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Correlation of body mass index on static postural stability in different age groups

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Abstract
The incidence of obesity is increasing in different age groups associated with poor balance. Little is known about the impact of BMI on static postural stability in different age groups (children, adolescents, middle age, and elderly).
Objective: To find out correlation of BMI in double leg stance, single leg stance, tandem stance in different age groups.
Method: 400 individuals were subjected to static balance tests using balance error scoring system. The subjects were ask to stand on firm and foam surface in three different stance (double leg stance, single leg stance, tandem stance) in eyes open and eyes close position for 20 seconds and the number of errors was noted. Mean, standard deviation was calculated, Pearson's correlation was used to find out correlation of BMI and three different stance in various age groups.
Results: There is a significant correlation between static balance and BMI in middle age adults and elderly. There was a positive relationship in double leg stance (EC) single leg stance (EO & EC) and tandem stance (EO & EC) on firm surface. Whereas on foam surface there is positive relationship in double leg stance (EC) single leg stance (EO & EC) and tandem stance (EO & EC). In elderly population on firm surface there was positive relationship in double leg stance, single leg stance and tandem stance. (EO & EC), and on foam surface there is positive relationship in double leg stance, single leg stance, and tandem stance (EO & EC).
Conclusion: Higher BMI level is associated with poor balance.

Keywords: Postural stability, BMI, Balance error scoring system, eyes open (EO), eyes close (EC)

Introduction

Amidst factors affecting the health, fall is being a major event resulting in a number of functional, psychological and social impairments [1, 2]. Globally, falls are a major public health problem [3]. Falls are the second leading cause of accidental or unintentional injury deaths worldwide. A fall is an event which results in a person coming to rest inadvertently on the ground or floor or other lower level [4]. The largest morbidity occurs in people aged 65 years or older, young adults aged 15–29 years and children aged 15 years or younger [4]. There is nearly 40% of the total DALYs (disability-adjusted life years) lost due to falls worldwide occurs in children, this measurement may not accurately reflect the impact of fall-related disabilities for older individuals who have fewer life years to lose [5]. In addition, those individuals who fall and suffer a disability, particularly older people, are at a major risk for subsequent long-term care and institutionalization.[5]Childhood falls occur largely as a result of their evolving developmental stages, innate curiosity of their surroundings, and increasing levels of independence that coincide with more challenging behaviors commonly referred to as 'risk taking' [4]. Across all age groups and regions, both genders are at risk of falls. Older women and younger children are especially prone to falls and increased injury severity [4]. Causes of the falls are occupations at elevated heights or other hazardous working conditions; socioeconomic factors including poverty, overcrowded housing, young maternal age underlying medical conditions, such as neurological, cardiac or other disabling conditions, side effects of medication, physical inactivity and loss of balance, particularly among older people poor mobility, cognition and vision, particularly among those living in an institution, such as a nursing home, unsafe environments, particularly for those with poor balance and limited vision [1]. They should support policies that create safer environments and reduce risk factors [6].

Effective fall prevention programmes aim to reduce the number of peoples falls, the rate of falls. For older individuals, fall prevention programmes can include a number of components to identify and modify risk, such as: screening within living environments, clinical interventions to identify risk factors, such as medication review and modification, treatment of low blood pressure, Vitamin D and calcium supplementation, treatment of correctable visual impairment,[7]home assessment and environmental modification; prescription of appropriate assistive devices to address physical and sensory impairments, for middle age muscle strengthening and balance retraining prescribed by a trained health professional, community-based group programmes which may incorporate fall prevention education and Tai Chi-type exercises or dynamic balance and strength training. For children, effective interventions include multifaceted community programmes modifications of nursery furniture, playground equipment, and other products. Other promising prevention strategies include: use of guard rails/gates, home visit programmes, mass public education campaigns, and training of individuals and communities in appropriate acute pediatric medical care when fall occur.[7]Balance problems are conditions that make you feel unsteady or dizzy, when a person is standing, sitting or lying down, he might feel as if he is moving, spinning or floating, or when a person is walking, he might suddenly feel as if he is tipping over or generally unsteady. Many body systems including muscles, bones, joints, vision, and the balance organ in the inner ear, nerves, heart and blood vessels must work normally for good balance. When balance systems impaired person can experience balance problems. Signs and symptoms of balance problem include- sense of motion or spinning (vertigo), feeling of faintness (presyncope), loss of balance (disequilibrium), dizziness [8] Balance is the ability to maintain equilibrium in a gravitational field by keeping or adjusting the centre of mass (COM) over the base of support (BOS). There are 2 types of balance static and dynamic. Static balance is the ability to maintain a posture in a resting position, while dynamic balance is the ability to maintain postural control during the performance of functional tasks [6]. Good balance is important to control and maintain body's position weather we are in dynamic or in static position. An intact sense of balance helps in walking without staggering, get up from the chair without falling, climb stairs without tripping and bend over without falling. It helps the person to get around, stay independent in society, and carry out activities of daily living [9]. Balance requires complex interaction of musculoskeletal and neural systems [7]. It is processed by receiving the multiple sensory information from the peripheral systems, which are integrated and organized by the Central Nervous System [8, 9] Tandem stance is the ability to stand in a heel-to-toe position, reflects the degree of postural steadiness when the BOS in the medial/lateral direction is narrow, also known as the sharpened Romberg test. These tests are taken because they are simple and quick, yet are good indicators of falls and are good outcome measures. This tests takes less than 5 minutes to perform. All the balance measures can be used for measuring change in balance and have good psychometric properties [9]. Sway is the horizontal movement of the centre of gravity even when a person is standing. A certain amount of sway is essential and inevitable due to small perturbations within the body. An increase in sway is not necessarily an indicator of dysfunctional balance so much as it is an indicator of decreased sensorimotor control [10, 12]. Maintaining balance requires coordination of input from multiple sensory systems including the vestibular, somatosensory, and visual systems. Vestibular system: sense organs that regulate equilibrium (equilibrioception); directional information as it relates to head position (internal gravitational, linear, and angular acceleration).[10]Somatosensory system: senses of proprioception and kinesthesia of joints; information from skin and joints (pressure and vibratory senses); spatial position and movement relative to the support surface; movement and position of different body parts relative to each other [13]. Visual system: Refers to verticality of body and head motion; spatial location relative to objects [11]. The senses must detect changes of special orientation with respect to the base of support, regardless of whether the body moves or the base is altered. There are environmental factors that can affect balance such as light conditions, floor surface changes, alcohol, drugs, and ear infection [13]. Balance can negatively affect normal population through fatigue in the musculature surrounding the ankles, knees, and hips. Studies have found, however, that muscle fatigue around the hips (gluteus and lumbar extensors) and knees have a greater effect on postural stability (sway). It is thought that muscle fatigue leads to a decreased ability to contract with the correct amount of force or accuracy. As a result, proprioception and kinesthetic feedback from joints are altered so that conscious joint awareness may be negatively affected. [1]Obesity is a complex disorder involving excessive amount of body fat. according to WHO 10% 5-17 year old school children are overweight and 3% of them are obese. Middle-aged and older obese adults fall almost twice as frequently (27%) as their lean counterparts (15%) per year. In addition, the fall-related injury requiring medical treatment are 15%-79% higher for those that are overweight, obese, or morbidly obese [12]. Injuries such as sprains, strains, and dislocations in the obese are more frequently due to falls and are the main types of injury-related hospitalizations compared with non-obese persons. Obesity increases an individual's risk for multiple falls, which is also related to higher fracture risk. A higher fracture risk could therefore increase obese individuals' risk of incurring multiple major injuries. [12]BMI is the statistical analysis and most common method to quantify weight across a range of body sizes in adults [12]. -The BMI is calculated by dividing an individual's weight (in kilograms) by his or her height (in meters squared). Using the BMI, individuals can be classified as underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), class I obese (30–34.9 kg/m^2), class II obese (35–39.9 kg/m^2), or class III obese (≥40 kg/m^2).There are few studies reported that increased postural sway with increase in weight in young and middle age adults during quite stance [12] Another study done on obese adolescent show that they have same center of pressure displacement on hard surface and increase center of pressure on foam surface. Whereas a study done on children shows that, physical changes in children due to obesity reduce their balance ability. Hence according to related literature, being overweight has mal-effect on balance [12].

Methodology

Study design- cross sectional study design, Study setting- Shanti Nike tan School, Oxford College of physiotherapy, nearby community, Sample selection- convenient sampling, and Sample size-400 subjects.

Outcome measures

1 Balance error scoring system. 2. Body Mass Index. (Body Mass Index =Weight/ Height^2 (Kg/m^2).

Selection criteria: Inclusion criteria

School going children- age group between 6 to 12years, Adolescents and adults- 13 to 29 years, Middle age between 30 to 54 years, Elderly people 55 to 80 years, both genders are included.

Exclusion criteria

Children, adolescents and adults middle age and elderly with any neurological deficits, musculoskeletal problem especially of lower limb, immediate post-operative surgery. Falls in previous 6 months.

Procedure

The study was approved by the Ethical Committee of the institution. Subjects were selected based on selection criteria. The subjects in the age group of 6-80 years were included in this study from the Shanti Niketan School BTM, Oxford College of physiotherapy Bommanhalli, and nearby community Bengaluru. The target sample size was 400 (100 children, 100 adolescents, 100 middle age, 100 elderly), Permission was obtained from the Principal and the school Authority. A written consent letter was obtained from all parents of children, Adolescents, middle age and elderly population prior to the commencement of the study. Each subject was checked for inclusion criteria. And anthropometric measurements (height, weight) of subjects were taken. Prior to testing, participants were asked to remove shoes, and they were familiarized with balance test. Subject was first asked to stand on firm surface and then on the foam surface in double leg stance, single leg stance and then in tandem stance. (Children, adolescents, middle age, elderly population). Double leg stance on firm surface-Subject was asked to stand on floor/firm surface with feet side to side (touching), hands on the hips and eyes were open for 20 sec and the errors was noted, Followed by eyes closed position for 20 sec and error was noted.

Fig 1: Double leg stance on firm surface (EO & EC)

In single leg stance on firm surface-Subjects were asked to stand on floor/firm surface on his non-dominant foot, opposite legs hip was flexed to approximately 30^0 and knee flexed to approximately 45^0, hands on the hip and eyes were open for 20 sec and the errors was noted, Followed by eyes closed position for 0sec and the error sare.

Fig 2: Single leg stance on firm surface (EO & EC)

Tandem stance on firm surface-Subjects were asked to stand on floor/firm surface with non-dominant foot in the back. Heel of the dominant foot should be touching to the toe of non-dominant foot. Hands on the hips and eyes were open for 20 sec and errors was noted, followed by eyes closed position for 20 sec and the errors are noted.(NON-DOMINANT- It is defined as the opposite leg of the preferred kicking leg).

Fig 3: Tandem stance on firm surface (EO & EC)

Double leg stance on foam surface-Subjects were asked to stand on foam surface with feet side to side (touching),hands on the hips and eyes were open for 20 sec and errors was noted, followed by eyes closed position for 20 sec and the errors are noted

Fig 4: Double leg stance on foam surface (EO & EC)

Single leg stance on foam surface-Subjects were asked to stand on foam surface on his non-dominant foot, opposite legs hip was flexed
to approximately 30^0 and knee flexed to approximately 45^0, hands on the hip and eyes were open for 20 sec and errors was noted, followed by eyes closed position for 20 sec and the errors are noted

Fig 5: Single leg stance on foam surface (EO & EC)

Tandem leg stance on foam surface-Subjects were asked to stand on foam surface with non-dominant foot in the back. Heel of the dominant foot should be touching to the toe of non-dominant foot. Hands on the hips and eyes were open for 20 sec and errors was noted, followed by eyes closed position for 20 sec and the errors are noted. (NON-DOMINANT- It is defined as the opposite leg of the preferred kicking leg)

Fig 6: Tandem stance on foam surface (EO & EC)

SCORING- Each of the twenty-second trials was scored by counting the errors, or deviations from the proper stance, accumulated by the Subject. The examiner started counting errors only after the individual has assumed the proper testing position. Errors: An error is credited to the subject when any of the following occur: Moving the hands off of the iliac crests, Opening the eyes, Step stumble or fall, Abduction or flexion of the hip beyond 30°, Lifting the forefoot or heel off of the testing surface, Remaining out of the proper testing position for greater than 5 seconds. The maximum total number of errors for any single condition is 10.

Material used

1. Weighing machine
2. Measuring tape
3. Foam surface
4. Stop watch

Statistical analysis

400 subjects of different age groups (6-80 years) participated in the study. Mean and standard deviation were calculated for the baseline characteristics. Children of mean age 9.24±1.77 years, height 132.13±9.19 cm, weight 29.53±8.97 kg and BMI 17.17±4.57 were found. Adolescents of mean age21.73 ±3.62 years, height 162.64±8.06 cm, weight 56.2±9.68 kg and BMI 21.39±3.24 were found. Middle age adults of mean age39.30 ±7.37 years, height 168.82±8.13 cm, weight 76.65±16.76 kg and BMI 26.45±3.83 were found. Elderly of mean age 66.01 ±7.89 years, height 158.56±7.31 cm, weight 60.15±10.97 kg and BMI 23.75±3.52 were found. Pearson's correlation were used to find out correlation of body mass index and double leg stance, single leg stance and tandem stance on both firm and foam surface(EO & EC) in children, adolescents, middle age and elderly population. SPSS version19.0 was used for statistical analysis.

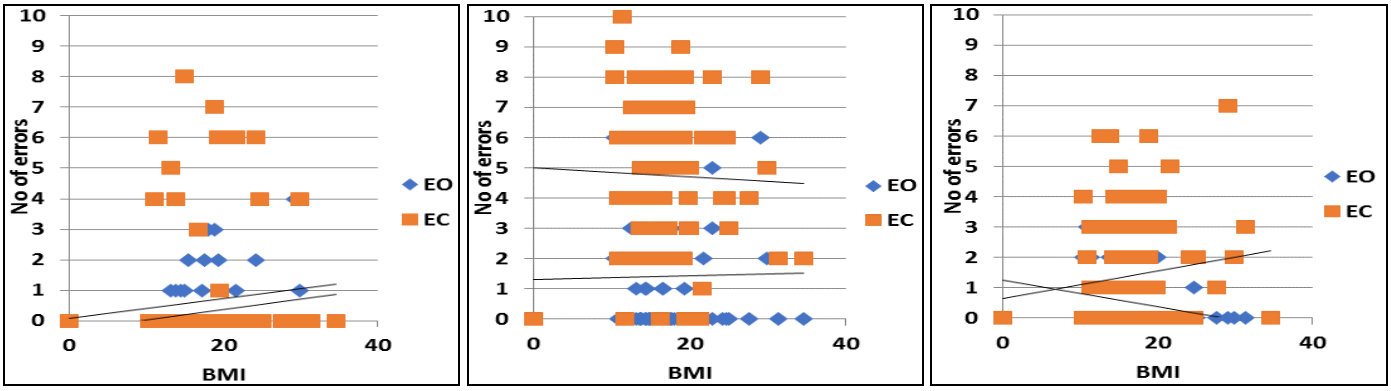
Table 1: correlation of body mass index of children in double single and tandem stance (EO & EC) on firm surface**.**

Children			R value	Correaltion
Double stance	BMI	EO		
Firm	17.17	0.28	0.2185	Positive*
	BMI	EC		
	17.17	0.64	0.0826	Positive*
Single	BMI	EO		
Firm	17.17	1.42	-0.0126	Negative
	BMI	EC		
	17.17	4.79	-0.1083	Negative
Tandem	BMI	EO		
Firm	17.17	0.51	-0.2473	Negative
	BMI	EC		
	17.17	1.42	0.1028	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index

Table 2: mean and standard deviation of subject

Firm surface		Children	Adolescents	Middle age	Elderly
Double stance	EO	0.21 ± 0.7664	0.46 ± 0.500	0.33± 0.4725	1.09± 2.399
	EC	0.64± 1.7838	0.56± 0.4988	1.44± 0.5915	1.37± 1.7846
Single stance	EO	1.42± 1.965	0.94± 0.8855	1.15± 0.9360	6.81± 3.0869
	EC	4.79± 2.358	3.46 ± 2.3502	4.28± 1.5959	7.38± 2.8133
Tandem stance	EO	0.51± 0.9897	0.36 ± 0.6438	1.03± 0.7310	4.92± 3.647
	EC	1.42± 1.7932	1.98 ± 1.470	2.46± 0.881	6.06± 3.6454
Foam surface					
Double stance	EO	0.37± 0.7608	0.48 ± 0.5218	0.65± 0.6571	1.14± 2.3995
	EC	2.4± 2.0201	1.04 ± 1.0241	1.92± 0.7341	6± 3.6625
Single stance	EO	6.17± 1.279	1.98 ± 0.9742	5.56± 1.5723	7.39± 2.4851
	EC	7.9± 1.167	5.38 ± 2.237	7.63± 1.2115	7.84± 2.4851
Tandem stance	EO	1.2± 1.3026	0.77 ± 0.8147	1.44±0.8204	5.31± 3.3865
	EC	2.45± 1.887	3.36 ± 1.5143	2.97± 0.9040	7± 2.9842



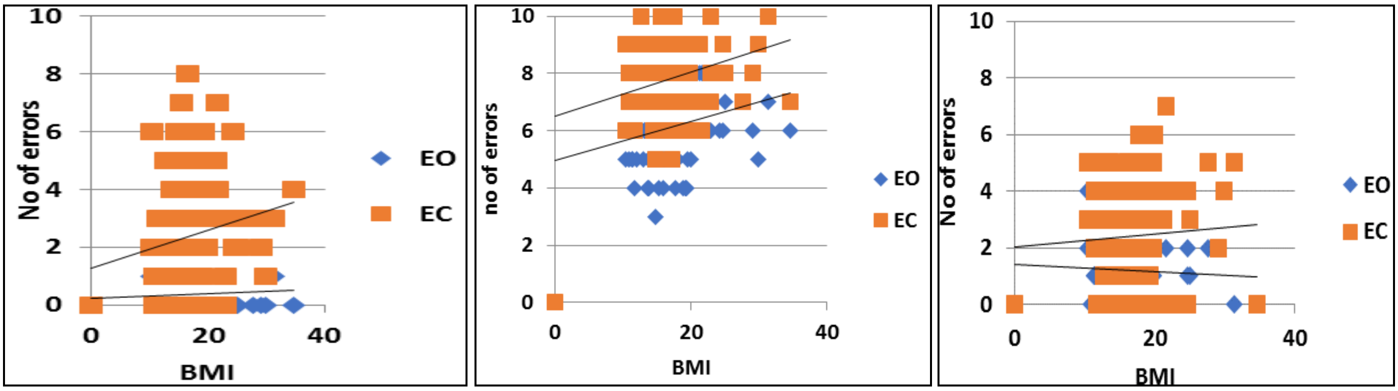
(a) Double stance (b) Single stance (c) Tandem stance

Graph 1: Correlation of BMI and double, single and tandem stance on firm surface (EO & EC) in children

Table 3: It shows correlation of body mass index of children in double single and tandem stance (EO & EC) on foam surface.

Children			R value	Correlation
Double stance	BMI	EO		
Foam	17.17	0.37	0.0405	Positive*
	BMI	EC		
	17.17	2.4	0.1266	Positive*
Single	BMI	EO		
Foam	17.17	6.17	0.0942	Positive*
	BMI	EC		
	17.17	7.9	0.089	Positive*
Tandem	BMI	EO		
Foam	17.17	1.2	-0.0882	Negative
	BMI	EC		
	17.17	2.46	0. 0147	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index



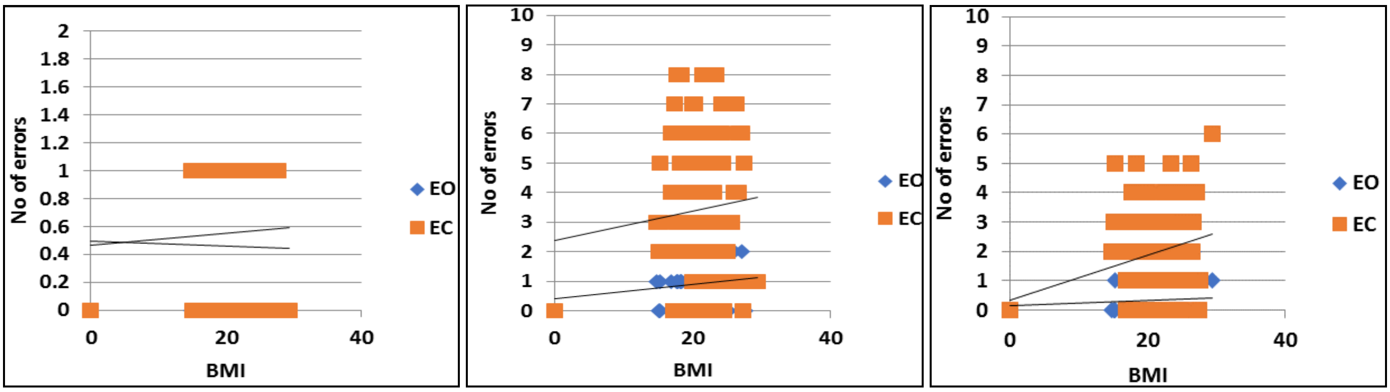
(a) Double stance (b) Single stance (c) Tandem stance

Graph 2: correlation of BMI and double, single and tandem stance on foam surface (EO & EC) in children

Table 4: correlation of body mass index of adolescents in double single and tandem stance (EO & EC) on firm surface.

Adoloscents			R value	Correlation
Double stance	BMI	EO		
Firm	21.39	0.46	-0.078	Negative
	BMI	EC		
	21.39	0.56	-0.0359.	Negative
Single	BMI	EO		
Firm	21.39	0.94	0.054	Positive*
	BMI	EC		
	21.39	3.46	0.0005	Positive*
Tandem	BMI	EO		
Firm	21.39	0.36	0.0303	Positive*
	BMI	EC		
	21.39	1.98	0.1551	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index



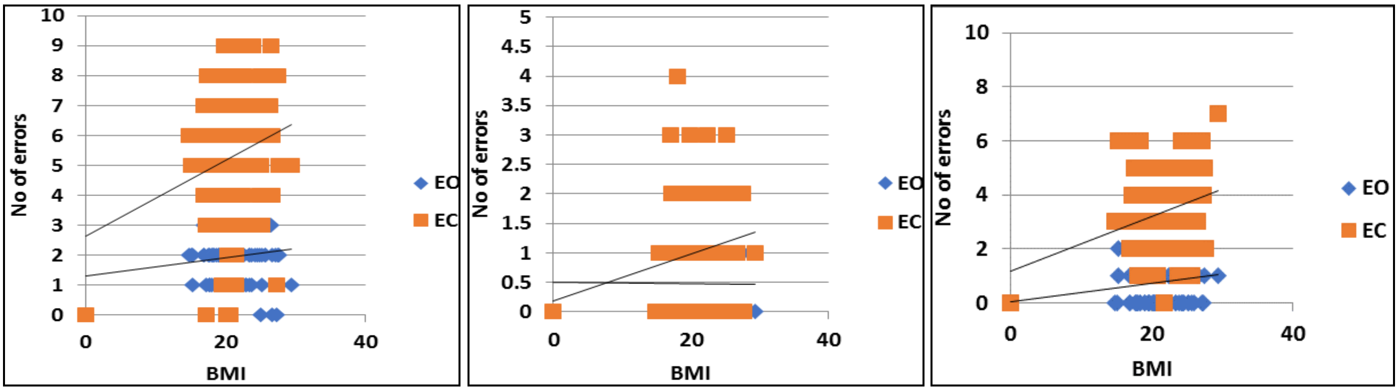
(a) Double stance (b) Single stance (c) Tandem stance

Graph 3: correlation of BMI and double, single, and tandem stance on firm surface (EO & EC) of adolescents.

Table 5: correlation of body mass index of adolescents in double single and tandem stance (EO & EC) on foam surface.

Adolescent's			R value	Correlation
Double stance	BMI	EO		
Foam	21.39	0.48	-0.0694	Negative
	BMI	EC		
	21.39	1.04	0.1145	Positive*
Single	BMI	EO		
Foam	21.39	1.98	0.0118	Positive*
	BMI	EC		
	21.39	5.38	0.1036	Positive*
Tandem	BMI	EO		
Foam	21.39	0.77	0.1303	Positive*
	BMI	EC		
	21.39	3.36	0.1682	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index



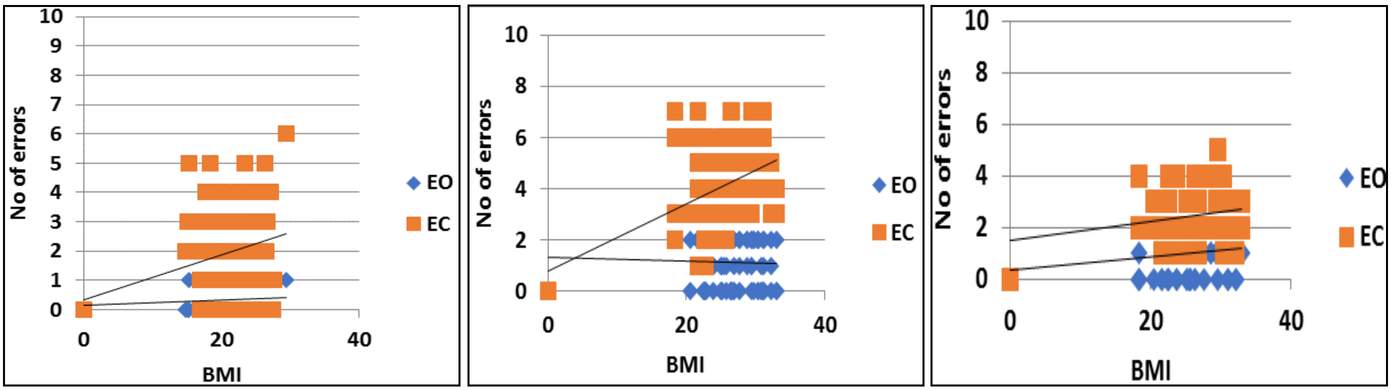
(a) Doubletance (b) Single stance (c) Tandem stance

Graph 4: correlation of BMI and double, single, and tandem stance on foam surface (EO & EC) of adolescent

Table 6: correlation of body mass index of middle age in double single and tandem stance (EO & EC) on firm surface

Middle age			R value	Correlation
Double stance	**BMI**	**EO**		
Firm	26.45	0.33	-0.0319	Negative
	BMI	EC		
	26.45	1.44	0.054	Positive*
Single	BMI	EO		
Firm	26.45	1.15	1	Positive*
	BMI	EC		
	26.45	4.28	0.2804	Positive*
Tandem	BMI	EO		
Firm	26.45	1.03	0.1108	Positive*
	BMI	EC		
	26.45	2.46	0.0347	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index



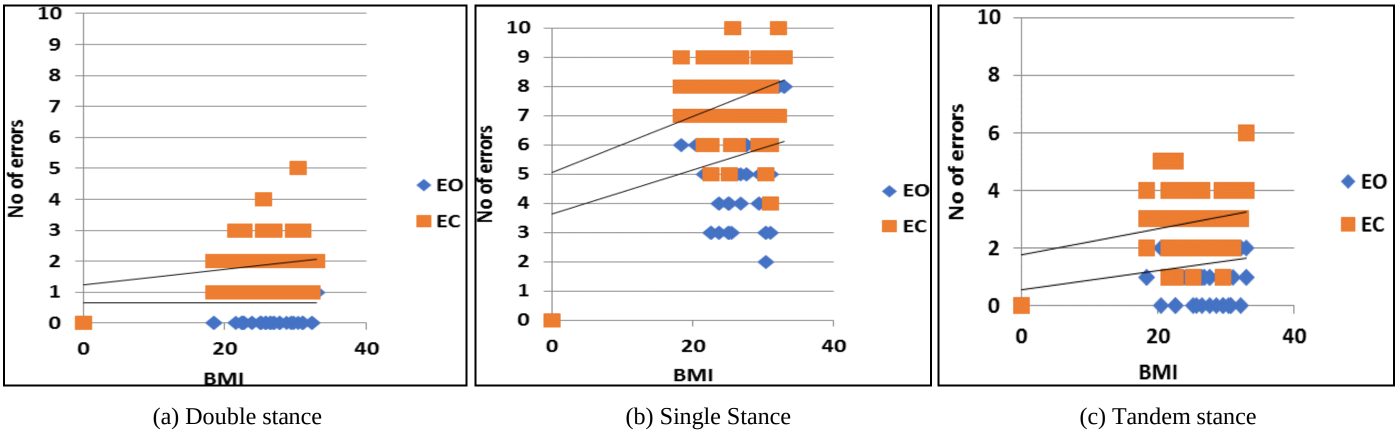
(a) Double stance (b) Single stance (c) Tandem stance

Graph 5: Correlation of BMI and double, single, and tandem stance on firm surface (EO & EC) of middle age.

Table 7: correlation of body mass index of middle age in double single and tandem stance (EO & EC) on foam surface

Middle age			R value	Correlation
Double stance	**BMI**	**EO**		
Foam	26.45	0.65	-0.0693	Negative
	BMI	EC		
	26.45	1.92	0.0114	Positive*
Single	BMI	EO		
Foam	26.45	5.65	0.0211	Positive*
	BMI	EC		
	26.45	7.63	0.0087	Positive*
Tandem	BMI	EO		
Foam	26.45	1.44	0.1086	Positive*
	BMI	EC		
	26.45	2.97	0.0523	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index

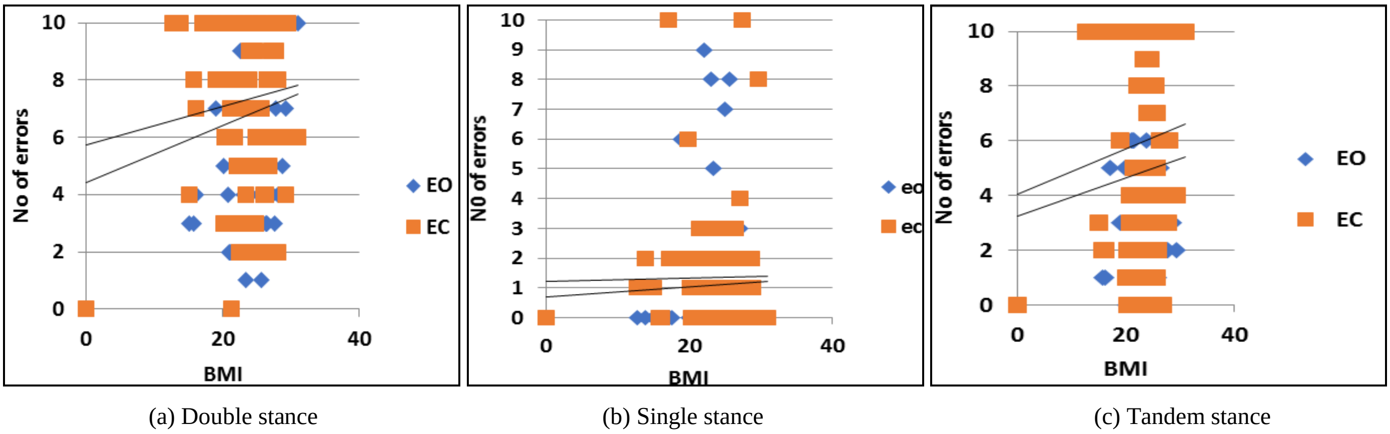


Graph 6: correlation of BMI and double, single, and tandem stance on foam surface (EO & EC) of middle age**.**

Table 8: Correlation of body mass index and double, single, and tandem stance in elderly (EO&EC) on firm surface

Elderly			R value	Correlation
Double stance	**BMI**	**EO**		
Firm	23.56	1.09	0.0262	Positive*
	BMI	EC		
	23.56	1.37	0.0057	Positive*
Single	BMI	EO		
Firm	23.56	6.81	0.0858	Positive*
	BMI	EC		
	23.56	7.38	0.0642	Positive*
Tandem	BMI	EO		
Firm	23.56	4.72	0.0556	Positive*
	BMI	EC		
	23.56	6.06	0.0679.	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index

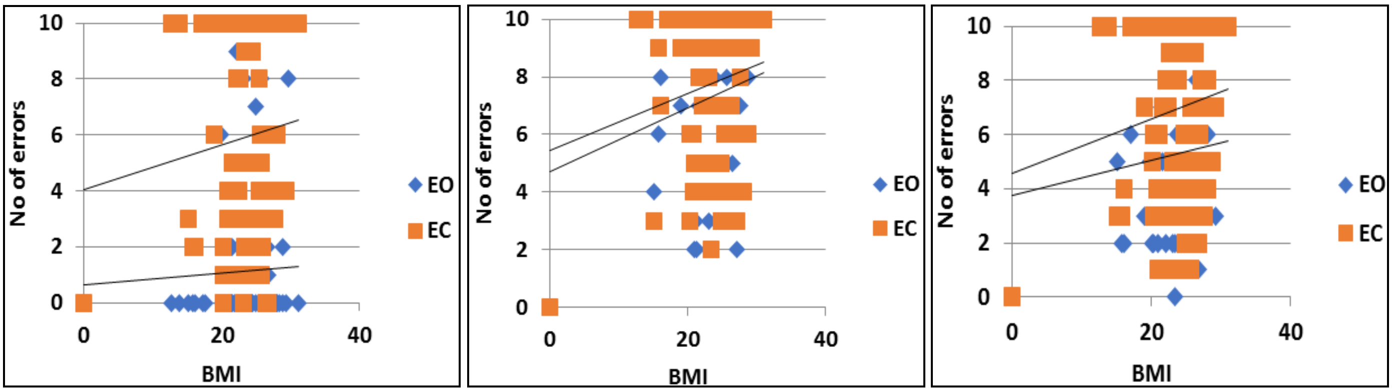


Graph 7: correlation of BMI and double, single, and tandem stance on firm surface (EO & EC) of elderly

Table 9: Correlation of body mass index and double, single, and tandem stance in elderly (EO&EC) on foam surface.

Elderly			R value	Correlation
Double stance	BMI	EO		
Foam	23.56	1.14	0.0343	Positive*
	BMI	EC		
	23.56	6	0.0649	Positive*
Single	BMI	EO		
Foam	23.56	7.39	0.1122	Positive*
	BMI	EC		
	23.56	7.84	0.0434	Positive*
Tandem	BMI	EO		
Foam	23.56	5.31	0.038	Positive*
	BMI	EC		
	23.56	7	0.1057	Positive*

EO- Eyes Open, EC- Eyes Close, BMI- Body Mass Index



(a) Double stance (b) Single stance (c) Tandem stance

Graph 8: correlation of BMI and double, single, and tandem stance on foam surface (EO & EC) of elderly**.**

Results

A total number of 400 subjects participated during the study period. Table 1shows the mean and standard deviation of the subjects in double leg stance, single leg stance and tandem stance on firm and foam surface resp (EO &EC).Table 2 revealed the correlation of body mass index and double leg stance of children on firm surface with EO & EC has r value of 0.2185 and 0.0826 respectively indicate positive correlation. whereas, in single leg stance the value of r is -0.0126 and -0.1083 resp indicate negative correlation, and in tandem stance the value of r for EO is -0.2473 indicates negative correlation and for EC the value of r is 0.1028 indicating positive correlation. Table 3 revealed the correlation of body mass index of children in double single and tandem stance (EO & EC) on foam surface. there is a positive relationship in double leg stance (EO & EC) and single leg stance (EC & EC), tandem stance (EC) has r value of 0.0405, 0.01266,0.0942, 0.089.0.014 respectively, and negative relationship in tandem leg stance (EO) having r vale of -0.0882. Table 4 revealed the correlation of body mass index of adolescents in double single and tandem stance (EO & EC) on firm. there is a positive relationship in single leg stance (EO & EC) and tandem leg stance (EO &EC) which has r value of 0.054, 0.005, 0.0303, 0.1551 resp, and negative relationship in double leg stance (EO & EC) and tandem stance (EO) which has r value of -0.078, -0.0359.Table 5 revealed correlation of body mass index of adolescents in double single and tandem stance (EO & EC) on foam surface. There is a positive relationship in double leg stance (EC) single leg stance (EO & EC) and tandem leg stance (EO &EC) which has a r value of 0.1145, 0.0118. 0.1036, 0.1303, 0.1682 resp and negative relationship in double leg stance (EO) 0.0694.Table 6 showed correlation of body mass index of middle age in double single and tandem stance (EO & EC) on firm surface. there is a positive relationship in double leg stance (EC) single leg stance (EO & EC) and tandem stance (EO & EC) having r value of 0.054, 1, 0.2804, 0.1108, 0.0347 resp and negative correlation in double leg stance (EO) having r value of -0.0319.Table 7 showed correlation of body mass index of middle age in double single and tandem stance (EO & EC) on foam surface. there is a positive relationship in double leg stance (EC) single leg stance (EO & EC) and tandem stance (EO & EC) having r value of 0.0114, 0.0211, 0.0087, 0.1086, 0.0523 resp and negative correlation in double leg stance (EC) having r value of -0.0693.Table 8 showed correlation of body mass index of elderly in double single and tandem stance (EO & EC) on firm surface. There is a positive relationship in double leg, single, and tandem stance (EO & EC) having r value 0.0262, 0.0057, 0.0858, 0.0642, 0.0556, 0.0679 resp. Table 9 showed correlation of body mass index of elderly in double single and tandem stance (EO & EC) on foam surface. there is a positive relationship in double leg, single, and tandem stance (EO & EC) having r value 0.0343, 0.0649, 0.112, 0.0434, 0.038, 0,1057.

Discussion: The study aimed to establish correlation of body mass index on static postural stability in different age groups. In the present study, the total numbers of participants were 400. 100 were children, 100 adolescents, 100 adults, 100 elderly. There are very few studies done on the level of balance and there corresponding risk of falls in geriatric population, but much of the research has not been done on balance aspect of children, adolescents, adults and also there are less proven data to correlate body mass index to the level of stance. The result of the current study shows that there a strong correlation between increase body mass index and decrease postural stability in middle age adults and elderly. Physiologically, when the person's body weight is more there is accumulation of fat and loss of soft tissue tone among the individuals having more body weight which may alter the center of gravity and varies according to the body alignment, amount of weight borne by the joints and pull of muscles [15]. It is also observe that there is increase center of pressure speed to maintain stability, decrease mean peak stability times and increase mean distance between stable position. All these measurements suggest that person having higher body mass index are less responsive to perturbations than normal weight person. The potential explanation for this decreased sensitivity is the increase in mean pressure that the mechanoreceptor- the body's sensory receptors are under pressure due to an elevation in body's weight. [16]. There are other reason for explaining the strong relationship between balance stability and body weight. When standing upright, the human body is often compared to an inverted pendulum system rotating around the ankle joint. The center of mass located closer to the anterior edge of the base of support, due to extra abdominal mass, presumably leads to an increased ankle torque necessary to maintain balance [17]. Greater ankle torque could add more noise in the feedback control system as greater muscle force is related to greater motor variability [18, 19]. Therefore, it is likely that the central command, allowing body sway regulation, is not adapted due to reduced capability of the mechanoreceptors to accurately signal the position of the CP and to greater motor variability. Existing evidence shows that patients with obesity adapt their gait in order to accommodate excess weight and temporarily protect bones and joints however by doing so put themselves at greater risk for damage to their joints and associated pain. In addition to impairments of the musculoskeletal system those patients with obesity may also have cognitive impairments that could interfere with motor planning and therefore also contribute to mobility disability. The age of the patient, distribution of body fat, and factors in the environment in which the person plans to be physically active must also be considered. In accordance there is research that shows a positive correlation body mass index and increase postural instability (greater shifts required in order to keep postural balance) that excess weight and low level of physical activity increased postural instability this study result proved his findings.[20] HILLS et.al. A 20% increase in body mass reduces the ability to make adjustments in response to external disturbances in the orthostatic position and increases postural instability [21]. The authors report that obesity (high BMI) will affect the selection of motor strategies employed to maintain postural balance [22, 23, 24]. The majority of studies indicate that there was a direct relationship between obesity and increased postural instability, as evaluated by means of various tools and methods [25, 26, 27, 28]. In this study, body mass presented a high correlation with the stability indices; that is, there was a need for greater movements to maintain postural balance. Hue *et al*. [29] found that body mass was responsible for more than 50% of balance at speed and Chiari *et al*. [29] demonstrated a strong correlation between body mass, antero-posterior movements, and the area of detachment. In both of these studies, a force platform was used in the evaluations. Other authors have reported that greater postural adjustments are necessary to maintain an erect posture when there is a buildup of adipose tissue, thus causing a reduction in balance and an increase in injuries and falls [25, 26, 28]. Studies on body mass index and postural stability has a conflicting findings, Angelica Castilho Alonso et.al in year 2012 evaluated the influence anthropometric characteristics and gender on postural balance, revealed poor correlation between balance and anthropometric variable (body mass, height, length of trunk cephalic region, length of upper and lower limb) are taken into consideration. The result of our study also shows that the number of error done by the elderly is more in single leg stance followed by tandem stance. This result maybe 2 distinct postural phases the dynamic and static phase. During the dynamic phase, there was a rapid decrease of force variability amplitude as the subjects made postural adjustments to regain standing balance after transferring weight to one leg. The change in force amplitude occurred within the first 5seconds of testing. During the second phase, static postural equilibrium was required to maintain balance on one foot, and the force variability was minimal. Elderly subjects had difficulty maintaining balance in the static phase due to difficulty adjusting postural control during the initial dynamic phase of one-leg stance [30]. Another reason for the more number of errors are decrease in lower extremity muscular strength and endurance. whereas, in tandem stance the base of support is narrow leading to the loss of balance. The number of fall is lower in double stance as the individual adopt some motor strategies through more coordinated timing of the muscles involved in postural activity and better integration occurs of neurosensory systems, increasing the postural balance [31].

Limitation

It is acknowledge that limitations may exist in the design that could possibly affect the results. While evaluating children, adolescents, middle age, and elderly population there were varying level of noise and distractions, which may be the contributing factor, Gender differences were not taken into consideration, Dynamic balance was not checked, BESS was performed on non-dominant leg, Physical activity among both the groups cannot be addressed.

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