Research Paper

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Sensory-Motor and Psychosocial Factors Correlates of Adaptive Locomotor Performance in Diabetes Patients

Medical Science

KEYWORDS : Adaptive walking, Fast walking, Obstacle crossing, Narrow based walking, Walk and talk

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ABSTRACT

Backssground. Abnormalities of gait during normal walking can occur due to impairment in sensory-motor and psychosocial factors.

Objective. To identify correlation of sensory-motor and psychosocial factors in adaptive locomotor performance in diabetes patients.

Design. Cross-sectional study

Methods. Walking performance was assessed in four walking tests: Fast walking, obstacle crossing, narrow-based walking and walking while talking. Possible correlates of the inability to perform the walking test included knee extensor strength, lower limb coordination, Cumulative Somatosensory Impairment Index (CSII), visual acuity ,cognition, depression, personal mastery and social support.

Result. The results of data analyses, demonstrated that poor knee extensor strength was associated with inability to perform adaptive locomotor tasks. Poor lower limb coordination is significantly associated with poor performance in all walking tests.
Poor visual acuity is associated with inability to perform adaptive locomotor tasks. Cognition was associated with inability in walking under varied challenging tasks. Poor personal mastery and depressive symptoms are associated with inability in performance in all walking tests.

Conclusion. The results demonstrated a systematic and coherent pattern in these correlations and suggested that sensory-motor factors except lower limb somatosensation and psychosocial factors except social support are significantly correlated with inability in adaptive locomotor performance in diabetes patients.

India is known as the diabetes capital of the world. [1] In 2000, India (31.7 million) topped the world with the highest number of people with diabetes mellitus.[2] Prevalence of diabetes is predicted to double globally from 171 million in 2000 to 366 million in 2030 with a maximum increase in India.[2] The prevalence rate of diabetes mellitus above 40 yr of age in India , was 5 per cent in urban and 2.8 percent in rural areas

Diabetic patients have muscle weakness at the ankle and knee, whereas the strength at the elbow and wrist is preserved[4]. Individual with diabetes walks with significantly slower speed and wider stance than control group[5]. Also they are present with nystagmus and slow scan movement of the eye. Also there is reduced muscle strength which further leads to poor balance[6].

Walking from one place to another is a fundamental component of everyday activities.[7].Mobility is defined as the ability to walk safely and independently in one's natural environment and thus, is a prerequisite for one's independence in activities of daily living (ADLs and IADLs), preserving social interactions and for maintaining overall quality of life. The natural environment commonly imposes varied challenges while walking; for example, increasing walking speed when necessary, avoiding or stepping over obstacles, walking longer distances ,accommodating different kinds of surfaces (e.g. slippery surfaces or slopes, narrow paths), performing simultaneous cognitive activities (e.g. holding a conversation), postural transitions (e.g. picking up something from the floor), and walking under suboptimal ambient conditions (e.g. low light levels) etc.Therefore, adaptive locomotion is the mainstay of mobility.

There are various factors that affect locomotion, sensory-motor factors and psychosocial factors being among them. Sensory-motor factors include lower limbstrength, coordination, and visual acuity and lower limb somatosensory function.Sensory-motor factors contributes to mobility and functional independence, performing simple to complex task. Successful locomotion thus requires a fine coordination among body segment to maintain equilibrium[7]. Vision provides information about distance, concerned with self-perception of motion, provide postural and movement information about body segments relative to each other and environment[6].

Psychosocial factors include cognition, emotional processes, sense of personal mastery and social support.

Method

Study design and participants

The study population is a representative sample of the population living in the New Delhi, India.

The protocol was approved by the ethical committee of jamia hamdard university,new delhi and participants signed on informed consent.

Inclusion criteria

Inclusion criteria includes diabetic subjects with age group 45-59,duration of diabetes 5-10 years,who are literate and who can walk 7m without any aid.

Exclusion criteria

Exclusion criteria include subjects without any neurological, musculoskeletal, infectious, systemic, metabolic disease, pregnancy and subjects who are using aids were excluded.

Groups

Subjects were divided into 2 groups-Experimental and control group. Experimental group consist of diabetic subjects in age group with chronicity of diabetes between 5-10 yrs. Control group consist of normal subjects in age group 45-59.

Procedure

Primary outcome measures

Adaptive walking tests—walking tests were carried out in a clinical setting. The starting location was marked with a colored tape. The end of the 7 m walking path was not marked, to prevent slowing in anticipation. The time taken to complete the walking test was measured using stopwatch.

The time data was then converted into walking speed (m/s). Initially, participants were asked to walk at their self-selected usual speed (normal speed).

For increasing demands while walking participants were asked to walk in the following four challenging walking tests. 1. Fast walking: participants were asked to walk as fast as possible. If the participant could not increase the speed by at least 0.1 m/s, a failure was recorded. 2. Obstacle crossing: Participants were required to cross over two obstacles placed in the path while walking as fast as possible. The obstacles were 6-cm and 30-cm tall,

Positioned, respectively, after 2m and 4m from the starting line. The participant failed the test if they tripped on or touched the first obstacle or needed manual assistance for any reason. 3. Narrow path walking: participants were instructed to walk at their usual pace, but to stay between lines of colored tape placed 25 cm apart. Failure to complete this test was recorded if the participant stepped on or outside the tape lines two or more times. 4. Walk and-talk: participants were required to walk while performing a cognitive verbal task in which they were asked to recite names of animals starting with a specific letter. They were instructed to focus equally on the verbal and the locomotor task. If the participant could not

Verbalize even one name, a failure was recorded. A zero value was assigned for gait speed in case of failure.

Sensory-motor Domain—Lower limb strength was represented by the strength of the knee extensor muscle groups and measured using biodex 4 pro isokinetic dynamometer at speed of 180^0/sec

A standard heel-shin clinical test in the supine position was used to assess lower limb coordination. The participant was instructed to place the right heel on the left shin just below the knee, and then slide it down to the foot, repeating this movement 10 times. The total time required to perform the test was measured in seconds.

The lower limb somatosensory function was assessed using a Cumulative Somatosensory Impairment Index (CSII). In this test a cumulative score is developed from standard clinical assessments of vibrotactile sensitivity, pressure sensitivity, knee proprioception and plantar graphesthesia.

Visual acuity testing and grading is done by ophthalmologist.

Psychosocial domain

Cognitive function was evaluated by the PGI memory scale. It is a short simple, objective, valid test for cognition and memory. It contains 10 sub-tests, remote and recent memory, mental balance, attention concentration, delayed recall, immediate recall, retention for similar and dissimilar pair, visual retention,recognition. Each sub tests has different scoring method. Score ranges from 0-115.Higher score indicates better cognition.

The Center for Epidemiological Studies Depression scale (CES-D), a 20 item self-report questionnaire, was used to assess depressive symptoms. Scores can range from 0 to 60, with higher scores indicating more depressive symptoms.

To evaluate the sense of personal mastery, a short version Pearlin and Schooler Mastery Scale (PSMS) was used (6 items, scores ranging from 6 to 30, higher scores indicate more mastery). Sense of mastery addresses the extent to which a person has a feeling of being in control of his or her own life circumstances and how s/he would react to stresses, difficulties and adversities of life.

Social support from 12 categories of people was included to measure the degree of available social support. Participants were asked about the availability of these 12 people (1 =completely available to 4 = not available) in a hypothetical scenario where help or assistance was required. The mean score was calculated with higher scores indicating less support.

Data Analysis

Data is analyzed by ANOVA (one-way analysis of variance) followed by Dunnett's't' test and expressed as Mean ± S.E.M.. Statistical analyses were performed using SPSS version 17.0. A $p< 0.05$ and $p<0.01$ was considered for statistical significance.

Result

A total of 60 participants who walked 7 m at a normal self-selected speed.Table 1 lists the variables that were significantly different in control (non-diabetic) group in each walking test. Table 2 lists the variables that were significantly different in experimental (diabetic) group in each walking test.Data analysis showed that lower knee extensor strength, poor coordination, impaired visual acuity, poor cognition, depressive symptoms and lower personal mastery were significantly associated with poor performance in adaptive walking tests in diabetic individuals. Whereas CSII and social support are not correlated with adaptive locomotor performance in diabetic individuals.

Discussion

This study investigated sensory-motor and psychosocial parameters associated with inability or poor performance in the adaptive walking under varied challenges in diabetes.

Lower limb extensor strength and different walking speed

Poor knee extensor strength is associated with inability to perform locomotor tasks and vice-versa.

With increase in speed, higher absorption of energy at knee produced by more contraction of muscles[8]. There is reduced toe-clearance of leading extremity which leads to tripping over obstacle. Gait abnormalities associated with diabetes exacerbate that leads to slowing of speed, decreased step length, increased double-limb support because of limitation in executive function[9].

Lower limb coordination and different walking speed

Poor lower limb coordination is associated with poor performance in all walking tests.

Foot placement gets altered because of changes in foot and ankle biomechanics that's occurs during adaptive locomotor performance which leads to poor coordination [10]. Narrow based walking can also be used as a clinical tool for diabetes and further studies should be done to explore this as this is already sug-

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gested for older individuals[11]. Poor lower limb coordination is associated with increased risk of fall. Poor lower limb coordination is associated with cerebellum abnormalities.[12]

Visual acuity and different walking speed
Impaired visual function will lead to inability to perform. With increase in gait speed, optic flow increase to match walking speed with speed of moving scene in different walking tests and provide's a structured representation of the 3-D surfaces of objects sufficient to serve as an index into memory. Crossing over obstacle requires accuracy and precision of leading limb elevation which is provided by feedforward system of vision. Visual problems lead to a more cautious and unstable gait pattern[13]

Cumulative somatosensory impairment index(CSII) and different walking speed
CSII and performance in different walking speed was not found to be significantly correlated may be due to fact that we have taken middle age group (45-59) with less chronicity of diabetes (5-10 yrs) and without neuropathy.

Cognition and different walking speed
Poor cognition is associated with inability in walking under varied challenging tasks. Fast walking decline is significant predictor of accelerated cognitive decline[14], whereas walking-talking is a worst predictor of cognitive decline[15]. Obstacle crossing requires more attention than usual walking.. Cognitive impairment leads to poor motor function and gait alternation in diabetes as motor function depend upon integrity of motor system through brain which regulate planning and execution of motor activity. Stepping over obstacles requires both the modification of gait kinematics and changes in the frequency and duration of visual sampling of the environment.

Depression and different walking speed
Depressive symptoms lead to inability in performance of adaptive walking tasks. Diabetes is associated with increased risk of depression[16]. A higher depressive symptom is known to cause slower movement[17].Depressive individuals are less steady on their feet.

Sense of personal mastery and different walking speed
Poor coping with emotions leads to poor performance in adaptive locomotor task. Diabetic individual is associated with high level of emotional stress as they manage their fluctuating blood glucose level. Diabetic person is more prone to experience negative emotions which include greater tendency to worry,comorbid depression, experience,anger,frustation,guilt,sadness,hopelessness.Unable to cope up with stress .Coping with stress and emotions depend upon how much an individual is having positive and negative emotions. Positive emotions such as happiness, movements are faster than normal. Negative Emotions like fear and sadness are associated with small, slow movements during gait. Negative emotions leads to poor limb coordination, difficulty in maintaining posture while crossing obstacle that leads to increased obstacle contact, difficulty in providing attention while walking to cognitive task.[18], [19]

Social support and different walking speed
No correlation is found between social support and adaptive walking performance. In diabetes, social support is associated with presence of macro- and micro vascular diabetic complications like coronary heart disease, stroke, blindness, nephropathy, and peripheral neuropathy, older age, less physical activity, early retirement[20]. In diabetes no correlation is found because we have taken middle aged, without neuropathy, without any weakness or any other illness.

This study has few limitations. First of all, our findings are based on very small size of 60 with small spectrum of age group.Secondly; chronicity of diabetes is small for significant effect to be seen.

Future studies can be done on large number of people with broad spectrum of age group and more chronicity of diabetes. Also, comparison can be done between middle aged individual and elderly to determine correlation between sensory-motor and psychosocial factors in adaptive locomotor performance.

Conclusion
This study shows that sensory –motor factors except lower limb somatosensation and psychosocial factors except social support are significantly correlated with inability in adaptive locomotor performance in diabetic individual. Thus, it can be concluded that timely intervention can be suggested to minimize the challenges faced by them in adaptive locomotor performance.

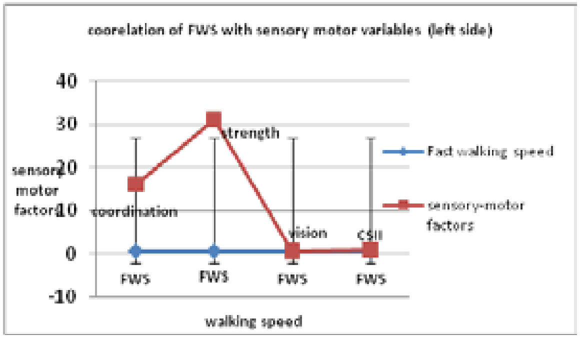
Table 1

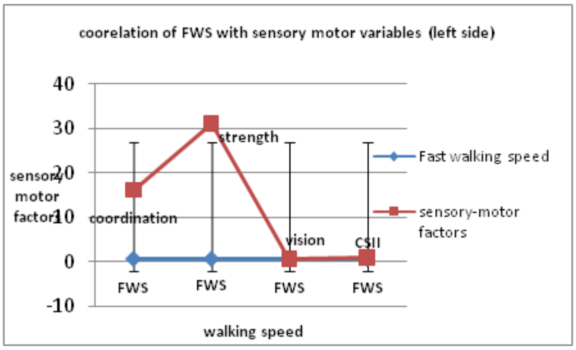
	Coordination (sec)		Strength (N-m)		Vision		CSII score		PGI	CES-D	PSMS	Support
	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt				
FWS (m/s) 1.03±0.05	16.56±0.69**	16.2±0.85**	32.44±4.88**	31.20±4.52**	6/7.7±0.53NS	6/8.9±0.71NS	1.4±0.13/8NS	1.1±0.13/8NS	72.53±2.57/115**	20.16±1.16/60**	17.8±0.74/42**	1.46±0.16NS
NPWS (m/s) 0.65±0.04	16.56±0.69**	16.2±0.85**	32.44±4.88**	31.20±4.52**	6/7.7±0.53NS	6/8.9±0.71*	1.4±0.13/8NS	1.1±0.13/8NS	72.53±2.57/115**	20.16±1.16/60**	17.8±0.74/42**	1.46±0.16NS
OCS (m/s) 0.67±0.06	16.56±0.69**	16.2±0.85**	32.44±4.88**	31.20±4.52**	6/7.7±0.53NS	6/8.9±0.71*	1.4±0.13/8NS	1.1±0.13/8NS	72.53±2.57/115**	20.16±1.16/60**	17.8±0.74/42**	1.46±0.16NS
WTS (m/s) 0.64±0.04	16.56±0.69**	16.2±0.85**	32.44±4.88**	31.20±4.52**	6/7.7±0.53NS	6/8.9±0.71*	1.4±0.13/8NS	1.1±0.13/8NS	72.53±2.57/115**	20.16±1.16/60**	17.8±0.74/42**	1.46±0.16NS

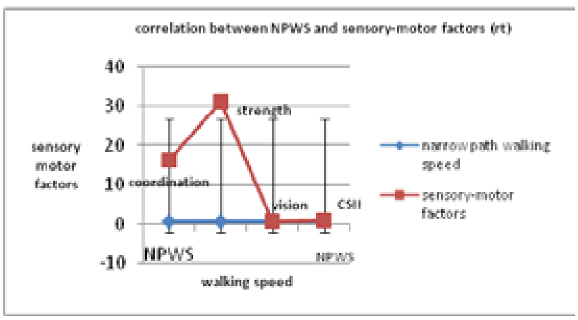
Table 2

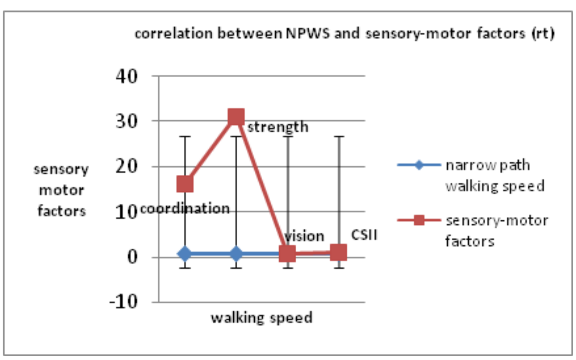
	Coordination (sec)		Strength (N-m)		Vision		CSII score		PGI	CES-D	PSMS	Support
	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt				
FWS (m/s) 0.93±0.07	17.83±1.13**	17.73±1.04**	37.97±4.83**	27.47±3.67**	6/8.3±0.70NS	6/8.6±0.63NS	1.43±0.11/8NS	1.36±0.13/8NS	74.16±2.93/115**	20.66±1.11/60**	17.8±0.94/42**	1.63±0.16NS
NPWS (m/s) 0.66±0.04	17.83±1.13**	17.73±1.04**	37.97±4.83**	27.47±3.67**	6/8.3±0.70NS	6/8.6±0.63*	1.43±0.11/8NS	1.36±0.13/8NS	74.16±2.93/115**	20.66±1.11/60**	17.8±0.94/42**	1.63±0.16NS
OCS (m/s) 0.66±0.04	17.83±1.13**	17.73±1.04**	37.97±4.83**	27.47±3.67**	6/8.3±0.70NS	6/8.6±0.63*	1.43±0.11/8NS	1.36±0.13/8NS	74.16±2.93/115**	20.66±1.11/60**	17.8±0.94/42**	1.63±0.16NS
WTS (m/s) 0.73±0.05	17.83±1.13**	17.73±1.04**	37.97±4.83**	27.47±3.67**	6/8.3±0.70NS	6/8.6±0.63*	1.43±0.11/8NS	1.36±0.13/8NS	74.16±2.93/115**	20.66±1.11/60**	17.8±0.94/42**	1.63±0.16NS

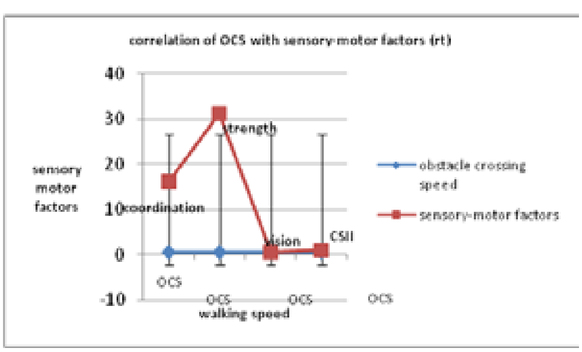
SENSORY-MOTOR FACTORS IN DIABETES

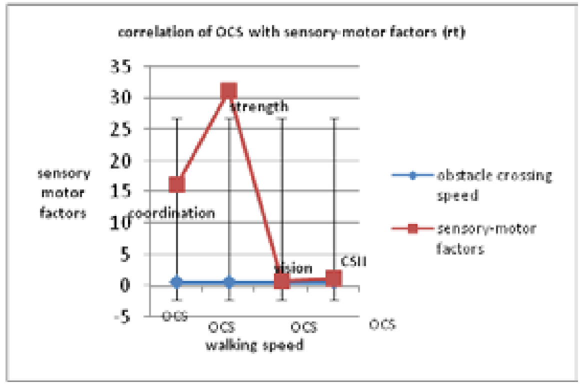


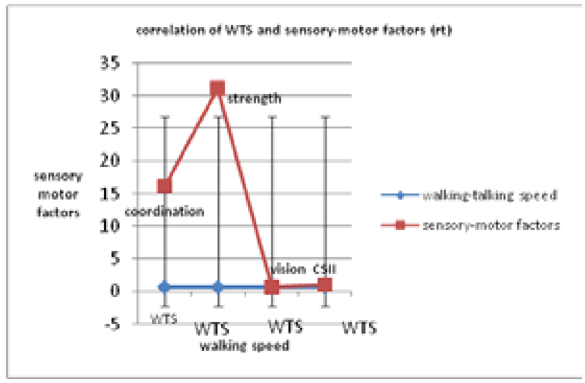


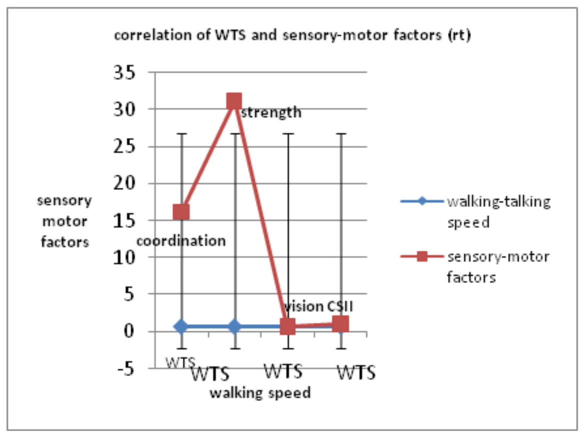




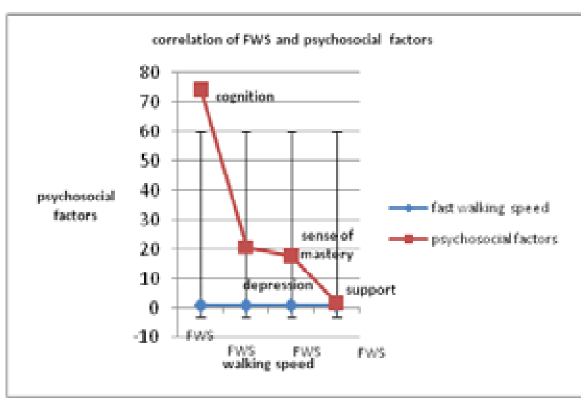


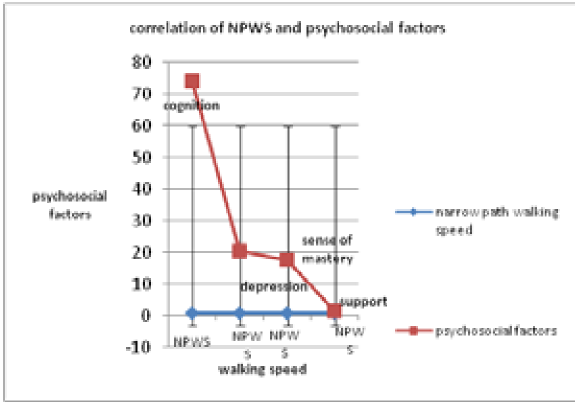


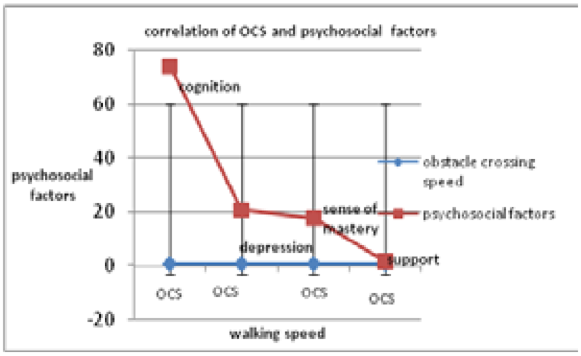


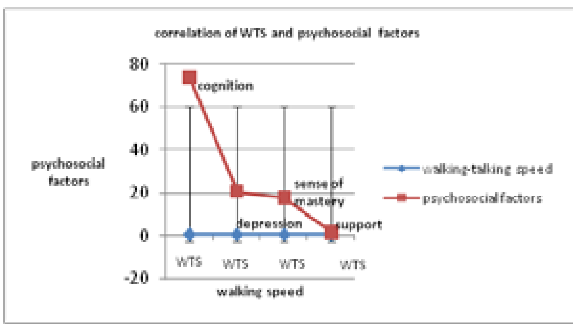


PSYCHOSOCIAL FACTORS IN DIABETES









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