CORRELATION BETWEEN BODY WEIGHT AND POSTURAL CONTROL IN HEALTHY INDIVIDUALS USING SWAY METER

© Tharani G*, Vedha Varshini M G, Senthil Nathan C V, Mohan Kumar G, Kamatchi K

Dr. M.G.R. Educational and Research Institute, Faculty of Physiotherapy, Chennai, India

BACKGROUND: Postural control is critical for ensuring a safety activity of daily living. Individuals with poor stability are more prone to fall while doing activities of daily living. A certain level of sway is essentially present due to small perturbation within the body during shifting body weight from one to other foot, breathing, etc. The purpose of this study was to analyze the correlation between body mass and postural control in normal, lean and obese individual.
AIMS: to analyze the correlation between body mass and postural control in healthy individuals using sway meter.
MATERIALS AND METHODS: This is an observational study done with 75 participants. Both male and female healthy individuals between 18-23 years were included in this study. Individuals with any musculoskeletal injuries, neurological conditions, peripheral artery disease and pregnant women were excluded from the study. BMI of each participant was calculated and assigned into three groups. Group A-lean, group B-normal and group C-obese. Postural control was analyzed for each group by using sway meter; level of postural sway was compared between groups A, B & C.
RESULTS: On comparing mean values of groups A, B and C there was a positive association and strong correlation between body mass index and postural control with eye open and eye closed in anterior, posterior and postural sway towards left between the groups at ($P \leq 0.05$). However, there was a negative association and weak correlation between BMI and postural control with eye open & eye closed in postural sway towards right between the groups at ($P \geq 0.05$).
CONCLUSIONS: This study reveals that there is strong correlation between BMI and postural control. Subjects in eyes closed and eyes opened conditions showed sway in anterior, posterior and left directions but there was less sway towards right side direction.

KEYWORDS: *obesity; postural sway; BMI; sway meter; postural control.*

АНАЛИЗ КОРРЕЛЯЦИИ МЕЖДУ МАССОЙ ТЕЛА И ПОСТУРАЛЬНЫМ КОНТРОЛЕМ У ЗДОРОВЫХ ЛИЦ ПРИ ПОМОЩИ СТАБИЛОМЕТРИИ

© Tharani G*, Vedha Varshini M G, Senthil Nathan C V, Mohan Kumar G, Kamatchi K

Учебно-исследовательский Институт М.Г. Рамачандрана, факультет физиотерапии, Ченнай, Индия

Обоснование. Постуральный контроль имеет большое значение в обеспечении безопасности в повседневной жизни человека. При постуральных нарушениях склонность к падениям существенно увеличивается. Определенный уровень колебательных движений присутствует у всех людей в связи с небольшими пертурбациями внутри тела, например, при перемещении массы тела с одной ноги на другую, дыхании и т. д. Целью данного исследования являлся анализ корреляции между массой тела и постуральным контролем у людей с разным индексом массы тела (дефицит веса, норма или ожирение).
Цель исследования – проанализировать корреляцию между массой тела и постуральным контролем у здоровых лиц при помощи стабилометрии.
Материалы и методы. В данное обсервационное исследование были включены 75 мужчин и женщин в возрасте от 18 до 23 лет. Из исследования были исключены лица с любыми травмами опорно-двигательного аппарата, неврологическими нарушениями, заболеваниями периферических артерий и беременные женщины. Участники были распределены на 3 группы после расчета индекса массы тела (ИМТ). В группу А были распределены участники с дефицитом массы тела, в группу Б – с нормальной массой тела, в группу В – с ожирением. Постуральный контроль анализировали для каждой группы при помощи стабилометрии; уровень осаночных колебаний сравнивали между группами А, Б и В.
Результаты. При сравнении средних значений групп А, Б и В наблюдались положительная ассоциация и сильная корреляция между ИМТ и постуральным контролем с открытыми и закрытыми глазами при отклонении тела вперед, назад и влево между группами ($p \leq 0{,}05$). Однако отмечены отрицательная ассоциация и слабая корреляция между ИМТ и постуральным контролем с открытыми и закрытыми глазами между группами при колебании тела вправо ($p \geq 0{,}05$).
Заключение. Это исследование показывает, что существует сильная корреляция между ИМТ и постуральным контролем. У лиц с закрытыми и открытыми глазами регистрировались осаночные колебания вперед, назад и влево и в меньшей степени – отклонения тела вправо.

КЛЮЧЕВЫЕ СЛОВА: *ожирение; осаночное колебание; индекс массы тела; стабилометрия; постуральный контроль.*

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BACKGROUND

Postural control is the process of maintaining the Centre of gravity (COG) within the base of support through continuous activity of muscular activity and joint positioning [1]. Postural stability is important in maintaining body balance during activities of daily living, like quiet standing, walking and mostly important during high degree of balance control when participating in sports and dancing. Sway is the horizontal movement of COG present in the body even when a person is standing still. A certain amount of sway is unavoidable due to some perturbations within the body during breathing, shifting weight from one foot to other foot. During standing, there will be separate Centre of pressure under each foot. An appropriate motor response, sensory detection of body's movement and integration of sensory motor information into the CNS are important to maintain body balance [2,3,4]. The position of the body in relation to space is determined by visual, vestibular and somatosensory systems. Static and dynamic maintenance of body balance involve the activity of coordinated muscular kinetic chain. Individuals with poor postural balance are more prone to falls that causes injuries, fractures, etc..[5]

Increased adipose tissue and body mass leads to reduction in body balance and causes risk of falls mainly when combined with lower muscular mass, which leads to biomechanical failure of muscular response results in loss of stability. Increased abdominal fat in obese individuals leads to increased lumbar lordosis, so there will be more anterior dislocation of COG [6,7]. The prevalence of overweight and obese among college students was found to be 13.2% and 5.2% respectively.

In underweight individuals due to poor nutrition supply they loss their energy quickly. Due to poor nutrition their muscles may become weak and it get fatigue easily. Mainly the lower limb muscles will get easily fatigue. Due to muscle fatigue there is altered somatosensory input which results in deficits in neuromuscular and postural control [8,9].

In normal weight individuals they have normal appropriate motor response, visual, vestibular and somatosensory systems. The body mass is measured using BMI [10]. Body mass index is a measure of body fat based on height and weight of an individual.

According to body mass index (BMI) the value below 18.5 is considered as lean, 18.5 to 24.9 as normal, 25 to 29.9 as overweight and above 30 as obese. Forceplate and Posturography is a simple method that is commonly used in the contemporary laboratory and clinic to measure postural sway. However, it is an expensive procedure and may not be easily available in rural set-ups. Sway meter is an inexpensive method and sway measurement obtained from sway meter is strongly correlated with the measurements obtained from the force plate, in this sway can be measured during bipedal stance [11]. Hence, this study was intended to analyze the correlation between the body mass and postural control in bipedal stance among healthy individuals.

AIM

To analyze if there is any effect of body mass on postural sway in healthy individuals.

METHODS

Seventy-five young individuals between 18 to 23 years of age were included in the study (both males and females). After initial general assessment each individuals were assigned into three groups based on their BMI by using BMI chart: group A (n=25) underweight subjects (BMI below 18.5), group B (n=25) normal weight subjects (BMI 18.5 to 24.9), group C(n=25) obese subjects (BMI>30). Then postural control was analyzed using the sway meter for all the individuals.

The sway meter was developed with a 40 cm pole attached to a belt and at the opposite end of the bar pen was appended to quantify the postural sway. The belt was fit at level of anterior superior iliac spine. The graph sheet was set behind the subject and relocation of graph sheet ought to be avoided amid the estimation. Sway meter was set behind the subject, where the impact of vision was likewise barred as illustrated in Fig.1 and Fig.2. Subject should remain on the sheet of paper with foot impressions; the separation between the feet was around 3 inches. The technique was explained to the subjects previously beginning every preliminary.

The subjects were told to keep their hands by their side and stand as still as possible on the foot imprints in bare foot. Duration of each trial was 30 seconds. A starting point was marked on the graph sheet, at the end of 30 second the rod of the sway meter was taken away from the graph sheet. Rest period of about 5 to 10 seconds was given to the subjects after each trial, but the subjects were not allowed to move the feet from the footprints. The procedure was repeated for each trial. Six trials were done, first three trials with eyes opened and next three trials with eyes closed. Total duration of all trials was 6 to 7 minutes, maximum deviation in three trials was taken for analysis.

DATA ANALYSIS

The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS) version 24. One Way ANOVA includes following

Fig 1.
Sway measure posterior view

Fig 2.
Sway measure lateral view

tests (Test of Homogeneity of Variance, ANOVA, Post Hoc test Tukey HSD) (multiple comparison) was adopted to find statistical difference between three groups. Pearson's Co- relation of Co-efficient analysis was done to find the association factors between three groups.

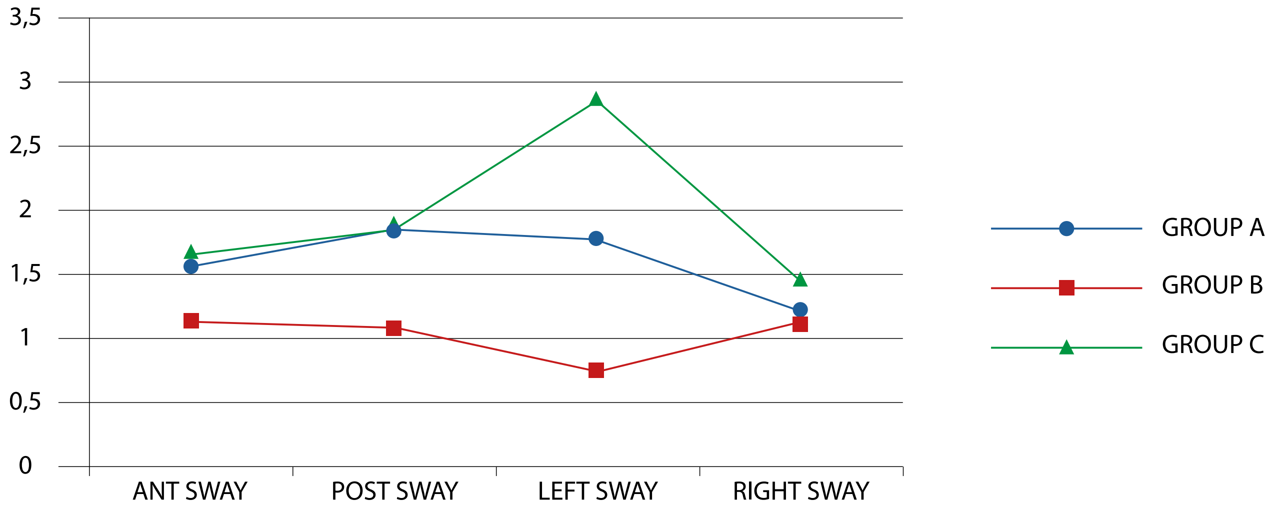
RESULTS

On comparing Mean values of Group A, Group B & Group C on Body Mass Index (BMI) & Postural Control in Eye Open from Graph I and Table-1. There significant difference in Anterior, Posterior & Postural Sway towards left between (Group A) ,(Group B)& (Group C) (*- P ≤ 0.001). Hence Null Hypothesis is Rejected. But there is no significant difference based on Body Mass Index (BMI) & Right Postural Sway with Eye open between (Group A) ,(Group B)& (Group C) in (*- P > 0.05).Hence Alternative Hypothesis is Rejected.

On comparing Mean values of Group A, Group B & Group C on Body Mass Index (BMI) & Postural Control in Eye Closed from Graph II and Table-2. There is significant difference in Anterior, Posterior & Postural Sway towards left between (Group A) ,(Group B)& (Group C) (*- P ≤ 0.001). Hence Null Hypothesis is Rejected. But there is no significant difference based on Body Mass Index (BMI) & Right Postural Sway with Eye Closed between (Group A) ,(Group B)& (Group C) in (*- P > 0.05).Hence Alternative Hypothesis is Rejected.

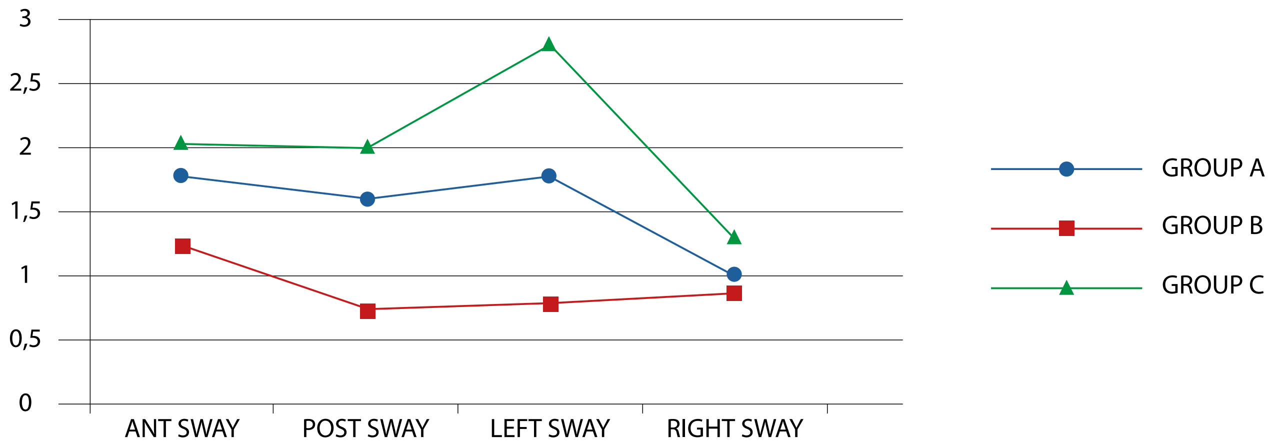
On analyzing Table-3 and Table-4, it is inferred that there is a Positive association and strong correlation between Body Mass Index and Postural Control with eye open & eye closed in anterior, posterior &postural sway towards left between the Groups at (P ≤ 0.05). Likewise, there is a Negative association and Weak correlation between Body Mass Index and Postural Control with eye open & eye closed in postural sway towards right between the Groups at (P ≥ 0.05).

GRAPH – I
Group Comparison of Body Mass Index (BMI) & Postural Control with Eye Open using Test of Homogeneity of Variance&One Anova Test between Group A, Group B and C



Comparison of Body Mass Index (BMI) & Postural Control with Eye Open using One ANOVA multiple comparison Post Hoc Tukey HSD Test between Group A , Group B and Group C (*- P > 0.05),(**- P ≤ 0.05),(***- P ≤ 0.001)

GRAPH – II
Comparison of Body Mass Index (BMI) & Postural Control with Eye Closed using Test of Homogeneity of Variance &One Anova Test between Group A, Group B and Group C



Comparison of Body Mass Index (BMI) & Postural Control with Eye Closed using One ANOVA multiple comparison Post Hoc Tukey HSD Test between Group A , Group B and Group C(*- P > 0.05),(**- P ≤ 0.05),(***- P ≤ 0.001)

TABLE-1. Comparison of Body Mass Index (BMI) & Postural Control with Eye Open using Test of Homogeneity of Variance &One Anova Test between Group A, Group B and Group C

TEST	GROUP A		GROUP B		GROUP C		df		F value	Significance
	MEAN	S.D	MEAN	S.D	MEAN	S.D	df1	df2		
ANT SWAY	1.59	0.741	1.14	0.541	1.71	0.646	2	72	5.32	0.000***
POST SWAY	1.85	0.743	1.09	0.471	1.88	0.899	2	72	9.54	0.000***
LEFT SWAY	1.78	1.51	0.760	1.29	2.89	1.77	2	72	12.03	0.000***
RIGHT SWAY	1.23	0.536	1.13	1.06	1.46	1.57	2	72	0.544	0.583*

ANT- ANTERIOR, POST - POSTERIOR, GROUP A - UNDERWEIGHT, GROUP B - NORMAL, GROUP C- OVERWEIGHT
(*- $P > 0.05$),(**- $P \leq 0.05$),),(***- $P \leq 0.001$)

TABLE- 2. Comparison of Body Mass Index (BMI) & Postural Control with Eye Closed using Test of Homogeneity of Variance&One Anova Test between Group A, Group B and Group C

TEST	GROUP A		GROUP B		GROUP C		df		F value	significance
	MEAN	S.D	MEAN	S.D	MEAN	S.D	df1	df2		
ANT SWAY	1.79	1.02	1.25	0.539	2.04	1.04	2	72	5.02	0.000***
POST SWAY	1.61	0.885	0.740	0.429	1.99	0.789	2	72	19.52	0.000***
LEFT SWAY	1.78	1.50	0.784	0.977	2.80	1.74	2	72	12.17	0.000***
RIGHT SWAY	1.03	0.871	0.876	0.943	1.30	1.40	2	72	0.917	0.383*

GROUP A - UNDERWEIGHT, GROUP B- NORMAL , GROUP C- OVERWEIGHT
(*- $P > 0.05$),(**- $P \leq 0.05$),),(***- $P \leq 0.001$)

TABLE -3. Pearson Correlation of Coefficient in Body Mass Index& Postural Control with Eye Open between Group A, Group B &Group C

BMI	ANTERIOR SWAY		POSTERIOR SWAY		POSTURAL SWAY TOWARDS LEFT		POSTURAL SWAY TOWARDS RIGHT	
	'r' value	P value	'r' value	P value	'r' value	P value	'r' value	P value
UNDER WEIGHT	0.998	≤ 0.05	0.465	≤ 0.05	0.135	≤ 0.05	0.082	≤ 0.05
NORMAL	0.465	≤ 0.05	0.998	≤ 0.05	0.151	≤ 0.05	0.105	≤ 0.05
OVER WEIGHT	0.135	≤ 0.05	0.151	≤ 0.05	0.998	≤ 0.05	-0.022	≥ 0.05

TABLE-4. Pearson Correlation of Coefficient in Body Mass Index& Postural Control with Eye Closed between GroupA,Group B &Group C

BMI	ANTERIOR SWAY		POSTERIOR SWAY		POSTURAL SWAY TOWARDS LEFT		POSTURAL SWAY TOWARDS RIGHT	
	'r' value	P value	'r' value	P value	'r' value	P value	'r' value	P value
UNDER WEIGHT	0.332	≤ 0.05	0.249	≤ 0.05	0.119	≤ 0.05	0.148	≤ 0.05
NORMAL	0.055	≤ 0.05	0.235	≤ 0.05	0.146	≤ 0.05	0.132	≤ 0.05
OVER WEIGHT	0.105	≤ 0.05	0.510	≤ 0.05	0.115	≤ 0.05	-0.007	≥ 0.05

DISCUSSION

This study aimed to find whether there is any correlation between Body Mass Index and balance control in healthy individuals .The postural sway was measured in two diverse conditions using sway meter, in eyes opened and eyes closed condition. In both eyes opened and closed conditions, there were subjects in normal group who did not show sway in any directions.

In some individuals, absence of sway was found in right lateral and left lateral direction. Maximum number of individuals did not show any sway in right lateral direction comparing to other directions as suggested by Sivakumar Ramachandra et al 2010[12]. There is a negative and weak correlation between Body Mass Index and postural control with eyes opened and eyes closed in postural sway towards right between the groups, this is because the individuals participated in this study had right hand dominance. When the subjects were solicited to share their experience of their participation in the study, 30% of the subjects reported that there was less time interval between the six trials, 60% of the subjects also admitted that they attempted to control their sway and many of the subjects stated they felt no discomfort.

For underweight individuals in eyes opened condition, the sway increased to a maximum in posterior direction and minimum sway in right side direction. In the eyes closed condition they had more sway in anterior direction and minimum sway in right side direction. The sway found in lean individuals could be due to localized plantar flexor fatigue that cause impairment to postural control as suggested by Yoav Gimmon et al 2011.

For normal weight subjects in eyes opened condition the sway increased in anterior direction and minimal sway was noticed in left side direction. In eyes, closed condition the sway increased in anterior direction and decreased in posterior direction. The increase in anterior sway could be because of the Wand phenomenon explained by Dennet.[13]

For overweight subjects, in eyes opened condition the sway was maximum in left side and minimum at right side. In eyes, closed condition the maximum sway was in left side and minimum sway in right side. Bulsara Z et al 2015 suggested that change in BMI affects the balance of the individuals and found that in increased BMI there is difficulty in making adjustments in response to external disturbances in orthostatic position and cause increase postural instability. In our study we found that there was least amount of sway in normal individuals followed by underweight and overweight individuals.

The limitations of this study are less sample size and the anthropometric influence on postural sway was not considered. 60% of the subjects reported that they attempted to control the postural sway, few subjects reported that they were not able to give 6 trials continuously (3 trials with eyes open & 3 trials with eyes closed) and difference in the postural sway within both the sexes was not considered.

CONCLUSION

In conclusion, this study reveals that there is strong correlation between Body Mass Index and postural control. Subjects with eyes closed and eyes opened condition showed sway in anterior, posterior and left directions, but there is weak correlation between BMI and postural control towards right side direction.

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ИНФОРМАЦИЯ ОБ АВТОРАХ [AUTHORS INFO]:

***Tharani G, MD**; адрес: Индия, Ченнай, 600095, Гопати Нараянасвами Четти 22 (121). [address: 22 (Old No.121), G.N. Chetty Road, 600017 Chennai, India]; ORCID: https://0000-0003-1364-7017; e-mail: tharani.physio@drmgrdu.ac.in

Vedha Varshini M G , student; e-mail: veda0997@gmail.com
Senthil Nathan C V; e-mail: senthilnathan.physio@drmgrdu.ac.in
Mohan Kumar G , professor; e-mail: mohankumar.physio@drmgrdu.ac.in
Kamatchi K; e-mail: kamatchi.physio@drmgrdu.ac.in

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