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Comparison between Procedures for Assessment of Physical Activity that reduces Risk of T2DM: A Study in Bengalee Young Adult Females in southern region of West Bengal, India

Sweety Bardhan[1], Sayantika Saha[2], Sambaran Mondal[3], Ayana Das[4], Neepa Banerjee5, Shankarashis Mukherjee[6*]

[1,2,3,4,6*]PHAU, Department of Food and Nutrition, West Bengal State University, Kolkata 700126, India

[5]Bhairab Ganguly College, Kolkata 700 056, India

*Email: msasish@yahoo.co.in

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ABSTRACT:

Background: Physical activity (PA) is one of the modifiable factors that is associated with the risk of type2 diabetes mellitus (T2DM). This study aimed to compare the level of PA assessed by using two subjective methods of PA assessment and to explore the effect of physical activity on the anthropometric indicators of T2DM in Bengalee young adult females. Methodology: This study was conducted on 114 Bengalee young adult females from Kolkata and surrounding areas. General socio-demographic information was collected in a pre-designed schedule. Level of PA was assessed by using International Physical Activity Questionnaire- Short form (IPAQ-SF) and values of Physical Activity Level (PAL). Indicators of T2DM in terms of Waist Circumference, and Body Fat Percentage of the participants were measured and BMI and Waist to Height Ratio were computed. Results: The mean age of the participating volunteers was 19.9 years. Study findings indicated that more than 70% of the participants was physically inactive. The spearman's correlation coefficient values of PA assessed using IPAQ and PAL was statistically significantly correlated ($P < 0.05$). The correlation coefficient between predicted and assessed criterion value was 0.61. Mean BMI (kg.m-2), WC (cm), WHtR and BF (%) of the participants were 23.71, 84.8, 0.53 and 30.12 respectively. Conclusion: The physical activity as assessed by two methods of PA assessment was positively significantly ($P<0.05$) correlated. Physical activity was inversely significantly related with BF (%) in the present study.

Keywords: Physical activity, non-communicable diseases, subjective tool, nutrition transition

1. Introduction

Nutrition transition due to shift in dietary and physical activity pattern is a well-known phenomenon across the ages in developing countries which is associated with increasing incidence of overweight, obesity and many other non-communicable diseases (NCDs) (Popkin, 2012, Bardhan, 2024). In recent years NCDs have emerged as one of the leading causes of mortality and morbidity both in developed and developing countries. Sedentary behaviors, engagement in activities which include energy expenditure of 1.5 or lower metabolic equivalent units (METs), tend to has specific contribution in development of NCDs (Banerjee et al., 2015a; Banerjee et al., 2021b). Physical inactivity is the fourth leading causes of death and it has been estimated that 3.2 million of global deaths every year are attributable to physical inactivity (WHO, 2014). PA is a modifiable risk factors of NCDs and it has been reported that the rate of NCDs can be resolve by around 10% by reducing the time spent in sedentary activities. Emerging health consequences of physical inactivity have highlighted not only the importance of PA but also to assess the PA with proper assessment tools as PA assessment is challenging due to complex and diverse human behavior. PA can be measured by using both subjective and objective methods. Objective method uses pedometer and/or accelerometer as a tool of measurement whereas subjective method involves use of self-reported questionnaire. Due to the cost effectiveness and ease of using, subjective tool is widely used for assessing PA in community level (Niestrój-Jaworska et al., 2023). A number of physical activity questionnaires (PAQs); International physical activity questionnaire (IPAQ), Global physical activity questionnaire (GPAQ) has been developed and are proved to assess PA level with high level of accuracy. Similarly, the status of physical activity can also be assessed based on Physical Activity Level (PAL) which is expressed as total energy expenditure (TEE) divided by basal metabolic rate (BMR) in 24hrs. This is also a subjective method and consist questions from different domains of activity including work, personal care, domestic chores, travel and recreational activity one performs daily in 24hours. In most of the previous studies comparison has been made between the subjective and objective instruments of PA assessment however, evidence regarding relationship between two subjective methods of assessing PA is scarce. In this context, this study seeks to compare IPAQ and PAL, the procedures for assessing the levels of physical activity, that reduces risk of T2DM; the study is being conducted among Bengalee young adult females in southern parts of West Bengal. It also seeks to find out the correlation, if any, between the values obtained in two different procedures, and also explore the effect of physical activity on the anthropometric markers of T2DM.

2. Methodology

Selection of study participants: The study was carried out on Bengalee young adult females attending higher education institutions (HEIs) located in and around Kolkata, West Bengal. Initially the study requirements were explained to the authorities of the HEIs and also the individuals. 114 consenting volunteers aged 18-24 years constituted the study participants' set.
Inclusion criteria: The consenting Bengalee young adult females attending HEIs located in greater Kolkata within the age group of 18-24y with no prior history of diabetes (self-reported) were considered for inclusion.
Exclusion criteria: Individuals with self-reported health disorders for which on continual medication or having oral contraceptives, pregnant women and candidates having loco-motor disability were excluded from this particular study.
Collection of background information: On appointed date and time based on mutual agreement information regarding age (y), ethnicity, marital status, socio-economic status (SES) (Kumar et al., 2022), educational attainment, about general health and family history with

regard to diabetes, was recorded in a pre-designed schedule. Systolic blood pressure (mm Hg), diastolic blood pressure (mm Hg) and pre-activity heart rate (beats.min^{-1}) were recorded using an automated blood pressure monitor and/or sphygmomanometer in resting condition in right arm (Liu, 2022; Santra, 2022). Three readings were recorded with an interval of at least 3min and average value was taken.

Assessment of physical activity: International Physical Activity Questionnaire short form IPAQ-SF was used to assess physical activity of the study participants (Lee, 2022). Information regarding the activity that people do in their daily life including intensity and duration of work at home, work place and recreational physical activity, time spent in walking and sitting in the last seven day were collected. PA was also assessed based on the value obtained by calculating physical activity level (PAL) (FAO/WHO, 2005). Information regarding activities in different domains including general personal care, household chores, transport related activities, activities in work place and recreational PA were collected. Total energy expenditure (TEE) was estimated and PAL value was computed.

Assessment of diabetes risk indicators: Body height (cm) was measured using anthropometric measurement set (resolution: 0.1cm). Body weight (kg) was measured using a weighing scale (resolution: 0.1kg) with subjects in socially acceptable minimal clothing. Waist Circumference (cm) was measured midway between the lowest ribs and iliac crest at the end of expiration using non-stretchable measuring tape (resolution: 0.1 cm). Body Mass Index (BMI) in kg.m^{-2} and Waist to Height Ratio (WHtR) were computed (Hartwig, 2016; Chatterjee, 2015a). Body fat percentage (BF) was measured using impedance method (Banerjee, 2015b) Cut off values for BMI $\geq$ 25 kg.m^{-2}, WC $\geq$ 80 cm, WHtR $\geq$ 0.50 (Lee, 2016) and BF $\geq$ 32% (Rush, 2004) were used to define T2DM risk.

Statistical analysis: The findings were presented as mean ± standard deviation or proportion. Spearman rank-order correlation coefficient was applied to assess the strength of correlation between level of physical activity assessed by using IPAQ and PAL. Prediction equation was developed using linear regression model and was validated. PA of the participants in terms of PAL and time spent in sedentary activities and moderate-vigorous physical activity (MVPA) was distributed among various risk predictors of T2DM. The difference in PA between risk groups of T2DM was assessed. $P < 0.05$ considered as significant.

3. Results

Table 1 highlights the general socio-demographic profile of the young participating volunteers.

Table 1: Background information of the participating volunteers

Variables	Values
Number of study participants	114
Age (y)[#]	19.9 ± 1.26
SES (%) Upper and Upper Middle Lower Middle Upper Lower and Lower	 20 (17) 52 (46) 42 (37)
SBP (mm Hg)[#]	104.8 ± 12.7
DBP (mm Hg)[#]	69.2 ± 8.6
Pre-activity Heart Rate (beats.min^{-1})[#]	88 ± 12.0

AM ± SD

A total number of 114 Bengalee young adult females with mean age of 19.9 years participated in the present study. Most of the participants belonged to the lower middle socio-economic class.

Mean minutes spent in PA in an average day in various domains of activity has been calculated and presented in table 2.

Table 2: Distribution of mean minutes spent in various domain of activity in an average day

Domains	**Time spent (min. d^{-1})**
Sleeping	430.4 ± 66.19
Personal care [a]	113 ± 36.97
General household chores	67.4 ± 62.82
Study [b]	380.3 ± 116.93
Commuting	55.5 ± 40.64
Recreational physical activity	20.4 ± 36.15
Leisure [c]	358.7 ± 135.94
Total	~ 1426

[a] Eating, bathing and dressing; [b] time spent in study in tuition, HEIs and home; c leisure time sitting, watching TV, using mobile and computer for entertainment purpose

The maximum time spent was in sleeping which was followed by study and leisure time activity respectively. The lowest time spent was reported in recreational physical activity domain.

The values of PA of the participants have been calculated using the two methods and has been presented in table 3.

Table 3: Status of physical activity of the participating volunteers

	Values
IPAQ (MET minutes. $week^{-1}$)	1573 ± 1305.5
PAL	1.45 ± 0.18

AM ± SD

A bivariate correlation analysis was performed to find out the relationship between the values of PA as calculated by using two methods that is PAL and IPAQ. A statistically significantly positive correlation ($P < 0.05$) has been found between two methods. The relationship between the two has been presented graphically in figure 1.

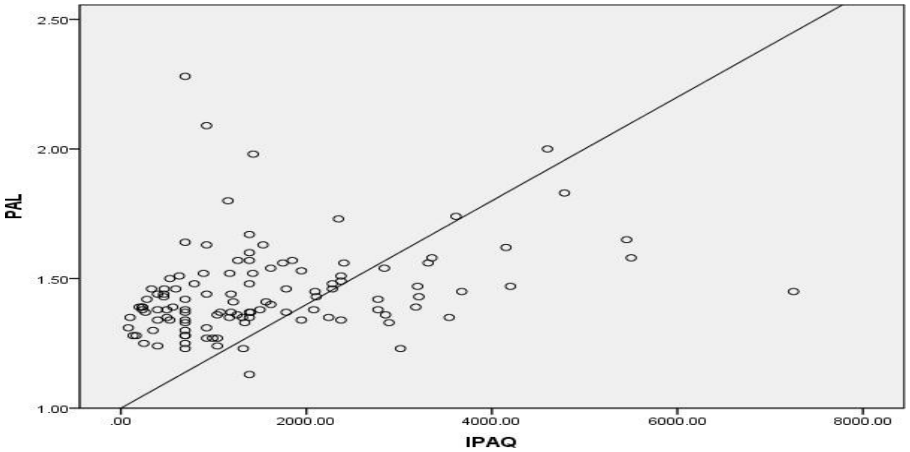

Figure 1: Scatterplot depicting the relationship between PA status obtained from two methods of PA assessment

Based on the relationship between values of PA, simple linear regression was applied to develop prediction equation using IPAQ value as predictor and PAL value as criterion. The prediction equation has been presented in table 4.

Table 4: Regression model for estimating PAL value by using values of PA obtained from IPAQ

Predictor (X)	**Criterion (Y)**	**Prediction equation**
IPAQ (MET minutes. Week^{-1})	PAL	Y= 1.386 + 0.00003980 X

A new set of data collected from 32 individuals from comparable age, ethnicity, physiological and socio-economic status for criterion validity constitute the validation group. Table 5 presents the background information of the individuals constituting validation group.

Table 5: Background information of the validation group

Variables	**Values**
Number of study participants	32
Age (Y)$^{\#}$	19.9 ± 0.79
Socio economic status$^{\#}$	Lower Middle
SBP (mm Hg)	101.3 ± 9.6
DBP (mm Hg)	70.2 ± 7.3
Pre activity Heart Rate (beats.min^{-1})	81 ± 12.5

AM ± SD

The developed prediction equation was tested on the validation group. The correlation between PAL value as predicted from the newly developed equation and assessed has been presented in table 6.

Table 6: Correlation between Assessed and predicted values of physical activity

Assessed PAL value	**Predicted PAL Value**	**r value**
1.53 ± 0.15	1.50 ± 0.07	+0.61*

AM ± SD; *P < 0.05

The mean values of PAL as assessed and predicted was 1.53 and 1.50 respectively. The correlation coefficient of the assessed and predicted PAL values was 0.61 and was positively significantly correlated (P < 0.05).

The difference in time spent in sitting, MVPA and value of PAL between the risk groups of T2DM has been presented in table 7. It has been found that BF (%) was inversely significantly associated with PAL. However, other indicators of T2DM showed no significant difference in time spent in various domain of activities and PAL hence, not presented.

Table 7: Difference in PA between the risk groups of T2DM in terms of Body Fat (%)

Risk category in terms of BF%	**Low**	**High**	P
BF (%)	< 32	≥ 32	
Number of participants (%)	66 (58)	48 (42)	
Sitting time (min. d^{-1})	725.45 ± 119.38	758.19± 125.73	0.76^
MVPA (min. d^{-1})	62.25 ± 50.31	54.79 ± 37.30	0.44^
PAL	1.47 ± 0.20	1.40 ± 0.11	0.01*

*P<0.05, ^ns

4. Discussion

This study was carried out to compare the two methods of physical activity assessment in Bengalee young adult females in West Bengal. By definition all the activities such as professional work, household chores, leisure activities, commuting, shopping, recreational physical activity, which require energy to perform is included in PA. However, it is important to measure the intensity of PA to get an idea about its beneficial effect on positive health outcome. The status of PA of the participants in the present study was reported to be very low and more than 70% of the participants was physically inactive. Total time spent in sedentary activity in the present study ranged between 8 h and 19 h with the mean of 12.31 h. As the participants was students by occupation the work domain that is time spent in study also included in sedentary activity. In line with the present study, a study on medical students and young medical faculty in Maharashtra also reported spending of more than 10 h in a day in sitting (Joshi, 2023). Among all the leisure time sedentary activities, mobile screening (4.53 h. d^{-1}) was most common among the participants. In contrast with a previous study (Khan, 2016), much lower tendency of television watching was reported in the present study. Only 44 (38%) volunteers in the present study have reported to practice recreational physical activity for more than 30 min in a day for five days in a week. Instead of walking or cycling which can add some value in overall PA, most of the participants was likely to choose passive mode of transport for commuting. In this study the physical activity of the participants as assessed by using IPAQ and PAL was significantly positively correlated ($r=0.38$, $P=<0.05$). Based on the linear relationship between two methods, prediction equation was developed. The result of criterion validity of the new equation found to have significant ($P<0.05$) test-retest correlation.

The mean BMI ($kg.m^{-2}$) and WC (cm) of the participants were 23.71 and 84.8 respectively indicating the individuals had the risk of cardiometabolic diseases including T2DM. The status of overall obesity in terms of BMI was 38% in the participants which was higher than obesity status of females in West Bengal as reported in NFHS 5. Whereas, 54% of the participating individuals reported to have central obesity which was lower than that reported in NFHS 5 (NFHS, 2021). The average BF% of the young adult participants in this study was 30, the value was lower than that reported in a study conducted on females in comparable age in West Bengal (Banerjee et al., 2014).

The beneficial effect of increased PA in indicators of obesity and T2DM has been illustrated in several previous studies (Banerjee, 2022; Banerjee, 2021a; Bhattacharjee, 2021; Banerjee, 2018; Banerjee, 2017). PA exerts its beneficial effects on delay of onset of T2DM primarily by three mechanisms; increasing the blood flow into the muscle cells which in turn enhance plasma glucose uptake, reducing the truncal fat deposition, one of the promoting factors of insulin resistance and enhancing the glucose uptake by about 40% (Galicia-Garcia, 2020).

The individuals with greater PAL values had lower body fat percentage in this study and the difference was statistically significant ($P<0.05$). Findings of a study carried out on young adult females from similar socio-demographic background (Chatterjee, 2015b) was in agreement with the findings of this study. However, no other indicators of T2DM; BMI, WC and WHtR showed any notable relationship with neither PAL nor time spent in sitting and MVPA. Similar to the findings of the present study several other studies have also reported statistically insignificant relationship of physical activity with anthropometric indicators of T2DM (Yousif, 2019; Khan, 2016). The possible explanation of the insignificant relation between PA and measures of T2DM would be that the positive health outcome of PA can be achieved if the individuals are active or very active and more physical activity is required to prevent obesity and only 8% of the volunteers of this study was physically active (moderate or vigorous) based on the cut-off values. It has been observed in the present study that those with increased obesity defined by BMI, WC and WHtR reported to have greater PAL values. Similar result has been

reported in other previous studies also (Mogre, 2015; Lee, 2016). Although the exact etiology is not well understood it may be due to increased awareness among obese to achieve ideal body weight.

Both the methods of physical activity assessment used in this study was subjective in nature which is reliant on self-report of the respondents hence, may subjected to recall error and over and under estimation of PA and sedentary activity respectively. Moreover, the study was cross-sectional which cannot infer any causal relationship between PA and risk of T2DM.

5. Conclusion:

The level of physical activity as assessed by two methods of PA assessment has significant positive correlation ($P< 0.05$) in the present study and has high test-retest validity. Body Fat (%) had statistically significant relation with physical activity.

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6. References:

1. Banerjee, N., Biswas, P., Chatterjee, S., Santra, T., Chatterjee, S., Mukherjee, S. (2021a). Impact of Bharatnatyam Dancing on Obesity and Diabetes Risk Status: A Study in Bengalee Female Human Resources Engaged in Sedentary Occupations. In: Muzammil, M., Khan, A.A., Hasan, F. (eds) Ergonomics for Improved Productivity. Design Science and Innovation. Springer, Singapore. https://doi.org/10.1007/978-981-15-9054-2_107
2. Banerjee, N., Chatterjee, S., Chaterjee, S., Bhattacherjee, S., De, S., Mukherjee, S. (2021b). Relation Between Occupational Sitting Duration and Central Obesity? A Study in Bengalee Female Human Resources Engaged in Sedentary Occupation. In: Muzammil, M., Khan, A.A., Hasan, F. (eds) Ergonomics for Improved Productivity. Design Science and Innovation. Springer, Singapore. https://doi.org/10.1007/978-981-15-9054-2_106
3. Banerjee, N., Chatterjee, S., Chatterjee, A. and Mukherjee, S. (2015a). Body fat estimation by anthropometric and impedance techniques in Bengalee females engaged in sedentary work. In Ergonomics for Rural Development. (1st ed pp. 448-455). Department of Human Physiology with Community Health, Vidyasagar University, Midnapore, West Bengal
4. Banerjee, N., Chatterjee, S., Chatterjee, S., Bhattacharjee, S., Bhattacharya, B. and Mukherjee, S. (2018). Indian Classical dancing and cardiovascular health status: a study in Bengalee female adults. Science & Culture (ISSN 0036 8156). 84, 339-343.
5. Banerjee, N., Chatterjee, S., Chatterjee, S., De, S. and Mukherjee, S. (2014). Relationship between two body adiposity estimating methods: a study in Bengalee female adolescents being trained in Bharatnatyam dance. International Physiology. 2 (2), 41-49.
6. Banerjee, N., Chatterjee, S., Chatterjee, S., Ghosh, K. and Mukherjee, S. (2017). Impact of Indian Classical Bharatnatyam dancing in terms of novel anthropometric markers of cardio-vascular health status: a study in Bengalee adult females. International Journal of General Medicine and Pharmacy. 6, 7-16.
7. Banerjee, N., Santra, T., Bardhan, S., De, S., Mukherjee, S. (2022). Impact of Practicing Bharatnatyam Dancing on Obesity Status in Terms of Adiposity Indices in Human Resources Engaged in White Collar Jobs: A Study in Bengalee Females. In: Chakrabarti, D., Karmakar, S., Salve, U.R. (eds) Ergonomics for Design and Innovation. HWWE 2021. Lecture Notes in Networks and Systems, vol 391. Springer, Cham. https://doi.org/10.1007/978-3-030-94277-9_130

8. Banerjee, N., Santra, T., Chatterjee, S. and Mukherjee, S. (2015b). Prevalence of overweight in rural sedentary human resources in southern part of West Bengal, India. In Ergonomics for Rural Development. (1st ed. pp 89-94). Department of Human Physiology with Community Health, Vidyasagar University, Midnapore, West Bengal.
9. Bardhan, S., Mondal, S. and Mukherjee, S. (2024). Dietary intake and risk of Diabetes: A Study in Bengalee young adult females. Brazilian Journal of Development (ISSN: 2525-8761). 10 (6). DOI:10.34117/bjdv10n6-030
10. Bhattacharjee, S., Santra, T., Chatterjee, S., Biswas, P., Banerjee, N., Mukherjee, S. (2021). A Study on Flexibility and Fitness Status of Adult Bengalee Males Undergoing Training in Football. In: Muzammil, M., Khan, A.A., Hasan, F. (eds) Ergonomics for Improved Productivity. Design Science and Innovation. Springer, Singapore. https://doi.org/10.1007/978-981-15-9054-2_102.
11. Chatterjee, S., Banerjee, N., Chatterjee, S. and Mukherjee, S. (2015a). Effect of kathak dancing on body composition in adult Bengalee occupationally engaged women of Kolkata. In Ergonomics for Rural Development. (1st ed. pp 461 – 467). Department of Human Physiology with Community Health, Vidyasagar University, Midnapore, West Bengal.
12. Chatterjee, S., Banerjee, N., Chatterjee, S., Chatterjee, A., Chakraborty, B,. Banerjee, D. and Mukherjee, S. (2015b). Indian Classical dancing: an approach for obesity management. International Physiology (ISSN: 2347-1505). 3, 23 – 28.
13. Galicia-Garcia, U., Benito-Vicente, A., Jebari, S., Larrea-Sebal, A., Siddiqi, H., Uribe K. B., Ostolaza, H., and Martín, C. (2020). Pathophysiology of Type 2 Diabetes Mellitus. International Journal of Molecular Science. 21 (17), 6725.
14. Hartwig, S., Kluttig, A. and Tiller, D. (2016). Anthropometric markers and their association with incident type 2 diabetes mellitus: which marker is best for prediction? Pooled analysis of four German population-based cohort studies and comparison with a nationwide cohort study. BMJ Open. 6 (e009266). doi: 10.1136/bmjopen-2015-009266
15. Human energy requirements. Scientific background papers from the Joint FAO/WHO/UNU Expert Consultation. October 17–24, 2001. Rome, Italy. Public Health Nutrition. 2005; 8:929–1228.
16. International Institute for Population Sciences (IIPS) and ICF. 2021. National Family Health Survey (NFHS-5), India, 2019-21: Mizoram. Mumbai: IIPS
17. Joshi, B. P., Mahajan, S. M. and Tayade, D. N. (2023). Physical activity and its correlation with various measures of obesity among medical students and young faculty. Clinical Epidemiology and Global Health.
18. Khan, Z. N., Assir, M. Z., Shafiq, M., Chaudhary, A. E. and Jabeen, A. (2016). High prevalence of preobesity and obesity among medical students of Lahore and its relation with dietary habits and physical activity. Indian Journal of Endocrinology and Metabolism. 20, 206-10.
19. Kumar, G., Dash, P., Patnaik, J. and Pany, G. (2022). Socioeconomic status scale-modified Kuppuswamy scale for the year 2022. International Journal of Community Dentistry. 10(1), 1-6.
20. Lee, P. H., Macfarlane, D. J., Lam, T. H. and Stewart, S. M. (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. International Journal of Behavioral Nutrition and Physical Activity. 8(1), 115. https://doi.org/ 10.1186/1479-5868-8-115 PMID: 22018588
21. Lee, O., Lee, D-c., Lee, S. and Kim, Y. S. (2016). Associations between Physical Activity and Obesity Defined by Waist-To-Height Ratio and Body Mass Index in the Korean Population. PLoS ONE. 11(7), e0158245. doi: 10.1371/journal.pone.0158245

22. Liu, Z., Zhou, C., Wang, H. and He, Y. (2022). Blood pressure monitoring techniques in the natural state of multi-scenes: A review. Frontiers in Medicine (Lausanne). 26 (9), 851172.
23. Mogre, V., Nyaba, R., Aleyira, S. and Sam, N. B. (2015). Demographic, dietary and physical ctivity predictors of general and abdominal obesity among university students: a cross-sectional study. Springerplus. 4, 226.
24. Niestrój-Jaworska, M., Polechoński, J. and Nawrocka A. (2023). Subjective and objective assessment of recommended physical activity in female healthcare professionals. Applied Science. 13 *(15), 8569. https://doi.org/10.3390/app13158569*
25. Popkin, B. M. and Adair, L.S. (2012). Global nutrition transition and the pandemic of obesity in developing countries. Nutrition Reviews. 70, 3-21.
26. Rush, E., Plank, L. and Chandu, V. (2004). Body size, body composition, and fat distribution: a comparison of young New Zealand men of European, Pacific Island, and Asian Indian ethnicities. New Zealand Medical Journal. 117(1207), U1203.
27. Santra, T., Banerjee, N., Chatterjee, S,. Chatterjee, S., Chatterjee, A., Bhattacharjee, S., Bardhan, S. and Mukherjee, S. (2022). Facilitating occupational health using mathematical models: a study on pulmonary functional status of female human resources engaged in bidi-making. Science and Culture. 88 (3–4), 123-128. DOI: https://doi.org/10.36094/sc.v88.2022.
28. World Health Organization. Diet and physical activity: a public health priority; 2014. Available from: https://www.who.int/dietphysicalactivity/background/en/. Accessed August10, 2023.
29. Yousif, M. M., Kaddam, L. A. and Humeda, H. S. (2019). Correlation between physical activity, eating behavior and obesity among Sudanese medical students Sudan. BMC Nutrition. 5, 6. doi: 10.1186/s40795-019-0271-1.