)	r	.035	-.020	-.033	-.096	-.144
	Sig.	.868	.923	.876	.649	.491
Right P1	r	1	.889**	.894**	.784**	.210
	Sig.		.000	.000	.000	.313
Right P2	r	.889**	1	.857**	.874**	.406*
	Sig.	.000		.000	.000	.044
Left P1	r	.894**	.857**	1	.899**	.261
	Sig.	.000	.000		.000	.207
Left P2	r	.784**	.874**	.899**	1	.347
	Sig.	.000	.000	.000		.089
IPAQ '7d'	r	.210	.406*	.261	.347	1
(MET.minute/week)	Sig.	.313	.044	.207	.089	
Sitting (minutes/week)	r	.317	.153	.361	.223	-.466*
	Sig.	.123	.464	.076	.285	.019

*. Correlation is significant at the 0.05 level
**. Correlation is significant at the 0.01 level

Table 4. Showing correlations of different variables within males (n=25)

	Pearson correlation	SLR range of motion				IPAQ '7d' (MET.minute/week)
		Right P1	Right P2	Left P1	Left P2	
Age (yrs)	r	.286	.318	.159	.258	.037
	Sig.	.165	.122	.448	.214	.860
Height (cm)	r	-.177	-.123	-.159	-.160	-.005
	Sig.	.397	.558	.449	.446	.982
Weight (kg)	r	.079	.146	-.108	.007	.160
	Sig.	.709	.485	.606	.973	.444
BMI (kg/cm^2)	r	.159	.217	-.066	.070	.163
	Sig.	.447	.297	.753	.739	.437
Right P1	r	1	.913**	.883**	.909**	.204
	Sig.		.000	.000	.000	.327
Right P2	r	.913**	1	.797**	.912**	.178
	Sig.	.000		.000	.000	.394
Left P1	r	.883**	.797**	1	.926**	.310
	Sig.	.000	.000		.000	.131
Left P2	r	.909**	.912**	.926**	1	.388
	Sig.	.000	.000	.000		.056
IPAQ '7d'	r	.204	.178	.310	.388	1
(MET.minute/week)	Sig.	.327	.394	.131	.056	
Sitting	r	-.216	-.222	-.357	-.307	-.235
(minutes/week)	Sig.	.300	.287	.080	.135	.257

*. Correlation is significant at the 0.05 level
**. Correlation is significant at the 0.01 level

DISCUSSION

The characteristic of the study was to establish a random order of AMNT in young and healthy individuals and correlate it with physical activity, in order to setup a correlation with reference to gender (female/male) in Indian population. There was no significant difference of age, height, weight, SLR ROM and sitting between F_n and M_n. These are in contrast to Boyd and Villa, (2012) who indicated more SLR ROM in females than men. In this study M_n were found more physically active. This pattern is similar to Scholes and Mindell (2012) findings showing that men averaged more time than women in any non-occupational physical activity per week. Maximal onset of AMNT was significantly higher than first onset of AMNT and is independent of gender.

The findings of present study suggested that AMNT was interconnected and also as high degree of correlation exist independent of gender and side compared. These findings are in limelight of Borges and Leitao (2012) who suggested that dominant limb and non dominant limb had no difference between the MNCV and Bhorania and Ichaporia, (2009) who found no significant difference in velocity between the dominant and non dominant limbs of the same individuals. But somewhat different to Tayade and Latti, (2011) who find more sensory nerve conduction velocity in left upper limb than right upper limb. Present study also compare PA to AMNT of nervous system in lower limb as literature suggests that motor nerve conduction velocity benefits from physical exercise predominantly in lower limb and Borges and Leitao (2012) suggested that greater use of one upper limb over the other could lead to significant differences in MNCV values of dominant limb and non dominant limb.

Present study does compare both lower extremities and find that in N_n the PA positively correlated to maximal onset of AMNT of left lower limb and this is when all our participants reported right leg dominancy. These are in accordance to Boyd and Villa (2012) but more specific to one extremity. But on gender differentiation PA is positively correlated to maximal onset of AMNT of right lower limb in F_n and in M_n neither of them was found correlated. Neither IPAQ '7d' nor SLR had any significant correlation to BMI in N, F_n or M_n. Again in contrast to Boyd and Villa (2012) who had stated a negative correlation of BMI and SLR. Age of the N_n was correlation to maximal onset of AMNT of right lower limb.

Scholes and Mindell (2012) reported proportion of participants classed as inactive generally increased with age in both sexes; from 8% of men and 22% of women aged 16-24. Our findings suggested a fair positive correlation of PA to AMNT so reduction of physical activity will reduce the AMNT and increase the chances of abnormal AMNT. Therefore physical interventions should incorporate especially in younger age groups. Bauman *et al.* (2005) defined physical interventions as systematic approaches to increase any of the various domains of PA (occupation, transport, domestic chores, leisure-time), using a range of intervention strategies (e.g. raising awareness, education, skill development, increasing physical activity practice), either focusing on PA promotion in particular, or healthy lifestyle promotion with PA as one component in addition to other lifestyle factors (e.g. diet, tobacco use, alcohol consumption).

Conclusion

In young and healthy adults AMNT of both lower limbs has extremely positive correlation bilaterally and independent of both gender and side of reference. AMNT has a fair positive correlation to PA in general population to left lower limb: contrast to dominant limb while in females to dominant side. BMI don't have any correlation to AMNT and PA.

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