Physical activity patterns and its influence on risk factors for metabolic syndrome among an urban working population

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Abstract

Background: Physical activity is a fundamental means of improving the physical and mental health of individuals, its beneficial effect on the metabolic risk factors such as obesity, weight, lipid profile, blood glucose, and blood pressure has been well established. There is a change in pattern of physical activity in India, which has nearly made 50%-80% of Indians physically inactive, predisposing them to obesity and metabolic risk factors, which increases the risk of NCDs and its consequences.

Objective: To study the pattern of physical activity, estimating the prevalence of metabolic syndrome and risk factors and to assess the effect of physical activity on metabolic syndrome and its risk factors.

Materials and Methods: It was a cross-sectional study among 320 secondary school teachers of Mysore City. A self-administered, pretested, and structured questionnaire based on the WHO Steps Approach for noncommunicable disease risk factors and physical activity was evaluated using GPAQ questionnaire.

Result: The prevalence of metabolic syndrome was 38.3% and physical inactivity was 67.7%. Those who were physically less active had three times risk of developing MS (OR = 3.25). The proportion of physical inactivity was inversely proportional to the risk factors for metabolic syndrome such as body mass index, obesity, hypertension, and low high-density lipoprotein cholesterol.

Conclusion: The high levels of metabolic risk factors in the urban population, working population, and younger age group especially the modifiable risk factors (obesity and physical inactivity), which are preventable and hence if targeted (regular, moderate physical activity) will be a very cost-effective way of improving and maintaining the health and help in having healthy workforce. The work places interventions can be an effective intervention.

KEY WORDS: Physical activity, risk factors, metabolic syndrome, NCDs, sedentary

Introduction

Health is an important determinant of development and a precursor to economic growth. There has been a paradigm shift in the balance of the major causes of mortality and morbidity as a result of epidemiological and demographic shift in the developed countries and is being followed by the developing countries wherein, non communicable diseases (NCDs) are becoming the major cause of disease burden. The burden of NCDs is expected to reach nearly 66% by 2020 from 40% in 1990.[1] The above transformation is a result of changes in diet and lifestyle, which has in turn increased the prevalence of risks factors of NCDs.[2,3]

Physical activity is a fundamental means of improving the physical and mental health of individuals. The beneficial effect of lifestyle modification (diet and physical activity) on the metabolic risk factors such as obesity, weight, lipid profile, blood glucose, and blood pressure has been established.[4,5] Therefore, physical activity is any activity leading to calorie

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consumption, it can be accumulated throughout the day in blocks as short as 10 min. Work-related activity should be encouraged wherever possible.[6]

Thus, physical activity is one of the important factor in lifestyle modification and has significant impact on the health profile.[7] Higher levels of physical activity not only improves the cardiorespiratory fitness but also helps in reducing insulin resistance (increases the glucose uptake and insulin action on skeletal muscle), hypertension (systolic blood pressure [SBP] by 3.8 mm Hg and diastolic blood pressure [DBP] by 2.6 mm Hg), and improves dyslipidemia (increases high-density lipoprotein cholesterol [HDL-C], reduces TGs, and has a variable effect on low-density lipoprotein cholesterol), which has a protective effect against development of metabolic risk factors, which may or may not be associated with weight loss.[8,9] Exercise also reduces postprandial triglyceride exacerbation, which provides antiatherogenic protection.[10] Physical activity even without improvement in aerobic fitness is protective of the metabolic syndrome and its complications.[11]

Globally in 2010, 23% of the adults were insufficiently active (men 20% and women 27%). Overall, older adults were less active than younger adults and 19% of the youngest age group did not meet the recommended level of physical activity, compared with 55% of the oldest age group, and young women were slightly less active than middle-aged women.[12] A comparative study showed that South Asians are physically less active when compared with Caucasians, which along with higher genetic predisposition and thrifty genes are more likely to increase the risk of obesity, T2DM, and CVD.[3,8,13] The study conducted in India reveals that nearly 50%–80% of the Indians are physically inactive, more so the female subjects and those in urban areas, and most of the activity was done at the workplace.[13,14]

The change in the pattern of physical activity has been due to the changes seen in occupations, technology, urban pace of life (passive commuting modes and mechanized household chores), along with the shift of leisure time activities from outdoor play to indoor entertainment (television, computer games), which has resulted in more sedentary work and less energy expenditure.[2] Most studies have related reduced physical inactivity with increased risk of metabolic syndrome and its components more so in men.[15–19]

Though the relationship between physical activity and metabolic risk factors is well-known, there are very few studies to support this in Indian settings (urbanization and more women entering the workforce) and with the background of genetic predisposition, increasing awareness about prevention we wanted to know the role of the same.

This study was conducted with the objective of (1) studying the pattern of physical activity among a working urban population, (2) estimating the prevalence of metabolic syndrome and risk factors among working urban population of Mysore, and (3) assessing the effect of physical activity on metabolic syndrome and its risk factors.

Materials and Methods

A cross-sectional study was carried out among 300 secondary school teachers from 213 secondary schools of Mysore City; those who were aged 20 years and above, with at least 1 year of teaching experience, and who gave consent to participate in the study were included. Sample size was estimated based on CURES 2006 Chennai study that reported a prevalence of 25.8% metabolic syndrome according to the International Diabetic Federation criteria.[20] Relative allowable error of 20% was considered and the sample was estimated to be 288, adding 10% of nonresponse, the final sample was 320. Of which 300 subjects were considered for analysis as their pro formas were complete.

Multistage sampling technique was adopted where, in first step all the secondary schools in Mysore City were stratified into government, private-aided, and private-unaided schools, and from each of these strata, teachers were selected by probability proportionate to size technique.

A self-administered, pretested, and structured questionnaire based on the WHO Steps Approach for NCD evaluation was used to assess the sociodemographic profile, disease profile, level of physical activity, and habits (smoking, alcohol, and diet). The blood pressure and anthropometric measurements including weight, height, and waist measurements were obtained using standard techniques.[21] The estimation of blood glucose was done by using GOD/PAP method, HDL-C by direct immunodilution method, and the triglyceride by GPO-PAP method using RX DYTONA and RX series autoanalyzer.

The physical activity during leisure time was considered, that is, the type, duration, and frequency of physical exercise they are involved in to keep themselves fit. The physical activity was quantified by using the GPAQ score for moderate and intense activity.[22] The physical activity was worked out for MET-minute/week = sum of the total MET minutes of activity computed for each setting.

Intense physical activity (MET) = No. of days × no. of minutes × 8
Moderate physical activity (MET) = No. of days × no. of minutes ×4
Sedentary activity (in minutes) = No. of days × no. of minutes

The level of physical activity is classified as follows:

High:
1. 1500 MET-minute/week of intense activity
2. 3000 MET-minute/week of walking, moderate activity

Moderate:
1. ≥600 MET-minutes/week (3 days of vigorous activity, 5 days of moderate activity)

Low:
1. <600 MET-minutes/week

The institutional ethics committee clearance, permission of the regional Deputy Director of Public Instructions, principals, and the written informed consent of the teachers were obtained before starting the study.

Statistical Analysis

Data collected were entered in MS Excel 2010 and analyzed using SPSS version 22. Descriptive statistical measures such as mean, standard deviation for continuous variables, and number and percentage for categorical variables were used. Comparison between continuous variables was done using analysis of variance (ANOVA) test and for categorical variables chi-square test was used. The differences and associations were interpreted as statistically significant at $p < 0.05$.

Result

Sociodemographic and Metabolic Syndrome Risk Factors

In this study, among 300 secondary school teachers of Mysore City, 112 (37.3%) were men and 188 (62.7%) were women (M:F = 1:1.6) [Table 1]. The mean age of the subjects was 42.5 ± 10.1 years. Most of the teachers, 253 (84.3%) were married, 195 (65.0%) of them were staying in nuclear families. A total of 58 (19.3%) teachers belonged to government school, 97 (32.3%) belonged to private-aided schools, and 145 (48.3%) belonged to private-unaided schools. Among the 190 obese teachers, 115 (60.5%) of them had metabolic syndrome, 66 (22.0%) had diabetes, 143 (47.7%) were hypertensive, 105 (35.0%) had systolic hypertension, and 85 (28.3%) had diastolic hypertension on examination. A total of 123 (41.0%) teachers had hypertriglyceridemia ≥150 mg/dL of TG, 92 (30.7%) had low HDL-C (≤40 mg/dL in men and ≤50 mg/dL in women), and the overall prevalence of dyslipidemia was 139 (46.3%).

The presences of obesity (WC) with any two of the following factors (DM, hypertension, HTG, and low HDL-C) was considered to identify metabolic syndrome. Thus, 144 (48.0%) subjects had ≤ 2 risk factors and 115 (38.3%) had ≥3 risk factors.

Physical Activity

In this study, 142 (75.4%) and 61 (54.5%) teachers were sedentary, 44 (23.4%) and 33 (29.4%) teachers were indulging in moderate activity, and 2 (10.0%) and 18 (90.0%) were doing intense physical activity (female and male teachers, respectively). The male teachers have higher odds for doing some physical activity (moderate to intense activity) OR = 1.35 (95% CI: 1.10-1.65), which was statistically significant ($\chi^2 = 10.008$, $p = 0.002$) [Figure 1].

In this study, 74 (36.5%) of those who did not do any physical activity, 38 (49.4%) of those teachers who did moderate intensity physical activity, and only 3 (15.0%) of the teachers who did intense physical activity developed metabolic syndrome. The difference in prevalence between the various groups was statistically significant ($\chi^2 = 8.87$; $p < 0.012$) [Table 2].

The proportion of those having higher body mass index (BMI) (52.2%, 57.1%, and 35%), waist circumference (60.6%, 75.3%, and 45%), hypertension (50.7%, 42.9%, and 35%), and low HDL-C (35.5%, 23.4%, and 10%) was inversely proportional to the level of physical activity. The level of physical activity was different among the three categories and was statistically significant with age ($p = 0.005$), sex ($p = 0.001$), obesity ($p = 0.016$), especially in female teachers ($p = 0.01$), systolic hypertension ($p = 0.001$), diastolic hypertension ($p = 0.011$), triglycerides ($p = 0.019$), low HDL-C ($p = 0.017$), and metabolic syndrome ($p = 0.012$). The subjects belonging to middle-age group (31-50 years, i.e., 29.1% and 34.9%) and also 144 (75.5%) women were sedentary and did not indulge in any physical activity [Table 3].

On comparing the variables by the ANOVA test, age, waist circumference in female teachers, BMI, systolic blood pressure, weight, triglycerides, and low HDL-C in female teachers were statistically associated ($p \leq 0.01$) with the level of physical activity. The subjects not physically active tend to be younger compared with those who indulge in some form of activity [Table 4].

After adjusting for metabolic syndrome, physical activity was independently predicted by age ($p = 0.029$, $\beta = -0.029$), BMI ($p = 0.002$, $\beta = 0.039$), weight ($p = 0,052$, $\beta = -0.013$), and HDL-C ($p = 0.047$, $\beta = -0.005$).

Discussion

Among the 300 subjects, 203 (67.7%) were physically inactive and 115 (38.3%) had metabolic syndrome. Male teachers and older subjects were more physically active (45.5% vs. 25.5%) and had higher odds (OR = 1.35, 95% CI = 1.10–1.65) for doing physical activity compared with female teachers. The proportion of those having higher BMI, waist circumference, hypertension, and low HDL-C was inversely proportional to the level of physical activity. However, 74 (36.5%) of those who did not do any physical activity, 41(42.3%) of those teachers who did moderate to intensity physical activity developed metabolic syndrome. The odds for having metabolic syndrome because of physical inactivity was threefold higher (OR = 3.25, 95% CI = 2.61-3.89) and fivefolds for moderate activity (OR = 5.52, 95% CI = 4.83-6.21) when compared with those who did intense activity.

However, this study was similar to Prasad et al.[18] in the eastern India study where 43% versus 27% were sedentary among those having/not having metabolic syndrome, respectively.[18] Similarly, in the urban Ahmadabad, study population around 82% were physically inactive, male subjects were more active than female subjects (26.2% vs. 10.9%, $p < 0.000$) but, with presences of diabetes or hypertension, was associated with an higher proportion of those doing physical activity (32.8% and 21.4%, respectively).[14] The ICMR-INDIAB study also revealed that inactive subjects had higher BMI, WC, SBP, DBP,

Table 1: General characteristics of the study population: sociodemographic and metabolic syndrome risk factors ($N = 300$)

Characteristics	Description
Age (years)	42.5 ± 10.1 years
Sex	
Male	112 (37.3)
Female	188 (62.7)
Marital status	
Single	37 (12.3)
Married	253 (84.3)
Type of school	
Government	58 (19.3)
Private-aided	97 (32.3)
Private-unaided	145 (48.3)
Type of family	
Nuclear	195 (65)
Joint	75 (25)
Others	30 (10)
Waist circumference	85.9 ± 11.2 cm
Male	90.10 ± 9.17 cm
Female	83.49 ± 11.57 cm
BMI	25.7 ± 4.9 kg/m^2
Systolic blood pressure	123 ± 15.9 mm Hg
Diastolic blood pressure	80.1 ± 10.2 mm Hg
Fasting blood glucose level	93.1 ± 31.8 mg/dL
Triglycerides	149 ± 78.4 mg/dL
HDL-C	52.9 ± 12.9 mg/dL
Male	50.12 ± 10.77 mg/dL
Female	54.26 ± 14.2 mg/dL
Metabolic syndrome	115 (38.3)

BMI, body mass index; HDL-C, high-density lipoprotein cholesterol.
Figures in parenthesis are percentages.

total cholesterol, and TGs, and younger age groups were highly active. The study also showed that physical inactivity was more likely among female subjects (59.6% in rural and 71.2% in urban) and among the urban (65.0%) population across the country.[13] Similar to this study, the Japanese study on middle-aged population pattern of physical activity and metabolic syndrome shows that age, sedentary time, and low intensity physical activity were significantly associated with metabolic syndrome, especially in women.[17]

A study among law enforcement officers found that low and moderate levels of physical activity were associated with more than three- and twofold higher odds (OR = 3.13, 95% CI = 1.56-6.26 and OR = 2.30, 95% CI = 1.29-4.09, respectively) for having the metabolic syndrome than high levels of physical activity.[11] Another study comparing the general population and the police officers revealed that they were less physically active (3.2 ± 2.0 vs. 5.6 ± 3.1 h/day standing, 3.5 ± 2.3 vs. 3.9 ± 3.0 h/day sitting, and 2.1 ± 1.3 vs. 1.6 ± 2.4 walking) and were more prone to develop metabolic syndrome (57.3% vs. 28.2%; $\chi^2 = 64.5$, $p < 0.0001$) and its risk factors, respectively.[16] According to another study, sedentary behavior ≥1 h per day is associated with higher risk of metabolic syndrome (OR = 1.27, 95% CI = 10.03-1.51). A study that objectively measured the sedentary time also had an increased odds for metabolic syndrome (OR = 1.52, 95% CI = 1.04-2.21) and the duration was associated with all the risk factors for metabolic syndrome ($p < 0.001$).[19]

Thus, the association between physical activity and metabolic syndrome is consistent with the above studies showing similar findings. However, higher odds for moderate intensity physical activity in this study mostly reflects that there is awareness regarding the need for physical activity among teachers to prevent the risk factors for NCDs and hence have started to do some physical activity**.** However, the female teachers mainly gave domestic reasons and lack of leisure time after working hours because of household chores to take up some activity resulting in low level of physical activity.

Physical activity and its health benefits are well established and they are mostly noticeable in sedentary individuals who get introduced to regular physical activity into their lifestyle.[1,15] The pattern of physical inactivity and metabolic

Table 2: Distribution of study participants according to the level of physical activity and sedentary behavior with/without metabolic syndrome

Variable	With MS	Without MS	Total	*p*-Value
Physical activity				
Sedentary activity	74 (64.3)	129 (69.7)	203 (67.7)	$p = 0.012$
Moderate physical activity	38 (33.04)	39 (21.1)	77 (25.7)	
Intense physical activity	3 (2.6)	17 (9.2)	20 (6.7)	
Sedentary time				
≥1 hour	56 (48.7)	79 (42.7)	135 (45.0)	$x^2 = 1.12$
≤1 hour	59 (51.3)	106 (57.3)	165 (55.0)	0.571
Total	115 (38.3)	185 (61.7)	300 (100)	

MS.
Figures in parenthesis are percentages.

Table 3: Association between sociodemographic variables and metabolic syndrome risk factors with level of physical activity

Variable	Sedentary *n* = 203	Moderate *n* = 77	Intense *n* = 20	Total	*p*-Value
Age (years)					
21–30	39 (19.2)	24 (31.2)	8 (40.0)	71 (23.7)	**0.005**
31–40	59 (29.1)	31 (40.3)	5 (25.0)	95 (31.7)	
41–50	71 (34.9)	18 (23.4)	3 (15.0)	92 (30.7)	
>50	34 (16.7)	4 (5.2)	4 (20.0)	42 (14.0)	
Sex					
Male	61 (30.0)	33 (42.9)	18 (90.0)	112 (37.3)	**0.001**
Female	142 (70.0)	44 (57.1)	2 (10.0)	188 (62.7)	
Waist circumference					
Obesity	123 (60.6)	58 (75.3)	9 (45.0)	190 (63.3)	**0.016**
Normal	80 (39.4)	19 (24.7)	11 (55.0)	110 (36.7)	
Male					
>90 cm	33 (54.1)	20 (60.6)	8 (44.4)	61 (54.5)	0.571
Normal	28 (45.9)	13 (39.4)	10 (55.6)	51 (45.5)	
Female					
Normal	90 (63.4)	38 (86.4)	1 (50.0)	129 (68.6)	**0.01**
>80 cm	52 (36.6)	6 (13.6)	1 (50.0)	59 (31.4)	
BMI					
Obese	106 (52.2)	44 (57.1)	7 (35)	157 (52.3)	0.173
Overweight	35 (17.2)	18 (23.4)	5 (25)	58 (19.3)	
Normal	62 (30.5)	15 (19.5)	8 (40)	85 (28.3)	
SBP					
≥130 mm Hg	60 (29.6)	37 (48.1)	8 (40.0)	105 (35.0)	**0.001**
Normal	143 (70.4)	40 (51.9)	12 (60.0)	195 (65.0)	
DBP					
≥85 mm Hg	48 (23.6)	32 (41.6)	5 (25.0)	85 (28.4)	**0.011**
Normal	155 (76.4)	45 (58.4)	15 (75.00)	215 (71.6)	
HTN					
Increased	103 (50.7)	33 (42.9)	7 (35)	143 (47.7)	0.251
Normal	100 (49.3)	44 (57.1)	13 (65)	157 (52.3)	
DM					
Diabetes	41 (20.2)1	20 (26)	5 (25)	66 (22)	**0**.549
Normal	62 (79.8)	57 (74)	15 (75)	234 (78)	
TG					
>150 mg/dL	73 (36.0)	42 (54.5)	8 (40.0)	123 (41.0)	**0.019**
Normal	130 (64.0)	35 (45.5)	12 (60.0)	177 (59.0)	
HDL-C					
Reduced	72 (35.5)	18 (23.4)5	2 (10.0)	92 (30.7)	**0.017**
Normal	131 (64.5)	9 (76.6)	18 (90.0)	208 (69.3)	
Metabolic syndrome					
Present	74 (36.5)	38 (49.4)	39 (85.0)	115 (38.3)	**0.012**
Absent	129 (63.5)	39 (50.6)	17 (15.0)	185 (61.7)	

BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HTN, ; DM, ; TG, ; HDL-C, high-density lipoprotein cholesterol.

Table 4: Comparing the mean values among levels of physical activity using ANOVA test

Variable	Sedentary (203)	Moderate activity (77)	Intense activity (20)	Total	*p*-Value
Age (years)	40.87 ± 10.06	46.27 ± 8.34	45.15 ± 12.1	42.54 ± 10.06	0.0001
Waist	84.34 ± 11.48	89.99 ± 9.7	86.70 ± 9.5	85.9 ± 11.2	0.001
Male	89.49 ± 8.33	92.42 ± 10.7	87.89 ± 8.42	90.1 ± 9.17	0.180
Female	82.2 ± 11.9	88.16 ± 8.68	76.0 ± 16.97	83.5 ± 11.6	0.006
BMI	25.5 ± 4.98	26.77 ± 4.67	24.04 ± 3.42	25.72 ± 4.85	0.039
SBP	121.93 ± 15.58	126.74 ± 16.14	127.45 ± 16.15	123.5 ± 15.95	0.04
DBP	79.25 ± 10.42	82.13 ± 9.94	81.45 ± 7.68	80.13 ± 10.19	0.089
Weight	64.9 ± 12.9	70.40 ± 11.9	67.22 ± 9.84	66.54 ± 12.7	0.005
TG	141.12 ± 79.2	170.4 ± 82.12	147.15 ± 42.3	149.04 ± 78.9	0.021
HDL-C					
Total	51.9 ± 12.4	54.4 ± 15.7	54.5 ± 11.8	52.7 ± 13.3	0.312
Male	49.6 ± 11.27	49.4 ± 9.77	53.11 ± 10.8	50.12 ± 10.7	0.439
Female	52.89 ± 12.8	58.2 ± 18.15	65.0 ± 19.8	54.3 ± 14.42	0.057

ANOVA, analysis of variance; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; TG, ; HDL-C, .

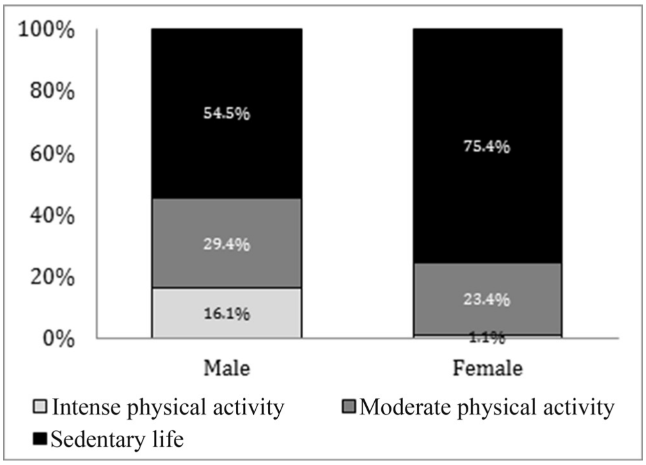

Figure 1: Distribution of study participants according to physical activity.

syndrome is very high in India and the younger age group and female subjects are less active. A study also suggests that most of the physical activity is done in workplaces. Therefore, utilizing workplace for health promotion and disease prevention can be an appropriate strategy to improve the levels of physical activity especially for women. Regular, moderate physical activity is a very cost-effective way of improving and maintaining health, and work places interventions will help in having healthy workforce.

Conclusion

The study evaluated the risk factors for NCD using all the three steps (risk factor and biophysical profile). The data on physical activity are based on self-reporting, which can introduce potential bias while underestimating or overestimating the energy expenditure. The study on physical activity would be better if assessed with the objective measurement using accelerometer. Because of financial constraints, they were difficult to afford in our study settings. There is a need to have an accurate assessment of physical activity as its reporting can be biased and misclassified.

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