International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319 – 6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 6; Issue 6; June 2017; Page No. 4310-4315
DOI: http://dx.doi.org/10.24327/ijcar.2017.4315.0490

Research Article

ASSOCIATION OF MUSCULAR STRENGTH AND FLEXIBILITY WITH SELECT ANTHROPOMETRIC MARKERS OF OBESITY: A STUDY ON ADULT BENGALEE KATHAK DANSEUSES

SurjaniChatterjee., Neepa Banerjee., SatabdiBhattacharjee., TanayaSantra., AyanChatterjee., SandipanChatterjee and ShankarashisMukherjee*

Human Performance Analytics and Facilitation Unit Department of Physiology, University Colleges of Science and Technology, University of Calcutta RashbehariShikshaPrangan 92,AcharyaPrafulla Chandra Road, Kolkata 700 009, India

A R T I C L E I N F O

Article History:
Received 9th March, 2017
Received in revised form 28th April, 2017
Accepted 5th May, 2017
Published online 28th June, 2017

Key words:

Anthropometry, Physical Inactivity, Muscular Fitness, Kraus-Weber Tests, Classical Dancing, Lower Limb Endurance

A B S T R A C T

Strength and flexibility of select muscular groups are necessary for the healthy functioning of the body, without which an individual gets prone the physical inactivity related co-morbidities. But the present technology friendly lifestyle, offers a hindrance from achieving the optimum muscular flexibility, by reducing the work load from the muscles and indulging in a sedentary lifestyle. Hence, there is a growing recognition, to introduce physical activity which may positively influence the personal health. Therefore, to establish physical activity as a routine component of daily life that can be maintained without setting in boredom, dancing has emerged to be a popular choice. In this backdrop, the present study has been undertaken to assess the impact of Kathak dancing, a North Indian classical dance, on the strength and flexibility of certain muscle groups and find its association, if any, with select anthropometric markers of obesity. 43 adult female individuals, receiving Kathak dancing training for a minimum period of 6 years and practicing for at least one hour for 6 days a week, constituted the Kathak Dancing Group (KDG). The Control Group (CG) had 45 female individuals of comparable age and socioeconomic background but not receiving training in any form of dance or exercise. The muscular fitness was assessed using Kraus-Weber Tests, lower limb endurance was assessed by sit - and - stand test and the vertical jump height (cm) was also measured. Anthropometric assessments were adjudged in terms of WC, BAI and skinfold measurements. The results indicated that the Kathak danseuses have significantly ($P < 0.05$) favorable muscular fitness status compared to their age and sex matched counterparts; and there exist significant negative relationship ($P < 0.05$) between fitness parameters and the anthropometric markers of obesity.It may therefore be concluded that Kathak dancing is a beneficial way of exercising which may be implemented in programs, designed to effect lifestyle changes, for the betterment of health.

INTRODUCTION

Physical fitness (PF) is one of the mostimportant components ofhealth, and thereby many healthhazards and disorders could be checked by maintaining a certain level of physical fitness. PF, a measure of strength and flexibility of particular muscular groups that are necessary for the healthy functioning of a body (Manmath *et al*, 2000), is a direct function of physical activity (PA) (Mukherjee *et al,* 2013). But the advents of labor-saving technologies have encouraged people, including children, to lead a sedentary lifestyle by decreasing the energy expenditure required to perform their daily activities (Alves *et al,* 2013).

Corresponding author:* **ShankarashisMukherjee
Human Performance Analytics and Facilitation Unit
Department of Physiology, University Colleges of Science and Technology, University of Calcutta
RashbehariShikshaPrangan 92, AcharyaPrafulla Chandra Road, Kolkata 700 009, India

It is imposing negative health impact including obesity and its related consequences (Napolitano *et al,* 2008, Banerjee *et al,* 2014a). This have major implications for health policy, as governments strive to maintain the health care cost that is posing a burden on the limited health care resources for low and middle income countries including India (Nawab *et al,* 2014, Chatterjee *et al,* 2015a). Hence, to have effective interventions, for public health management and tore-introduce/re-initiate an active life style, among the adult population, studies round the world are trying to adopt a method, in the form of physical activity or any form of aerobic exercise, that is feasible, low cost and has a novel approach (Dietz *et al,* 2009). In this context, dancing, a form of physical activity with complex spatio - temporal skill and coordination abilities (Bhattacharjee *et al,* 2014), has emerged to be a popular choice. It has the desired properties thathave already been proved to have beneficial impact on the body

composition (Mukherjee *et al*, 2014a), may simultaneously influence the physical fitness status of an individual regularly practicing it.In this backdrop, the present study has been undertaken to assess the impact of Kathak dancing, a North Indian classical dance, on the strength and flexibility of certain muscle groups and find its association, if any, with select anthropometric measurements.

METHODOLOGY

The study was carried out on 43 adult Bengalee female individuals undergoing Kathak dancing training, age range 20-30 years, after obtaining necessary permission from the Human Ethical Committee of the Institution along with the individual and institutional consentfrom the centres imparting training on Kathak dancing. With the initial consent from theindividuals, the names of volunteers were enlisted and the procedural requirements were explained elaborately. Females satisfying the inclusion criteria of receiving training in Kathak dancing for a minimum periodof 6 years and practicing it regularly for at least one hour for 6 days a week were considered for inclusion in Kathak Dancing Group (KDG). Female individuals ofcomparable age and socio-economic background, butnot receiving training in any form of dance and alsonot formally exercising, constituted the Control Group (CG) (n = 45). Participating volunteers were otherwise engaged in sedentary type of occupation. Individuals receiving Kathak dancing training for less than five years, being trained in other forms of exercise or other forms of dancing, and/or with diabetes, hypertension, hyper-lipidaemia and hyperthyroidism (self-reported) were excluded as probable study participants. Anthropometric and demographic data were obtained for each subject. Demographic data included age, marital status, occupation, lifestyle etc. Socio economic status of the participating individuals was assessed using updated Kuppuswami scale (Kumar *et al,* 2013). BMI was calculated from the measured body weight (kg) and stature (m) data of the participants in light indoor clothing and without shoes. Other anthropometric measurements included, Waist Circumference (WC), at the midpoint between the last rib and the iliac crest, with the subject standing, after complete exhalation (Hanna *et al,* 2011) and skin fold measurements at sub-scapular and abdominal sites (Ferrari *et al,* 2013); and Body Abdominal Index (BAI), an obesity index, was calculated. To reduce the inter-observer measurement variation coefficients, all anthropometric measurements were obtained by the same researcher (Banerjee *et al*, 2015a). The muscular fitness was assessed using Kraus-Weber Tests (Kulkarni *et al,* 2010), lower limb endurance was assessed by sit-and-stand test (Hui*et al,* 2009) and the vertical jump height (cm) (Merom *et al,* 2013) was measured. All measurements were taken in the morning hours with ambient temperature around 25˚- 27˚C.The data of KDGand CG individuals were compared to find out significant difference, if any. Correlation analysis was carried out between the anthropometric markers of obesity and the fitness parameters of the KDG individuals to find out their association. P value lower than 0.05 ($P < 0.05$) was considered significant.

RESULTS

In the present study, participants were young adult Bengalee non-pregnant females residing in the urban region of West Bengal; all of them were Bengalee Hindu, and were from upper- middle class stratum of the society. All individuals of KDG and CG were of comparable age and socio-economic status. But the mean BMI of the KDG individuals is significantly lower ($P<0.01$) compared to their CG counterparts.

Table 1 Basic physical profile of the study participants

Variables	KDG	CG
Age^(year)	22.14 ± 1.68	22.11± 1.74
Marital status	Unmarried	Unmarried
Socio – economic status^	Upper middle	Upper middle
Occupation	Sedentary working women	Sedentary working women
Type of exercise	Kathak Dancing	Nil
BMI ($kg.m^{-2}$)**	20.0 ± 2.43	25. 8 ± 3.31

*P<0.01,^ns

In figure1, comparison between KDG and CG individuals has been presented in terms of % of success in Kraus Weber Test.

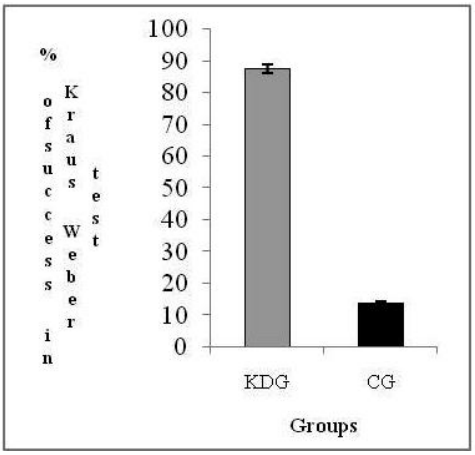
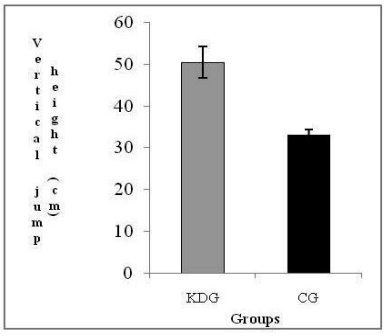
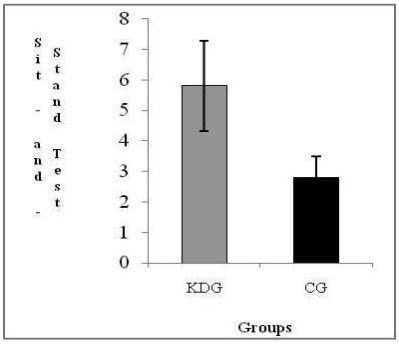


Fig 1 Comparison between KDG and CG individuals in terms of % of success in Kraus Weber Test

** P < 0.01



a) Vertical Jump Height (cm)**



b) Sit and Stand Test**

Fig 2 Comparison between KDG and CG individuals in terms of Vertical Jump Height (cm) (a) and Sit and Stand Test for Lower Limb Endurance (b)

** P < 0.01

In figure 2, comparison of muscular fitness between KDG and CG individuals in terms of Vertical Jump Height (cm) (a) and Sit and Stand Test for Lower Limb Endurance (b) has been presented.

In figure 3, comparisons of anthropometric markers of obesity, between KDG and CG individuals, in terms of WC (cm) (a) BAI (b) abdominal skin-fold (c) and sub-scapular skin-fold (d) has been presented.

with CVD and other risk factors and secondly it is directly related with human performance. There is aninverse association between muscular strength/fitness andfatness (Steene-Johannessen *et al,* 2009), a potential factor for the development of CVD. Simultaneously, the decreased muscular strength and power may affect the adults' ability to become skilled and successfully perform the daily activities (Faigenbaum *et al,* 2007). Evidences indicate that females are more likely to gainweight (Eisenmann *et al,* 2002) and tend to

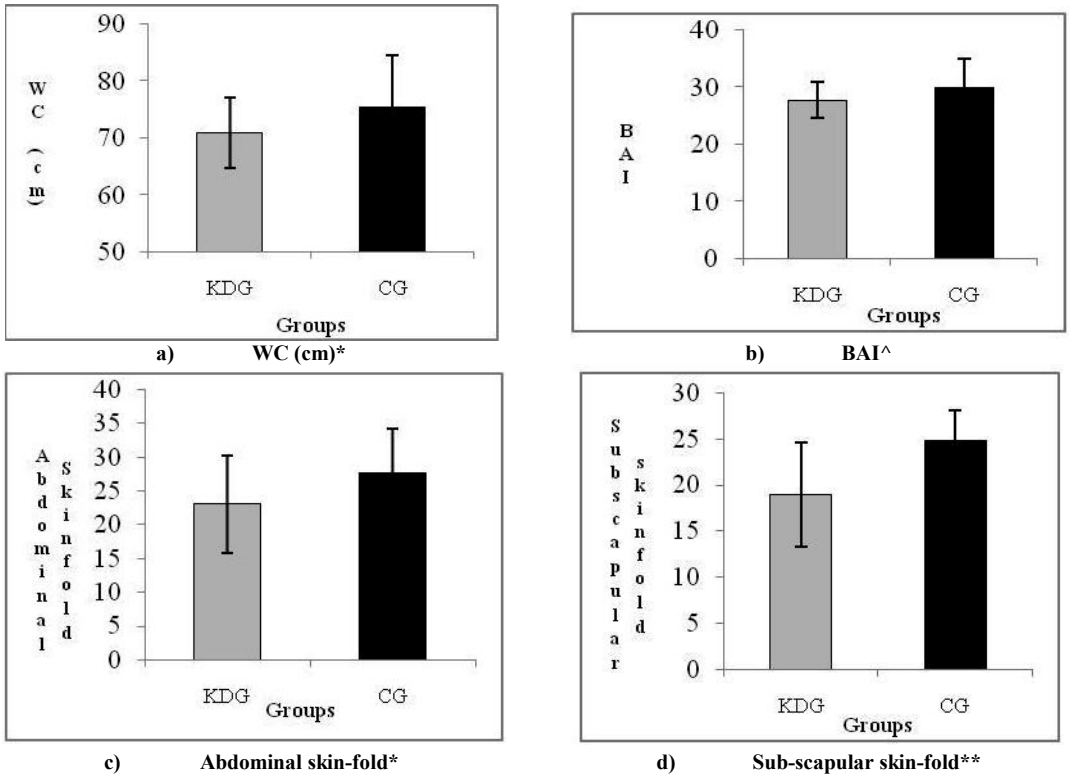


Fig 3 Comparison of anthropometric markers of obesity,between KDG and CG individuals in terms of WC (cm) (a) BAI (b) abdominal skin-fold (c) and sub-scapular skin-fold (d)

^ns, *P < 0.05, **P < 0.01

On finding significant difference between the KDG and CG individuals in terms of fitness variables as well as and anthropometric markers of obesity, correlation analysis was carried out between the fitness variables and the anthropometric marker of obesity, of the KDG individuals. Among the 6 tests of Kraus Weber, Sit up Test (Test 6) was selected for convenience. The correlation matrix of KDG individuals is presented in table 2.

be less active, (Jago *et al*, 2005) as they getolder, thus, require special attention. Our earlier studies on adult females, have already observed that Kathak dancing have a positive impact on the anthropometric and body composition parameters (Bhattacharjee *et al,* 2015, Chatterjee *et al,* 2014a) and Bharatnatyam dancing, a South Indian classical dance, have positive impact on the fitness variables of adult Bengalee female individuals (Chatterjee *et al.* 2013).

Table 2 The correlation matrix on the relationship - among the fitness variables and the anthropometric markersof obesityin KDG individuals

	BMI	WC	BAI	Subscapular skinfold	Abdominal skinfold	Sit and stand test	Vertical jump height	Sit up test
BMI	1	0.917**	0.774**	0.278	0.528**	**- 0.627****	**- 0.742****	**- 0.625****
WC		1	0.680**	0.107	0.408**	- 0.230	**- 0.330****	0. 007
BAI			1	0. 056	0. 035	- 0.230	- 0216	- 0.178
Subscapular skinfold				1	0.327	- 0.222	**- 0.400****	- 0.317
Abdominal skinfold					1	**- 0.369****	**- 0.498****	**- 0.366****
Sit and stand test						1	0.820**	0.726**
Vertical jump height							1	0.945**
Sit up test								1

*P < 0. 05, **P < 0. 01

DISCUSSIONS

The importance of physical fitness-PF- assessment lies in two aspects - firstly, the association of PF is very much clustered

Hence, the present study was aimed to assess the impact of Kathak dancing on physical fitness parameters along with select anthropometric marker of obesity. The study was carried out on 43 KDG and 45 CG individuals with

comparable age and socio-economic status (table 1). In the present study the muscular fitness is adjudged in terms of Kraus Weber Test; it is a combination of 6 tests and a 'fail' in any of the 6 test items implies a whole test failure (Kraus *et al*, 1953). Each test is to assess the strength of different important muscles: Test 1 (A + P) is for Abdominal and Psoas muscles, Test 2 (A - P) is for Psoas, Test 3 (P) is for Psoas and Lower Abdominal muscles, Test 4 (UB) is for Upper Back muscles, Test 5 (LB) is for Lower Back muscles, Test 6 (B +H) is for Back and Hamstring muscles and also the test for flexibility. The success percentage in KDG individuals were found to be 87.5, which was significantly higher ($P < 0.01$) compared to the success percentage of CG individuals; 13.7(fig 1). This may indicate that the complex postures and rigorous practice of Kathak dancing increases the muscular flexibility and fitness of the KDG individuals; and thereby probably reducing the consequent impactof hormonal changes on body weight and flexibility. Lower limb endurance was assessed by sit-and-stand test; KDG individuals had significantly higher ($P < 0.01$) values compared to their CG counterparts (fig 2a).The physical improvements observed may be due to the aerobic effects of Kathak dancing; as it predominantly involves contracting and exercising large muscles of the legs for certain duration. Hence, improvements in functional fitness tests involving dynamic movements of the lower limbs may be expected, such as in lower limb endurance (Hui *et al*, 2009). This may also be due to swift circular turns and the footwork with controlled coordination of hand and body of Kathak dancing. Jumping is an integral part of any dance performance, especially Kathak dancing. Jumping ability helps to determine the strength of lower limbs of an individual (Merom *et al,* 2013, Wyon *et al,* 2006). In the present study the mean Vertical Jump Height (cm) of the KDG individuals were found to be 50.5 cm while that of CG individuals were 33 cm (fig 2b). This may indicate that the jumping movements as well as the vigorous stamping of the feet with heavy ankle bells or 'gungroos' in Kathak dancing may have positive influence on developing the lower limb strength; that is required for jumping.

On observing significant difference in the fitness variables, some body composition parameters were also adjudged anthropometrically. Among several other methods for body composition assessment, anthropometry, the measurement of man, is universally applicable, inexpensive and non-invasive. In the present study the values of some of the obesity indices, derived from anthropometric measurements (anthropometric markers of obesity), were determined. In terms of BMI, the most popular measure of generalized obesity, which is found to be highly associated with the risk of obesity related co-morbidities (Raj *et al,* 2010, Mukherjee *et al,* 2014b), it hasbeen found that CG individuals belonged to overweight category as per WHO Asian classification (Mukherjee *et al,* 2014c)whereas KDG individuals belonged to normal weight category (table 1); similar finding has been found in previous study conducted on Bharatnatyam danseuses and male football players (Banerjee *et al,* 2014b, Mukherjee *et al,* 2012, Chatterjee *et al,* 2015b, Chatterjee *et al,* 2014). Recent studies show the trend of abdominal obesity to be increasing, in both developed and developing countries (Karageorghis *et al,* 2001). There is a significant positive trend of increased central adiposity and fat distribution in sedentary adults in the urban population and hence the estimation of the central adiposity indicators is important. WC is an indirect marker of abdominal adiposetissue and in the present study, it has been found that themean WC of KDG individualsis significantly lower ($P < 0.05$), compared to their CG counterparts (fig 3a). There commended WC thresholdvalue is 80 cm for Asian females and exceeding this valueincreases the risk of suffering from metabolic syndrome (Koh *et al,* 2010). The lower values of WC as observed in KDG could be attributed to different postures adopted for the Kathak dancing. Present finding is in agreement with previous studies (Mukherjee *et al,* 2014a, Chatterjee *et al,* 2014a, Chatterjee *et al,* 2013). Body Adiposity Index (BAI), predictor of body fat (Chatterjee *et al,* 2014b), is an alternative index based on hip circumference and body height (Ogden *et al,* 2012). In the present study, the CG individuals have been found to have a higher value of BAI (fig3 b); this can be attributed to their larger hip circumference Freedman *et al,* 2012), which is an indicator of higher plasma CRP, indicating insulin resistance and metabolic disorder, in obese females (Jou*et al,* 2006). The mean abdominal and sub-scapular skin fold values, the other anthropometric markers of obesity, of the KDG individuals, were also found to be significantly lower ($P < 0.05$), compared to their CG counterparts (fig 3 c and d), which further indicates that the KDG individuals have favourable body compositions, adjudged anthropometrically, compared to the CGindividuals.

As already indicated that Kathak dancing has beneficial impact on the anthropometric markers of obesity, and also has positive influence on the fitness variables, a correlation analysis was carried out between the anthropometric markers of obesity and fitness variables of the KDG individuals. It was observed that there was a significant ($P< 0.01$) negative correlation between BMI and lower limb endurance, lower back and hamstring flexibility and lower limb strength adjudged in terms of sit and stand test, sit up test and vertical jump height respectively. There also exists significant ($P < 0.01$) negative correlations between WC and lower limb strength and between subscapular skin fold andlower limb strength. There also exists a significant ($P < 0.01$) negative correlation between Abdominal skinfold and lower limb endurance, lower back and hamstring flexibility and lower limb strength (table 2). Hence, our present study indicates that there existsan inverse association between fitness variables and anthropometric markers of obesity. Given the fact that usually obese are more prone to cluster the CVD risk factors (Weiss *et al,* 2004, Kelishadi *et al,* 2009, Banerjee *et al,* 2014c, Banerjee *et al,* 2013, Banerjee *et al,* 2015b) our data for CG individuals raise some further concerns. Thus, reducing sedentary activities and increasing Physical Activity and Physical Fitness levels, by traditional exercise like Kathak dancing, may help to protect adults from excessive weight gain aswell as other metabolic diseases and help them to achieve relatively better fitness that might eventually increase their overall performance.

CONCLUSION

It may be concluded from the present study that improvement of physical fitness status has a positive impact in maintaining better body composition and thus Kathak dancing can serve as a potential tool for the desired healthy living agenda.

Acknowledgements

Authors are thankful to all volunteers for their participation.

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How to cite this article:

SurjaniChatterjee *et al* (2017) 'Association Of Muscular strength And Flexibility With Select Anthropometric Markers Of Obesity: A Study On Adult Bengalee Kathak Danseuses', *International Journal of Current Advanced Research,* 06(06), pp. 4310-4315. DOI: http://dx.doi.org/10.24327/ijcar.2017.4315.0490

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