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FRUIT- VEGETABLES INTAKE AND PHYSICAL ACTIVITY ON THE RISK OF METABOLIC SYNDROME AMONG OBESE ADULTS IN URBAN, PUDUCHERRY.

Nursing

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ABSTRACT

Background In most countries, metabolic syndrome (MetS) affects roughly one-fifth of the adult population, and its incidence is constantly growing. MetS risk factors have been identified as inadequate physical activity (PA) and inadequate fruit and vegetable (FV) intake. Due to a lack of research, the consequences of their association with MetS are unknown. The goal of this study was to investigate the independent and combined effects of FV and PA on MetS. **Methods** A baseline study of weight reduction randomized controlled trial carried out using random sampling among obese individuals in urban Puducherry, using WHO STEPS (version 3.2) questionnaire and fasting blood samples obtained from October 2022 to February 2023. MetS was defined using WHO criteria. The required sample size, according to Li tong X et al., is 306, however the current study has 438 participants. To investigate the interactive effect of PA and FV on the MetS, an interaction test was performed using STATA 14. **Results** MetS was found in 31.28% of subjects, with men and females having rates of 28.48% and 39.13%, respectively. In compared to their counterparts, those with adequate FV intake had a considerably decreased risk of MetS (OR = 0.6, 95% CI: 0.32, 0.9), whereas those with adequate PA had an insignificantly lower risk of MetS (OR = 0.75, 95% CI: 0.5, 1.2). In the interaction test, interaction between PA and FV was a significant predictor of MetS (unadjusted model P = 0.0297, adjusted model p = 0.001). **Conclusion** Findings of the current study shows that the combination of adequate FV intake and adequate PA was significantly associated with reduced MetS risk among adult residents of Puducherry. Therefore comprehensive intervention should be individualized based to each client with MetS.

KEYWORDS

Effect; Fruit-vegetables Intake; Physical Activity; MetS

INTRODUCTION

The metabolic syndrome (MetS) is the presence of various well-known cardiovascular risk factors, including insulin resistance, obesity, atherogenic dyslipidemia, and hypertension. These health conditions are related and have common underlying mediators, processes, and pathways.[1] In most developing countries, there are rural-urban differences in obesity, MetS, and type 2 diabetes.[2] Metabolic syndrome is frequent in an urban Indian population.[3] Despite differences in methodology, diagnostic criteria, and screening age, the Asia-Pacific region is witnessing a significant MetS pandemic.

MetS affected almost one-fifth of the adult population or more in most countries, with a steady increase in prevalence. Primary prevention methods are critical for preventing the pandemic's spread and reducing the morbidity and mortality associated with MetS.[4] The MetS in type 2 diabetes is linked to urban residency, senior age, physical inactivity, salt intake, inadequate fruit and vegetable consumption, palm oil, and meat consumption.[5]

Inactivity, poor nutrition, lack of sleep, and excessive alcohol intake are all risk factors for MetS . Due to nutritional absorption difficulties, pregnant women and shift workers with misaligned circadian clocks are also at greater risk. MetS risk increases with age, environment, family history, and genetics. Obesity, polycystic ovarian syndrome (PCOS), immune system problems, sleep problems, and certain medications can all increase the risk. Obesity and being overweight can raise LDL cholesterol, blood triglycerides, and blood pressure, whereas PCOS increases ovarian cysts and blood sugar levels. Immune system problems, skin diseases, and various cancer treatments can all increase the risk. Sleep problems, lack of sleep, and certain medicines can all increase the risk. Women are more prone than men to develop MetS as a result of hormonal changes during menopause.[6]

Physical exercise protects against MetS and all of its aberrant components, while increasing sitting time and sleep length are linked to an increased risk of MetS components such central obesity and elevated triglycerides, glucose, and diastolic blood pressure.[7]

A cohort of black and white men and women aged 18-30 years at baseline, the projected weight gain over a 10-year period associated with change in PA was four to five times greater in participants who were overweight at baseline compared to those who were not overweight at baseline. In this urban south Indian population, physical inactivity is associated to MetS and coronary artery diseases components. Lifestyle changes based on greater physical activity may help to avert India's developing MS and CAD epidemics.[8]

Poor vegetable consumption in men and women, as well as poor overall FV consumption in women, are associated with ≥ MetS risk factors. In addition, overall fruit and vegetable consumption was found to be adversely connected to abdominal obesity in women. More research is needed to determine whether a greater risk of low high density lipoprotein (HDL) is connected with increased FV or fruit intake in guys. The data indicate that FV intake had a protective effect in MetS risk factors in this group.[9]

High fruit consumption was linked with a decreased risk of incident MetS and its components in middle-aged and older people, whereas high vegetable consumption was associated with a lower risk of incident hyperglycemia but not MetS.[10] Existing evidence indicates that consuming vegetables and/or fruits is linked to MetS. Well-designed prospective cohort studies are needed to further investigate the issues at hand.[11] Fruit and vegetable consumption may be inversely related to MetS risk. It suggests that people consume more fruits and vegetables to lower their risk of MetS.[12]

Low fruit and vegetable diet, high meat consumption, and inadequate physical activity are all linked to MetS risk factors.[13] The high-risk urban population should be the focus of cardiovascular prevention.[3] MetS affects more than 40% of the population, and its incidence in the 40-year-old age group is rapidly increasing. It is critical to boost physical exercise before potentially fatal cardiovascular issues emerge.[14] Due to a lack of research, the consequences of their association with MetS are unknown. The goal of this study was to investigate the independent and combined effects of FV and PA on MetS.

MATERIALS AND METHODS

Participants and Sample Size

According to Li tong X et al., considering the prevalence of the disease 28.9%, Odds ratio for physical activity as 0.69, multiple correlation coefficient 0.4 at 5% one sided significance level and 80% power. The needed sample size, computed using nMaster was 306, whereas the current study had 438 people.

This was a baseline data of randomized controlled trial that investigated the effectiveness of a nurse-led intervention on weight loss among individuals with obesity in Puducherry's urban areas. After getting approval from the Institute Ethics Committee, JIPMER (JIP/CON/IEC/2021, dated 20.10.2021), the primary trial, which generated the data, was registered with the Clinical Trials Registry India (CTRI/2021/12/038785). The Health Research Wing was approved by the Puducherry government (No. 08/2021/ HRW/DHFWS, dated 23.09.2021).[(15)]

We employ primary research data (both intervention and control groups) in our analysis to investigate an independent and combined connection of fruit-vegetable diet and physical activity with MetS in obese individuals. Adults with a BMI of 25 or above, aged 18 to 50, and living in Puducherry's urban area were included in this study.

Metabolic Syndrome

The World Health Organisation (WHO) defines metabolic syndrome as people who have insulin resistance or its surrogates (impaired fasting glucose, impaired glucose tolerance, and type 2 diabetes) as a prerequisite in addition to two components. (SBP≥140 mm Hg or DBP ≥90 mm Hg and/or antihypertensive medication, Fasting TG ≥150 mg/dL (1.7 mmol/L) and/or HDL, BMI ≥30 and/or waist-to-hip ratio >0.9 (men) or >0.85 (women), Urinary albumin excretion rate ≥20 mg/min or albumin-to-creatinine ratio >30 mg/g).[(16)]

Measurements

From October 2022 to February 2023, information was collected using the WHO STEPS (version 3.2) questionnaire after consent was obtained. A face-to-face interview with the WHO STEPS survey questionnaire and blood collection were conducted. Height, weight, waist circumference (WC), and blood pressure (BP) measurements were taken in accordance with WHO STEPS guidelines. An overnight fasting blood sample for total cholesterol, thyroid, and fasting blood glucose profiles examination.[15]

Statistical analysis

The chi-square test was used to analyse participants' demographic, behavioral, and anthropometric features as they related to MetS . The independent t test was used to examine the differences between MetS components and fruit and vegetable consumption and physical activity. After controlling for age, gender, employment, and education, binary logistic regression was used to predict independent correlations between MetS , fruit and vegetable intake, and physical activity.

To investigate the individual effect of PA and FV on the MetS, a logistic regression was performed. To examine the combined effect the patients were divided into four groups depending on their level of PA and FV consumption and investigated the combined effects of PA and FV intake. After controlling for age, gender, occupation, and education, multivariable logistic regression was performed to investigate the relationship between PA, FV, and MetS. STATA 14 Version 14 was used for statistical analysis.

RESULTS

Demographic, Behavioral, and Anthropometric Parameters of the Study Population Based on Metabolic Syndrome

Overall, the average age of participants was 40.3 with the standard deviation of 7.9 years, with 59% falling between the ages of 40 and 50. Approximately 86% of those respondents were married. The majority (73.74%) were females, and nearly 88% were Hindus. Graduates made up 28.54% of the population, while professionals made up 10.27% and skilled workers made up 21.23 percent. Almost half (56.62%) had a household income of Rs. 25,000 or less. MetS was found in 31.28% of subjects, with men and females having rates of 28.48% and 39.13%, respectively. Around 80.37% had inadequate fruit-vegetable consumption, whereas only 11.43% used a combination of sunflower, palm, gingelly, and peanut oil. 21.26% of participants self-reported having 4-8 sitting hours each day. 68.95% of people were physically inactive. 96.58% of people had central obesity. (Table 1)

Comparison of Metabolic Syndrome Components with Fruit-Vegetable Intake and Physical Activity

The frequency of MetS and distribution of its components according to PA and FV intake was shown in Table 2. When compared to individuals with inadequate FV intake, those with adequate FV intake had considerably lower fasting blood glucose, triglycerides, and diastolic blood pressure, as well as a reduced prevalence of MetS. Despite the fact that appropriate PA resulted in considerably reduced SBP, no other statistically significant difference was discovered between the two PA groups.

Effect of Fruit- Vegetable Intake and Physical Activity on Metabolic Syndrome

After adjusting to age, sex, occupation, education, physical activity the odds of developing MetS is 0.39 times less in those taking five or more serving fruit vegetable intake (OR = 0.61, 95% CI: 0.34, 1.08), compared to those who do not and it is statistically highly significant. After adjusting to age, sex, occupation, education, fruit vegetable intake the odds of developing MetS is 0.22 times less in in those were physical active (OR=0.78, 95%CI: 0.48, 1.2) and its statistically highly significant. (Table 3)

The findings of the combined effects of PA and FV on MetS are shown in Table 4. After adjusting to age, sex, occupation, education, among those with inadequate fruit and adequate physical activity the odds of developing MetS is 0.3 times less in those were physical active (OR = 0.7, 95% CI: 0.4, 1.1), but the difference was not statistically significant. After adjusting to age, sex, occupation, education, among those with adequate fruit intake and adequate physical activity the odds of developing MetS is 0.2 times less in those were physical active (OR= 0.8, 95 % CI: 0.3,1.9), but the difference was not statistically significant. (un adjusted model P = 0.0297, adjusted model p = 0.001).

DISCUSSION

We examined the independent and combined effects of appropriate PA and adequate FV consumption on the risk of MetS in this population-based investigation. We discovered that having enough FV and PA was strongly related with a decreased risk of MetS. Furthermore, the combination of appropriate FV consumption and inadequate PA was linked to the lowest risk of MetS. Adequate physical activity for females was related with a lower risk of MetS (unadjusted OR =0.7, p=0.0028), and it lowers the risk of MetS with both gender (p<0.001) which was consistent with other prior research. For example, for both genders, increased MET-hours/week of total PA was related with a lower MS risk (ORs = 0.77 for men and 0.86 for women, both p =0.001). [17]A cross-sectional research of Mexican-Americans discovered that adequate physical activity was related with a lower risk of MetS [18] Other studies are largely intervention studies in which researchers assigned intense, ongoing activities. [19] PA in our study included occupational, transportation, domestic duties, and leisure activity, demonstrating that the advantages of PA may be obtained from a variety of settings in one's everyday life and not only from scheduled exercise. Previous research found that the weekly volume (i.e. cumulative duration per week) of PA sessions, rather than the frequency, was highly linked with MetS risk. [20]

Previous research has found that FV consumption has a positive effect on MetS and its components. In a 6-year prospective trial, persons who followed the Mediterranean diet, which included enough FV consumption, had a decreased incidence of MetS. [21] In our study, adequate FV consumption was associated with a lower risk of mets as compared to inadequate FV intake. It has also been discovered that appropriate FV consumption is connected with decreased blood pressure. [22] However, a cohort research found a negative relationship between FV intake, diastolic blood pressure, and the occurrence of MetS. Shin JY discovered that FV consumption was exclusively related with a decrease in diastolic blood pressure (DBP) in a meta-analysis of eight RCTs, with no significant impact reported for other MetS components. [23] These inconsistencies may be explained by the variation in FV consumption among trials. Green leafy vegetable consumption, rather than all vegetable consumption, has been linked to a lower risk of MetS. [24]Although there were significant differences in decreasing fasting blood glucose, lipids, and diastolic blood pressure, as well as a decreased prevalence of MetS among those who consumed enough FV in our trial, FV paired with appropriate PA also had favorable benefits.

These findings suggest that persons with appropriate FV consumption and enough PA may be less likely to develop MetS than those with inadequate PA and inadequate FV intake. More research is needed to determine the precise processes by which FV and PA lower the risk of metabolic disorders. One probable explanation is that FV has a lower calorie content and a greater fibre content, which can assist to reduce the overall energy content of daily food consumption. [25] The antioxidant content of FV, which contributes to the fight against free radicals and the lowering of systemic oxidative stress, may also explain the lowered risk of MetS components with increased FV intake [26]. FV's lower glycemic index may help to explain the reported effect of enough FV on glucose. [27] PA's benefits might be explained by its positive effects on body composition, which include increased skeletal muscle insulin sensitivity and decreased insulin resistance. [28] As a result, adequate FV and PA consumption can have a favourable impact in metabolic health.

Limitations

There are some limitations to the current investigation. First, the survey's cross-sectional design precludes causal analysis, instead focusing on the discovery of relationships between FV consumption, PA, and MetS. Second, data on FV consumption were gathered solely from those with a BMI of 25 using WHO STEPS, which may be impacted by memory bias and may potentially be erroneous self-reported estimates given the difficulties in determining precise serving size of FV intake. Third, using WHO STEPS questionnaires to evaluate enough PA is not as reliable as using accelerometers. However, because to the pragmatic nature of the survey and the limited resources available, accelerometers were not frequently used in the research region, instead self-reported METs were employed. Finally, the current study's conclusions must account for variances in ethnic, cultural, and lifestyle factors, since there may be disparities between individuals in the current study and other groups.

CONCLUSION

This study discovered that a combination of appropriate FV and adequate PA was related with decreased MetS risk, resulting in changes in specific MetS components. However, because FVs are effective in disease prevention, the combination of high FV and PA may promote metabolic health at the same time. To lessen the burden of MetS, multi-level treatments targeting both components are required.

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Conflicts of Interest: There is no conflict of interest in this study

Key messages:

Metabolic syndrome (MetS) is a risk factor for cardiovascular and metabolic diseases. MetS is negatively connected to fruit and vegetable consumption and physical exercise. The consumption of a sufficient amount of fruits and vegetables and staying physically active lowers the risk of metabolic syndrome.

Table 1 Demographic, behavioral and anthropometric, characteristics of study population according to metabolic syndrome N=438

Variables	Non-Metabolic Syndrome N=301 (68.72 %)	Metabolic Syndrome N=137 (31.28%)	Total N= 438 (100%)
Sex			
Male	70 (23.26)	45 (32.85)	115 (26.26)
Female	231 (76.74)	92 (67.15)	323 (73.74)
Age in years			
18-28 years	35 (11.63)	4 (2.92)	39 (8.9)
29-39 years	107 (35.55)	33 (24.09)	140 (31.96)
40-50 years	159 (52.82)	100 (72.99)	259 (59.13)
Marital Status			
Never married	29 (9.63)	2 (1.46)	31 (7.08)
Married	267 (88.7)	124 (90.51)	391 (89.27)
Widowed/Divorced/Separated	5 (1.66)	11 (8.03)	16 (3.65)
Religion			
Hindu	266 (88.67)	119 (86.86)	385 (88.1)
Christian	25 (8.33)	14 (10.22)	39 (8.92)
.Muslim	9 (3)	4 (2.92)	13 (2.97)
Educational status			
Primary	126 (41.86)	77 (56.20)	203 (46.35)
Secondary	77 (25.58)	33 (24.09)	110 (25.11)
Graduate	98 (32.56)	27 (19.17)	125 (28.54)
Occupation			
Housewives	142 (47.18)	61 (44.53)	203 (46.35)
Semi-skilled workers	58 (19.27)	39 (28.47)	97 (22.15)
Skilled workers	62 (20.6)	31 (22.63)	93 (21.23)
Professionals	39 (12.96)	6 (4.38)	45 (10.27)
Family Income (Rupees/ month)			
≤25000	170 (56.48)	78 (56.93)	248 (56.62)
25001/50000	97 (32.23)	41 (29.93)	138 (31.51)
≥50001	34 (11.3)	18 (13.14)	52 (11.87)
Type of diet			
Vegetarian	47 (15.61)	17 (12.41)	64 (14.61)
Non vegetarian	254 (84.39)	120 (87.59)	374 (85.39)
Frequency of consuming Non vegetarian food (days/week)			
0 days	48 (15.95)	16 (11.68)	64 (14.61)
2 days	167 (55.48)	83 (60.58)	250 (57.08)
3 days	86 (28.57)	38 (27.74)	124 (28.31)
Fruit - vegetable intake			
<5 servings/day	234 (77.7)	118 (86.13)	352 (80.37)
≥ 5 servings/day	67 (22.26)	19 (13.87)	86 (19.63)
Amount of salt to consume/day			
>6 grams per day	49 (16.28)	23 (16.79)	72 (16.44)
≥ 6 grams per day	252 (83.72)	114 (83.21)	366 (83.56)
Type of oil			
Sunflower oil	247 (82.06)	108 (78.83)	355 (81.05)
Mixed of sunflower, palm, gingelly, groundnut oil	54 (17.94)	29 (21.17)	83 (18.95)
Risk of disease due to sitting (sedentary behavior timing)			
(Low risk) <4 hrs. /day	237 (78.74)	102 (74.45)	339 (77.40)
(High risk) 4-8 hrs. /day	64 (21.26)	35 (25.55)	99 (22.6)
Physical activity			
Inactive (< 600 METS/week)	202 (67.11)	100 (72.99)	302 (68.95)
Active (≥ 600 METS/week)	99 (32.89)	37 (27.01)	136 (31.05)
Body Mass Index (kg/m2)			
25-29.9	31 (10.30)	2 (1.46)	33 (7.53)
30- 34.9	139 (46.18)	463 (5.99)	202 (46.12)
35-39.9	106 (35.22)	54 (39.42)	160 (36.53)
≥40	25 (8.31)	18 (13.14)	43 (9.82)
Abdominal obesity			
No	12 (3.99)	3 (2.19)	15 (3.42)
Yes	289 (96.01)	134 (97.81)	423 (96.58)

Table 2 Comparison of metabolic syndrome components with fruit-vegetable intake and physical activity

Mets components	Inadequate fruit-vegetable intake (352)	Adequate fruit-vegetable intake (86)	P value	Inadequate physical activity (302)	Adequate physical activity (136)	P value
	Mean± SD (95% CI)	Mean± SD (95% CI)		Mean± SD (95% CI)	Mean± SD (95% CI)	
M (N %)	99 (28.13)	16 (18.6)		82 (27.15)	33 (24.26)	
F (N %)	253 (71.88)	70 (81.4)		220 (72.9)	103 (75.74)	
Metabolic syndrome (N %)	118 (33.57)	19 (22.09)	0.040	100 (33.11)	37 (27.21)	0.217

Fasting blood glucose (mg/dl) (FBG)	118.7±62.1 (112.2, 125.3)	103.4±47.9 (93.1, 113.7)	0.0137	115.08 ±58.4 (108.5,121.7)	117±63.2 (106.4,127.8)	0.7486
Triglycerides (mg/dl) (TRIG)	132±61.15 (125.9, 138.4)	107.9±48.9 (97.5±118.5)	0.0002	130.1±60.8 (123.3, 137.02)	120.9±56.8 (111.3, 130.6)	0.1252
HDL cholesterol (mg/dl)	43.8±9.4(42.8,44.7)	43.5±9.1 (41.5, 45.4)	0.7832	43.8±9.6(42.7,44.9)	43.4 ±8.9(41.9,44.9)	0.6843
Waist circumference (WC) (cms)	99.5±9.2 (98.5,100.5)	99.6±7.9(97.9,101.3)	0.8890	99.7±9.1 (98.7,100.8)	99.1±8.5 (97.6,100.5)	0.4626
Systolic Blood Pressure (SBP)	131.3±16.9 (129.6, 133.1)	129±15.7 (125.6,132.4)	0.2259	132.4±16.5 (130.5,134.3)	127.5±16.6 (124.7,130.3)	0.0044
Diastolic Blood Pressure (DBP)	88.5±12.3 (87.2, 89.8)	85.7±11.5 (83.1, 88.1)	0.0449	88.3±11.9 (86.9,89.6)	87.2±12.9 (85, 89.4)	0.3948
Body Mass Index (kg/m2)	36.7±18.3 (34.8,38.6)	37.9±23.1 (32.9, 42.8)	0.6589	35.8±3.6 (34.2,37.8)	39.6± 28.1 (34.8, 44.3)	0.1358

Note- Inadequate Physical activity- < 600 METS/week, Adequate Physical activity- ≥ 600 METS/week, Inadequate fruit &vegetable intake- < 5 servings/day, Adequate fruit &vegetable intake- ≥ 5 servings/day (N %)- Frequency and percentage

Table 3. Logistic regression: Independent effect of fruit- vegetable intake and physical activity on metabolic syndrome among adults with obesity

Variables	Unadjusted OR (95% CI) P value	Adjusted OR (95% CI) P value				
	Female	Male	Both gender	Female	Male	Both gender
Inadequate fruit-vegetable intake	Base					
Adequate fruit-vegetable intake	0.7 (0.4,1.3) P=0.2310	0.31 (0.83,1.16) P=0.0599	0.6 (0.32,0.9) p=0.0356	0.7 (0.4,1.4) P=0.0028	0.4(0.08, 1.4) P=0.2581	0.61 (0.34, 1.08) P=0.0001
Inadequate physical activity	Base					
Adequate physical activity	0.84 (0.5,1.4) P=0.5345	0.6 (0.24, 1.4) P=0.2136	0.75 (0.5, 1.2) P=0.214	0.9 (0.51, 1.6) P=0.0028	0.55 (0.21, 1.41) P=0.2581	0.78 (0.48,1.2) P=0.0001

Note- After adjusting to age, sex, occupation, education, physical activity the odds of developing metabolic syndrome is 0.39 times less in those taking 5 or more serving fruit- vegetable intake compared to those who do not and it is statistically significant. After adjusting to age, sex, occupation, education, fruit- vegetable intake the odds of developing metabolic syndrome is 0.22 times less in in those were physical active and its statistically significant. Inadequate Physical activity- < 600 METS/week, Adequate Physical activity- ≥ 600 METS/week, Inadequate fruit -vegetable intake- < 5 servings/day, Adequate fruit -vegetable intake- ≥ 5 servings/day OR- odds ratio

Table 4 Logistic regression: Combined effect of fruit- vegetable intake and physical activity on metabolic syndrome among adults with obesity

Variables	N (%)	Unadjusted OR (95% CI) P value	Adjusted OR (95% CI) P value
Inadequate fruit-vegetable intake with Inadequate physical activity group- I	247 (56.39)	Base	
Inadequate fruit-vegetable intake with Adequate physical activity group-II	105 (36.53)	0.6 (0.4, 1.05) P=0.077	0.7 (0.4, 1.1) P= 0.085
Adequate fruit-vegetable intake with Inadequate physical activity group-III	55 (12.56)	0.4 (0.2,0.8) P=0.011	0.4 (0.2,0.9) P= 0.019
Adequate fruit-vegetable intake with Adequate physical activity group-I V	31 (7.08)	0.7 (0.3, 1.6) P= 0.419	0.8 (0.3, 1.9) P=0.60

Inadequate Physical activity- < 600 METS/week, Adequate Physical activity- ≥ 600 METS/week, Inadequate fruit -vegetable intake- < 5 servings/day, Adequate fruit -vegetable intake- ≥ 5 servings/day (N %)- Frequency and percentage OR- odds ratio After adjusting to age, sex, occupation, education, among those with inadequate fruit intake and inadequate physical activity the odds of developing metabolic syndrome is 0.3 times less in those with inadequate fruit intake and adequate physical activity but the difference is not statistically significant After adjusting to age, sex, occupation, education, among those with inadequate fruit intake and inadequate physical activity the odds of developing metabolic syndrome is 0.2 times less in those adequate fruit intake and adequate physical activity but the difference is not statistically significant.

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