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Research Article

# Dietary Habits as a Risk Factor for Metabolic Syndrome Among Adult Urban and Rural Females of Amritsar (Punjab)

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## Abstract

Dietary habits and practices predisposes individuals to obesity and increased metabolic disease risk. Therefore, this study was aimed to assess the of Metabolic Syndrome among adult urban and rural females of Amritsar (Punjab) on the basis of their dietary habits. The present cross-sectional data was collected from adult upper middle class females residing in various urban and rural areas of Amritsar district. The study group included 1520 females ranging in age (25 - 60 years), out of which, 800 females were urban and 720 women were rural. In context to dietary pattern, data was collected using relevant questions to determine eating habits of women who participated in the study. For data analysis, chi square test and multivariate logistic regression analysis were applied. Odds Ratio (OR) and Relative Risk (RR) with 95% confidence interval were also done. Skipping of breakfast, less intake of fruits and salads, higher consumption of junk and fried food, intake of sugar-rich eatable post-meal, drinking soft drinks frequently and ≤2 times daily meal frequency are significant dietary risk factors for emergence of metabolic syndrome which is quite prevalent in women of Amritsar.

**Keywords:** Dietary Habits; Food Consumption; Cholesterol; Hemoglobin

## Introduction

Dietary habits are the manner in which persons respond to societal and traditional food options, select, consume and make use of available food items. Several epidemiologic and clinical data suggests that eating local meal patterns appear beneficial to metabolic profiles on a global level. Worldwide, it is the provocative concern of the era that the disquieting drift of fast food consumption escalated cardio-metabolic abnormalities among individuals with highest preponderance of obesity which is a key component of metabolic syndrome. As per the definition of fast food quoted in encyclopaedias, it is mainly described as quickly and easily prepared processed food rich in fat and calories served in public places as the most frequently consumed meal [4]. Eating out of home especially fast food consumption is a main risk factor for poor diet quality, sugar as well as fat saturated high calorie ingestion on daily basis predisposing consumers to unhealthy lifestyle. Out-of-home meals and fast foods are rich in highly processed and refined carbohydrate, sodium, total fat, unsaturated trans-fatty acids, cholesterol and reduced dietary fibres [47]. A thirteen-year follow-up of adults joined CARDIA study carried out by Duffey., *et al.* [17] manifested that subjects indulged in consumption of fast foods more than two times had hypertriglyceridemia, reduced levels of good cholesterol, increased bad cholesterol, elevated fasting blood glucose and increased blood pressure which are components of constellation of metabolic syndrome.

Similar adverse health outcomes were encouraged by few studies [24] that indulging in the habit of eating fast food equal to and more than three times per week was associated with 20-129% elevated risk of general and abdominal obesity. It is worth mentioning that rather than the consumption of fast foods, the rate of ease of access to fast food choices has been stated as a risk factor for cardiovascular disease. The foremost element unfolding the obesity-induced properties of fast foods is enormously fat and sugar saturated feature. A peculiarity regarding the nature of fast foods have an tremendously high energy compactness approximately 158 to 163 kcal per 100 gram of food. Moreover, it also has been estimated that a fast food meal typically has an energy density twice the recommended healthy diet. Recurrent ingestion of fast foods as well as out-of-home meals is a lethal dietary risk factor for development of metabolic abnormalities including obesity, insulin resistance, T2DM as well as cardiovascular disorders. The

dairy consumption leads to significant reduction in the eruption of T2DM and associated with favourable changes of cardio-metabolic features. A recent meta-analysis of nine prospective studies and 12 cross-sectional studies quoted that dairy consumption is inversely associated with both incidence and prevalence of cluster of metabolic aberrations known as metabolic syndrome [27]. Only In the Korean population, a bit of evidence reported that increased dairy product ingestion may be defensive against metabolic syndrome [26,30]. In contrast, some studies have suggested positive or null associations between the intake of dairy products and metabolic syndrome [46].

Consumption of soft drinks may play prominent role in weight gain because of the low fullness of liquid calories. Intake of such drinks is not fully compensated by reductions in energy intake in successive meals was set forth by experimental studies and resulting in higher energy intake and positive energy balance. Accumulating evidences make a point that higher consumption of soft drinks enhances the emergence of T2DM and metabolic syndrome. It could be due to composition of soft drinks that contain enormous amounts of simple sugars which can tendency to trigger higher glycemic and insulinemic responses in the body of an individual. In Nutshell, dominance of trans fatty acids and preponderance of sugar content in terms of high glycemic load are the characteristics of fast foods and soft drinks, respectively that portraits unhealthy and life-threatening composition of fried and fast food meals which become responsible for emergence of chronic diseases like dyslipidemia, insulin resistance, hypertension and obesity leading to metabolic syndrome and CVDs [47].

## Materials and Methods

The present cross-sectional data was collected from adult upper middle class females residing in various urban and rural areas of Amritsar district. The study group included 1520 females ranging in age (25 - 60 years), out of which, 800 females were urban and 720 women were rural. An effective sample size was estimated through statistical power analysis by conducting a pilot study. Ethical clearance from the Institutional Ethics Committee of Guru Nanak Dev University, Amritsar was obtained prior to carry out the study. After fully explaining the nature, procedure, aims and objectives of the study to all the females in Punjabi language, verbal as well as written informed consent was obtained. The participation of women was voluntary. First of all, women were taken into confidence and then contacted for the study according to their convenience and prior appointment. The anonymity and confidentiality of participants information was guaranteed. Interview method was considered to be more appropriate for collecting personal information about lifestyle habits dealing with dietary pattern from each subject by investigator herself after ensuring confidentiality of the information.

Dietary habits of females with metabolic syndrome and without metabolic syndrome have been studied under the following headings:

- Dietary pattern (Vegetarian/Non-vegetarian)
- Daily meal frequency (≤3 times/≥4 times)
- Daily butter consumption (Homemade/Commercial)
- Skipping of breakfast (Yes/No)
- Fruit and salad intake (1 - 2 times per week/≥3 times per week)
- Intake of sugar-rich eatable post meal (1 - 2 times per week/≥ 3times per week)
- Milk at bedtime (Yes/No)
- Junk food consumption (1-2 times per week/≥ 3 times per week)
- Fried food intake (1 - 2 times per week/≥3 times per week)
- Soft drinks intake (1 - 2 times per week/≥3 times per week)
- Eating food in front of television (Daily/Rarely)

Statistical Analysis was done using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA version 21). The Chi square test was applied to compare differences between the proportions. A multivariate logistic regression analysis was performed for estimating Odds Ratio (OR) and Relative Risk (RR) with 95% confidence interval to examine the association between various selected dietary risk factors and MS among adult urban and rural women.

## Results

The dietary habits of the participants has been shown in table 1 and figure 1-11. Among urban females, 53.1% females were vegetarians. On the other hand, 46.9% females had non-vegetarian dietary pattern. In case of rural females, 79.7% females were observed as vegetarians whereas 20.3% were non-vegetarians. On the basis of daily meal frequency, 45.7% of urban females and 81.9% of rural females were engaged in having equal to or less than two meals per day whereas 54.3% of urban females and 18.1% of rural females had routine of consuming equal to or more than three meals per day. The urban females who preferred eating homemade butter were 32.6% while commercial butter was consumed by 67.4% females. Alarmingly, 91.7% of rural females were noticed to consume homemade butter. In contrast to this, only 8.3% females were indulged in consumption of commercial butter.

Majority (82.6%) of urban females had habit of skipping breakfast as compared to those (17.4%) who had their breakfast daily. In case of rural females, 71.5% females did not miss their breakfast

| Dietary habits | Adult females | |
|---|---|---|
| | Urban (800) | Rural (720) |
| Dietary Pattern | | |
| Vegetarian | 53.1 (41) | 79.7 (574) |
| Non - Vegetarian | 46.9 (375) | 20.3 (146) |
| Daily meal frequency | | |
| ≤2 times | 45.7 (366) | 81.9 (590) |
| ≥3 times | 54.3 (434) | 18.1 (130) |
| Daily butter consumption | | |
| Homemade | 32.6 (261) | 91.7 (660) |
| Commercial | 67.4 (539) | 8.3 (60) |
| Skipping breakfast | | |
| Yes | 82.6 (661) | 28.5 (205) |
| No | 17.4 (139) | 71.5 (515) |
| Fruit and Salad Intake | | |
| 1 - 2 times per week | 59.0 (472) | 78.2(563) |
| ≥3 times per week | 41.0 (328) | 21.8 (157) |
| Intake of sugar - rich eatable post meal | | |
| 1 - 2 times per week | 48.9 (391) | 68.2 (491) |
| ≥3 times per week | 51.1 (409) | 31.8 (229) |
| Milk at bedtime | | |
| Yes | 42.9 (343) | 82.2 (592) |
| No | 57.1 (457) | 17.8 (128) |
| Junk Food Consumption | | |
| 1 - 2 times per week | 32.2 (18) | 66.4 (478) |
| ≥3 times per week | 67.8 (542) | 33.6 (242) |
| Fried food consumption | | |
| 1 - 2 times per week | 26.0 (208) | 77.6 (559) |
| ≥3 times per week | 74.0 (592) | 22.4 (161) |
| Soft Drinks Intake | | |
| 1 - 2 times per week | 27.9 (223) | 67.0 (482) |
| ≥3 times per week | 72.1 (577) | 33.0 (238) |
| Eating food in front of television or using gadgets | | |
| Daily | 51.4 (411) | 35.6 (16) |
| Rarely | 48.6 (389) | 64.4 (464) |

**Table 1:** Distribution of urban and rural adult females according to their dietary habits.

Figures in parentheses indicate the number of subjects.

while 28.5% females usually skip their morning meal. The prevalence of females who had less than 3 times per week ingestion of fruit and salad was on higher side (urban: 59.0% rural: 78.2%) than their counterparts who eat fruit and salad equal to or more

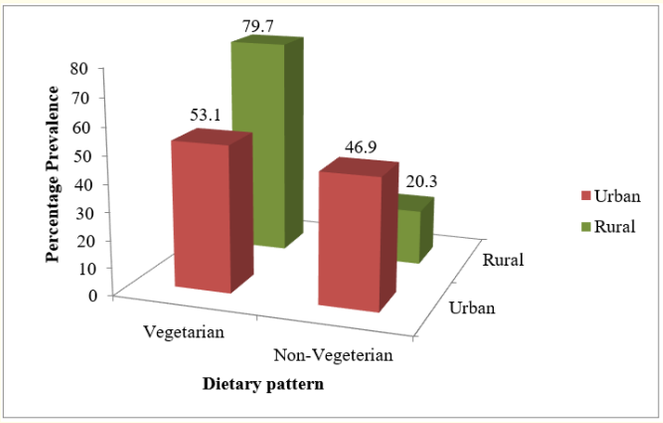


**Figure 1:** Histogram showing distribution of adult urban and rural females according to dietary pattern.

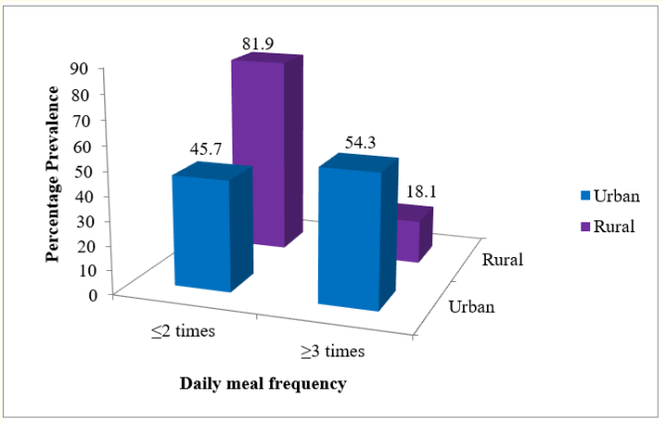


**Figure 2:** Histogram showing distribution of adult urban and rural females according to daily meal frequency.

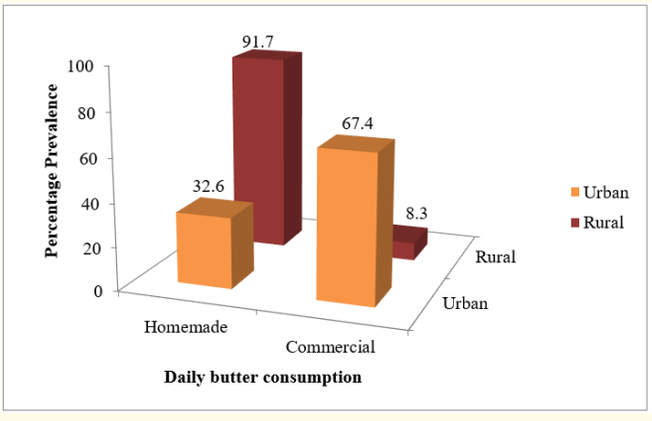


**Figure 3:** Histogram showing distribution of adult urban and rural adult females according to daily butter consumption.

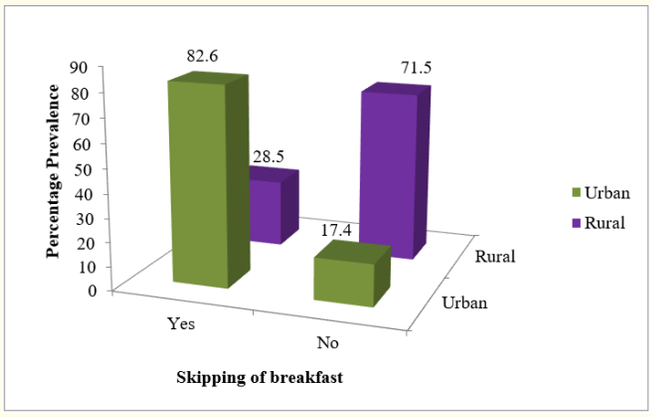


**Figure 4:** Histogram showing distribution of adult urban and rural females according to habit of skipping breakfast.

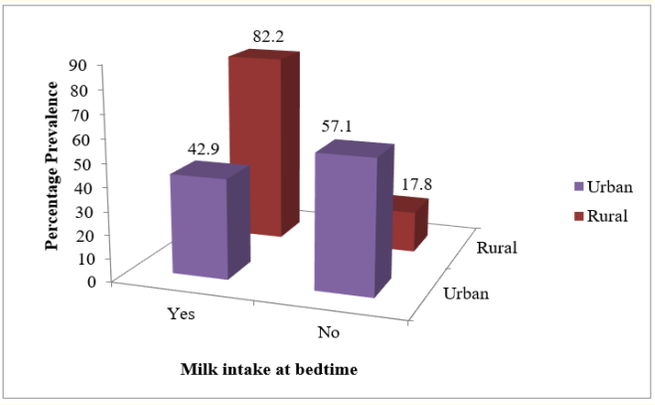


**Figure 7:** Histogram showing distribution of adult urban and rural females according to milk intake at bedtime.

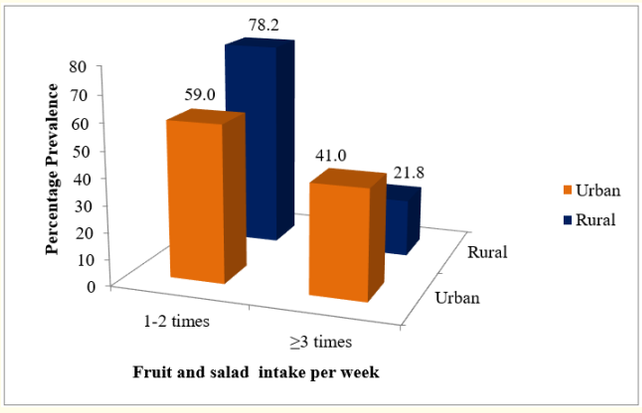


**Figure 5:** Histogram showing distribution of adult urban and rural females according to intake of fruits and salad.

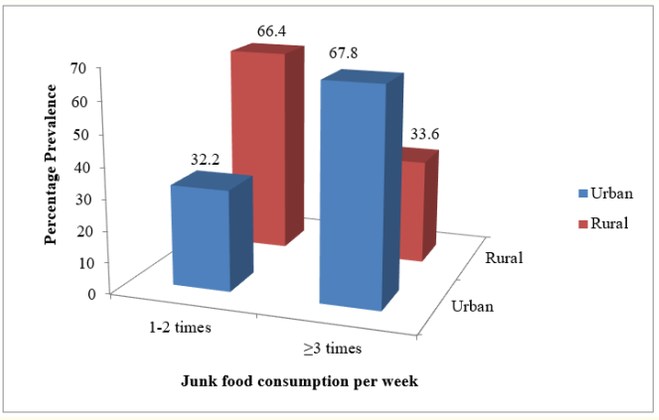


**Figure 8:** Histogram showing distribution of adult urban and rural females according to junk food consumption.

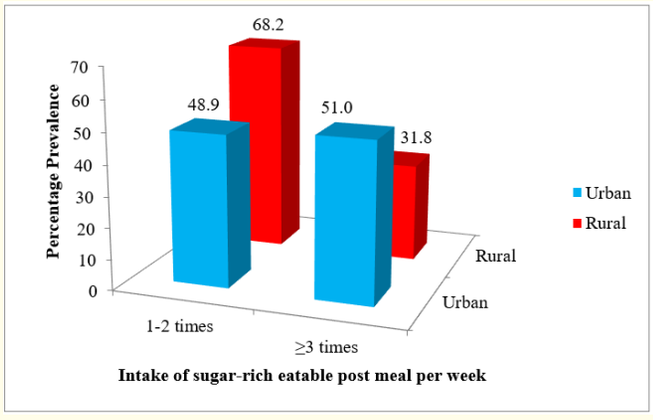


**Figure 6:** Histogram showing distribution of adult urban and rural females according to intake of sugar-rich eatable post meal.

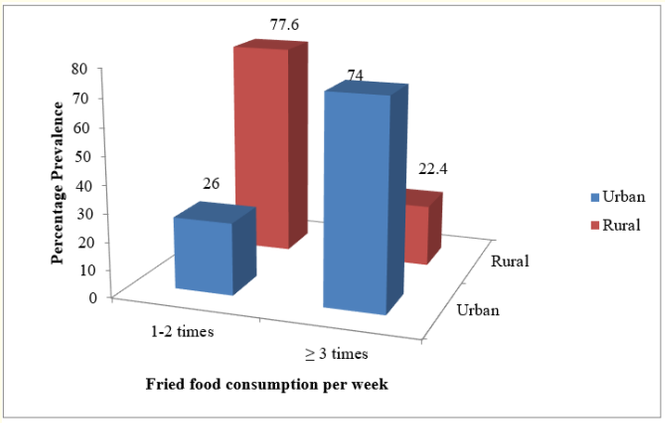


**Figure 9:** Histogram showing distribution of adult urban and rural females according to fried food consumption.

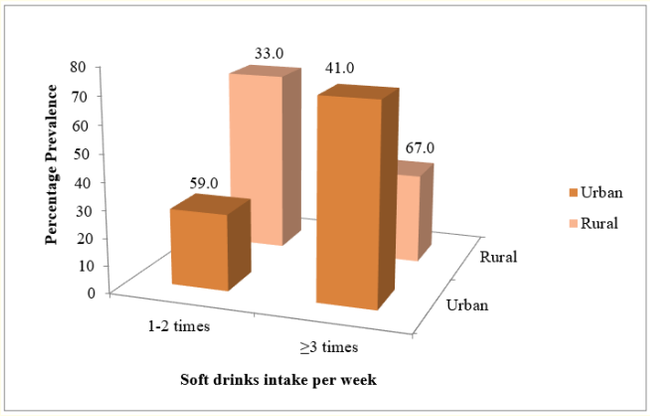


**Figure 10:** Histogram showing distribution of adult urban and rural females according to soft drinks intake.

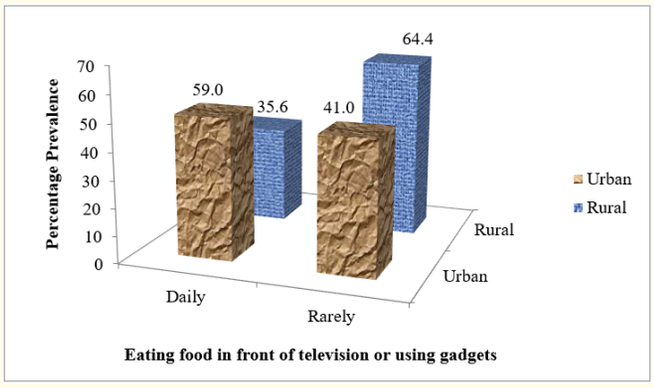


**Figure 11:** Histogram showing distribution of adult urban and rural females according to habit of eating food in front of television or using gadgets.

than three times per week (urban: 41.0% rural: 21.8%). The habit of intake of sugar-rich eatable post meal equal to or more than three times per week was depicted by 51.1% of urban females and 31.8% of rural females. Conversely, 48.9% of urban females and 68.2% of rural females manifested such habit less than three times per week. The prevalence of urban females who take milk at bedtime were 42.9%. On the other hand, 57.1% of urban females avoided intake of milk at night. In case of rural females, most of the females (82.2%) gulp down milk at bight before going to bed while 17.8% females did not take milk at bedtime.

The prevalence of urban females with respect to consumption of junk food, fried food and soft drinks equal to more than three times per week was 67.8%, 74.0% and 72.1%, respectively whereas the corresponding figures for rural females were 33.6%, 22.4% and 33.0%. Contradictory to this, ingestion of junk food, fried food and intake of soft drinks one or two times per week was shown by 32.2%, 26.0% and 27.9% of females belonging to urban areas. Additionally, the data also demonstrated that 66.4%, 77.6% and 67.0% of rural females were not indulged in ingestion of junk and fried food along with soft drinks very often i.e. one or two times per week. 51.4% of urban females and 35.6% of rural females eat their food while watching television or using gadgets every day. In contrast to this, the percentage prevalence of urban and rural females who did not prefer watching television or using gadgets during the consumption of their meal were 48.6% and 64.4%, respectively.

To study the relationship between metabolic syndrome and dietary habits, the results had been compared between adult females (with MS vs. without MS) as shown in table 2. Among urban females, 58.8% and 41.2% of females with and without MS were vegetarians, while 53.3% (with MS) and 46.7% (without MS) were non-vegetarians. The calculated chi-square value ($\chi^2$ = 2.4 df = 1, p ≥ 0.05), OR (1.2; 95% CI: 0.944-1.6548; p ≥ 0.05) and RR (1.1; 95% CI: 0.974-1.248; p ≥ 0.05) do not indicate significant relationship between two groups i.e. vegetarians and non-vegetarians with regards to presence or absence of MS. Among rural females, the alliance between dietary pattern and MS [with MS vs.. without MS – (veg: 45.3% vs.. 54.7%), (non-veg: 65.8% vs.. 34.2%)] was also found to be statistically non-significant ($\chi^2$ = 19.4, df = 1, p ≥ 0.05) which was further validated by 0.4 OR (95% CI: 0.295-0.630; df = 1; p ≥ 0.05) and 0.6 times RR (95% CI: 0.594-0.798; p ≥ 0.05).

The prevalence of MS was 57.7% more likely among urban females who favoured less than three meals per day than those (51.8%) who consumed equal to or more than three meals in a routine. The difference between two groups was statistically non-significant ($\chi^2$ = 2.7, df = 1, p ≥ 0.05) which was further explained by 1.1 OR (95% CI: 0.846-1.471; p ≥ 0.05) and 1.0 times RR (95% CI: 0.930-1.832; p ≥ 0.05). In case of rural females, the prevalence of metabolic syndrome who had daily meal frequency less than three times was on higher side (51.2%) than their counterparts (47.7%) who consume equal to or more than three meals per day. The calculated chi-square ($\chi^2$ = 0.5, df = 1, p ≥ 0.05) demonstrated that the relationship between metabolic syndrome and daily meal frequency did not reach level of significance. The urban females who preferred consumption of commercial butter had been more frequently diagnosed with MS (73.5%) than those who consumed homemade butter (72.8%) and the difference was statistically non-significant ($\chi^2$ = 0.04, df =, p ≥ 0.05). In addition to this, this non-significant relationship of MS with intake of butter was also affirmed by OR (1.0; 95% CI: 0.740-1.437; p ≥ 0.05) and RR (1.0; 95% CI: 0.921-1.104; p ≥ 0.05). In contrast to this, the rural females who preferred ingestion of homemade butter satisfied criterion of MS

| Dietary habits | Adult females | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | URBAN (800) | | | | | | | | RURAL (720) | | | | | | | |
| | With MS | Without MS | OR | 95% CI | p-value | RR | 95% CI | p-value | With MS | Without MS | OR | 95% CI | p-value | RR | 95% CI | p-value |
| Dietary pattern | | | | | | | | | | | | | | | | |
| Vegetarian | 58.8 (10) | 41.2 (175) | 1.2 | 0.944-1.654 | p ≥ 0.05 | 1.1 | 0.974-1.248 | p ≥ 0.05 | 45.3 (260) | 54.7 (314) | 0.4 | 0.295-0.630 | p ≥ 0.05 | 0.6 | 0.594-0.798 | p ≥ 0.05 |
| Non-vegetarian | 53.3 (200) | 46.7 (175) | | | | | | | 65.8 (96) | 34.2 (50) | | | | | | |
| Daily meal frequency | | | | | | | | | | | | | | | | |
| ≤2 times | 57.7 (211) | 42.3 (155) | 1.1 | 0.846-1.471 | p ≥ 0.05 | 1.0 | 0.930-1.832 | p ≥ 0.05 | 51.2 (302) | 48.8 (288) | 1.1 | 0.786-1.682 | p ≥ 0.05 | 1.0 | 0.881-1.306 | p ≥ 0.05 |
| ≥ 3 times | 51.8 (21) | 48.2 (209) | | | | | | | 47.7 (62) | 52.3 (68) | | | | | | |
| Daily butter consumption | | | | | | | | | | | | | | | | |
| Home-made | 72.8 (190) | 27.2 (71) | 1.0 | 0.740-1.437 | p ≥ 0.05 | 1.0 | 0.921-1.104 | p ≥ 0.05 | 63.0 (416) | 37.0 (244) | 1.2 | 0.711-2.083 | p ≥ 0.05 | 1.0 | 0.865-1.348 | p ≥ 0.05 |
| Commercial | 73.5 (396) | 26.5 (143) | | | | | | | 58.3 (35) | 41.7 (1) | | | | | | |
| Skipping of breakfast | | | | | | | | | | | | | | | | |
| Yes | 81.5 (539) | 18.5 (122) | 8.3 | 5.608-12.508 | <0.001 | 2.3 | 1.872-2.977 | <0.001 | 53.2 (109) | 46.8 (96) | 3.1 | 2.260-4.446 | <0.001 | 1.9 | 1.626-2.385 | <0.001 |
| No | 34.5 (48) | 65.5 (91) | | | | | | | 27.0 (139) | 73.0 (376) | | | | | | |
| Fruit and salad intake | | | | | | | | | | | | | | | | |
| 1-2 times per week | 61.9 (292) | 38.1 (180) | 2.8 | 2.100-3.763 | <0.001 | 1.6 | 1.442-1.982 | <0.001 | 55.4 (312) | 44.6 (11) | 1.9 | 1.328-2.731 | <0.001 | 1.4 | 1.140-1.726 | <0.001 |
| ≥ 3 times per week | 36.6 (120) | 63.4 (208) | | | | | | | 39.5 (62) | 60.5 (95) | | | | | | |
| Intake of sugar-rich eatable post meal | | | | | | | | | | | | | | | | |
| 1-2 times per week | 65.2 (15) | 34.8 (136) | 0.6 | 0.471-0.867 | <0.01 | 0.8 | 0.797-0.958 | <0.01 | 58.8 (289) | 41.2 (202) | 0.3 | 0.233-0.494 | <0.05 | 0.7 | 0.661-0.803 | <0.05 |
| ≥ 3 times per week | 74.6 (305) | 1.4 (104) | | | | | | | 81.0 (185) | 19.0 (44) | | | | | | |
| Milk at bedtime | | | | | | | | | | | | | | | | |
| Yes | 43.7 (150) | 56.3 (193) | 1.3 | 1.014-1.796 | p ≥ 0.05 | 1.1 | 1.009-1.389 | p ≥ 0.05 | 49.3 (292) | 50.7 (300) | 0.6 | 0.422-0.921 | p ≥ 0.05 | 0.9 | 0.860-0.985 | p ≥ 0.05 |
| No | 36.5 (167) | 63.5 (290) | | | | | | | 61.0 (78) | 39.0 (50) | | | | | | |
| Junk food consumption | | | | | | | | | | | | | | | | |
| 1-2 times per week | 27.9 (72) | 72.1 (186) | 0.1 | 0.068-0.136 | <0.001 | 0.3 | 0.285-0.426 | <0.001 | 36.0 (172) | 64.0 (306) | 0.1 | 0.101-0.210 | <0.001 | 0.4 | 0.396-0.519 | <0.001 |
| ≥ 3 times per week | 80.0 (433) | 20.0 (108) | | | | | | | 79.3 (192) | 20.7 (50) | | | | | | |
| Fried food intake | | | | | | | | | | | | | | | | |
| 1-2 times per week | 74.8 (443) | 1.2 (149) | 0.8 | 1.230-1.579 | <0.001 | 0.9 | 1.041-1.875 | <0.001 | 63.9 (357) | 36.1 (202) | 1.2 | 1.847-1.904 | <0.001 | 1.1 | 1.279-1.955 | <0.001 |
| ≥ 3 times per week | 77.9 (162) | 22.1 (46) | | | | | | | 57.8 (93) | 42.2 (68) | | | | | | |
| Soft drinks intake | | | | | | | | | | | | | | | | |
| 1-2 times per week | 59.3 (342) | 40.7 (235) | 1.9 | 1.408-2.632 | <0.001 | 1.3 | 1.624-1.666 | <0.001 | 60.5 (144) | 39.5 (94) | 1.6 | 1.918-3.632 | <0.001 | 1.6 | 1.409-1.91 | <0.001 |
| ≥ 3 times per week | 43.0 (96) | 57.0 (127) | | | | | | | 36.7 (177) | 63.3 (305) | | | | | | |
| Eating food in front of television or using gadgets | | | | | | | | | | | | | | | | |
| Daily | 65.8 (16) | 34.2 (133) | 3.3 | 2.505-4.476 | <0.001 | 1.8 | 1.557-2.087 | <0.001 | 75.4 (193) | 24.6 (63) | 2.2 | 1.582-3.116 | <0.001 | 1.3 | 1.171-1.443 | <0.001 |
| Rarely | 36.5 (150) | 63.5 (261) | | | | | | | 58.0 (269) | 42.0 (195) | | | | | | |

**Table 2:** Dietary habits of urban and rural adult females with metabolic syndrome and without metabolic syndrome. Figures in parentheses indicate the number of subjects.

(63.0%) more often than those who consumed commercial butter (58.3%) and the difference was statistically non-significant ($\chi^2$ = 0.5, df = 1, p ≥ 0.05).

81.5% of urban participants with metabolic syndrome were observed to skip their breakfast. On the other hand, 65.5% of urban females without metabolic syndrome were deprived of skipping their breakfast. The difference in the prevalence of metabolic syndrome between two groups was statistically significant ($\chi^2$ = 129.9, df = 1, p < 0.001) which is further validated by calculating OR (8.3; 95% CI: 5.608-12.508; p < 0.001) and RR (2.3; 95% CI: 1.872-2.977; p < 0.001). The rural females who skip breakfast had been more frequently diagnosed with MS (53.2%) than those who did not skip morning meal and the difference was statistically significant ($\chi$2 = 44.5, df = 1, p < 0.0001). The calculated results were further approved by OR and RR analysis which revealed that females indulged in skipping breakfast regularly had daunting odds of progression of MS i.e. 3.1 folds (95% CI: 2.260-4.446, p < 0.001) with 1.9 times RR (95% CI: 1.626-2.385, p < 0.001).

The prevalence of MS was more pronounced (61.9%) among urban females who had one or two times per week ingestion of fruit and salad than their counterparts (36.6%) accompanied by equal to more than three times per week intake of fruit and salad. The difference between two groups was statistically significant ($\chi^2$ = 49.5,df = 1, p < 0.001).Additionally, the alliance of fruit and salad intake with MS was also demonstrated by OR (2.8, 95% CI: 2.100-3.763, p < 0.001) and RR (1.6, 95% CI: 1.442-1.982, p < 0.001). Moreover, rural females illustrated higher prevalence of MS (55.4%) who used to consume fruit and salad less than three times per week. Contradictorily, lesser (39.5%) females identified with MS who ingested fruit and salad equal to or more than three times per week. The difference between two groups was statistically significant [($\chi^2$ = 12.4, df = 1, p < 0.0001), OR (1.9; 95% CI: 1.328-2.731; p < 0.001) and RR (1.4; 95% CI: 1.140-1.726, p < 0.001)].The calculated chi-square value ($\chi^2$ = 8.3, df =, p < 0.01), OR (0.6, 95% CI: 0.471-0.867, p < 0.01) and RR (0.8, 95% CI: 0.797-0.958, p < 0.01) revealed that the urban females were assessed to have higher prevalence of metabolic syndrome (74.6%) who were indulged in the intake of sugar-rich eatable post meal equal to or more than three times per week than those females (65.2%) who favoured post meal consumption of sugar rich product less than three times per week. Astoundingly, 81.0% of rural females with metabolic syndrome in the study group exhibited habit of eating sugar rich eatable after meal equal to or more than three times per week, whereas 19.0% females without metabolic syndrome were not indulged in post meal eating habit of sugar rich product equal to or more than three times per week. The difference in the prevalence of metabolic syndrome between two groups was statistically significant ($\chi^2$ = 4.2, df = 1, p < 0.05, OR (0.3, 95% CI: 0.233-0.494, p < 0.05) and RR (0.7, 95% CI: 0.661-0.803, p < 0.05).

In urban dwellers, the prevalence of females with metabolic syndrome and without metabolic syndrome with respect to their habit of consuming milk at bed time was 43.7% and 56.3%, respectively. The corresponding figures for rural females were 49.3% and 50.7%. The association of metabolic syndrome with intake of milk at night was non-significant. Furthermore, it was noticed among urban females that who preferred junk food consumption equal to or more than three times per week had been more frequently diagnosed with MS (80.0%) than those who did not indulge in junk food consumption very often (27.9%) and the difference was statistically significant ($\chi^2$ = 204.1, df = 1, p < 0.001). The calculated results were further approved by OR and RR analysis which revealed that females indulged in junk food consumption regularly had daunting odds of progression of MS i.e. 0.1 folds (95% CI: 0.068-1.362, p < 0.001) with 0.3 times RR (95% CI: 0.285-0.426, p < 0.001). The chances of falling in the category of MS was predicted to be significantly ($\chi^2$ = 120.8, df = 1, p < 0.001) elevated by 0.1 folds (95% CI: 0.101-0.210; p < 0.001) accompanied by 0.4 times RR (95% CI: 0.396-0.519; p < 0.001) among rural females who favoured ingestion of junk food on a regular basis (79.3%; ≥ 3 times per week) than their counterparts (36.0%; 1-2 times per week). 77.9% of urban females with metabolic syndrome and 74.8% of urban females without metabolic syndrome exhibited habit of ingesting fried food equal to or more than three times per week and one or two times per week, respectively. The difference in the prevalence of metabolic syndrome between two groups was statistically significant ($\chi^2$ = 12.7, df = 1, p < 0.001). Further, OR (0.8; 95% CI: 1.230-1.579; p < 0.001)and RR (0.9; 95% CI: 1.041-1.875; p < 0.001 ) were also calculated to approve this relationship between metabolic syndrome and fried food intake. In rural inhabitants, those females were encountered with the presence of metabolic syndrome (57.8%) who consumed fried food equal to or more than three times per week as compared to their non-metabolic syndrome counterparts (36.1%) who were deprived of intake of fried food equal to or more than three times per week. The calculated chi-square ($\chi^2$ = 1.9, df = 1, p < 0.001), OR (1.2, 95% CI: 1.847-1.904, p < 0.001) and RR (1.1, 95% CI: 1.279-1.955, p < 0.001) affirmed this relationship.

Apart from this, urban females tended to have higher prevalence of MS (59.3%) who had habit of drinking soft drinks frequently as compared to those who did not gulp down such drinks on a regular basis. The data suggests that drinking of soft drinks show significant association with the occurrence of MS among the studied females ($\chi^2$ = 17.0, df = 1, p < 0.0001, OR: 1.9, 95% CI: 1.408-2.632;

p < 0.001, RR: 1.3; 95% CI: 1.624-1.667, p < 0.001). In case of rural females, the prevalence of MS was (36.7%) among females who favoured to gulp down soft drinks frequently i.e. equal to more than three times per week whereas those who did not consume soft drinks equal to more than three times per week manifest metabolic syndrome (39.5%). The difference between two groups was statistically significant ($\chi^2$ = 36.4, df = 1, p < 0.0001). In addition to this, the relationship of MS with intake of soft drinks was also acknowledged by OR (1.6; 95% CI: 1.918-3.632; p < 0.001) and RR (1.6; 95% CI: 1.409-1.91; p < 0.001). Alarmingly, the prevalence of metabolic syndrome was significantly [(urban- $\chi^2$ = 68.7, df = 1, p < 0.001, OR: 3.3, 95% CI: 2.505-4.476; p < 0.001, RR: 1.8; 95% CI: 1.557-2.087, p < 0.001) (rural- $\chi^2$ = 21.7, df = 1, p < 0.0001, OR: 2.2, 95% CI: 1.582-3.116; p < 0.001, RR: 1.3; 95% CI: 1.171-4.443, p < 0.001) more among urban and rural females who had habit of eating while watching television or using gadgets on regular basis.

## Discussion and Conclusion

To study if any, selected dietary risk factors associated with MS, all the females studied in the present sample were categorized into two groups: i) with metabolic syndrome, ii) without metabolic syndrome based on the application of the most recent Joint Interim Statement [1] also known as Harmonized Asian-Specific Diagnostic Criterion. In the present study, among urban females, 53.1% females were vegetarians. On the other hand, 46.9% females had non-vegetarian dietary pattern. In case of rural females, 79.7% females were observed as vegetarians whereas 20.3% were non-vegetarians (Table 1). As per calculated chi-square, odds ratio and relative risk it was revealed that the relationship between two groups i.e. vegetarians and non-vegetarians with regards to presence or absence of MS among both urban and rural females were non-significant (Table 2). As per Kaur [25], vegetarian dietary habits play a protective role against metabolic syndrome which is not observed in the present study group. This could be attributed to the preponderance of females manifesting only vegetarian dietary as compared to non-vegetarian pattern included in the present study. The outcomes drawn by Shang., *et al.* [41] were in line with the results of current study in context to urban females by suggesting that vegan diets did not decrease the risk of metabolic syndrome compared with non-vegetarian diets. Conversely, Rizzo., *et al.* [39] explained reduction in the components of metabolic syndrome among subjects who believe in vegetarian dietary pattern than non-vegetarian eating trend. This observation was consistent with the observations laid down by rural females of Amritsar.

On the basis of daily meal frequency, 45.7% of urban females and 81.9% of rural females were engaged in having equal to or less than two meals per day whereas 54.3% of urban females and 18.1% of rural females had routine of consuming equal to or more than three meals per day (Table 1). The prevalence of metabolic syndrome was 57.7% more likely among urban females who favoured less than three meals per day than those (51.8%) who consumed equal to or more than three meals in a routine. The difference between two groups was statistically non-significant ($\chi^2$ = 2.7, df = 1, p ≥ 0.05) which was further explained by 1.1 OR (95% CI: 0.846-1.471; p ≥ 0.05) and 1.0 times RR (95% CI: 0.930-1.832; p ≥ 0.05). In case of rural females, the prevalence of metabolic syndrome who had daily meal frequency less than three times was on higher side (51.2%) than their counterparts ( 47.7%) who consume equal to or more than three meals per day. The calculated chi-square ($\chi^2$ = 0.5, df = 1, p ≥ 0.05) demonstrated that the relationship between metabolic syndrome and daily meal frequency did not reach level of significance (Table 2). Most of the females of current study had habit of consuming three meals per day indicating that though diet patterns in Punjab are rapidly changing however, eating three meals per day still is the typical major eating habits in Punjabi population.

Sierra-Johnson., *et al*. [44] encouraged daily meal frequency more than two times because it decreases occurrence of metabolic syndrome as compared to those who eat 1 or 2 meals/day. Similar observations were set forth by a study of Finnish adolescents [23]. Furthermore, Carlson., *et al.* [8] reported that intake of one meal per day during two months manifested elevated fasting plasma glucose and impaired glucose tolerance than their counterparts who consumed three meals per day. Contradictorily, reduced meal regularity results into beneficial health outcomes was suggested by Fontana., *et al*. [19].

The nationally representative data enrolled 12,389 adults (males: 5171; females: 7218 ) under Korean National Health and Nutrition Examination Survey (KNHANES) 2010–2012 and elucidated that lower meal frequency i.e. less than two times was associated with increased metabolic syndrome. There are more than a few possible details for the association between lower meal frequency and higher risk of metabolic syndrome. Indulgence in only one or two meals per day is more likely to make a person eat more calories at each meal. An abrupt increase in postprandial glucose level induces higher insulin response and sooner or later upshots in insulin resistance [6]. Furthermore, postprandial elevation in glucose and lipids add to oxidative stress and chronic inflammation predisposing a systematic link between these adverse conditions and components of metabolic [9,10].

An elevated eating attempts were significantly associated with reduced screening of cardio-metabolic components (waist circumference, fasting glucose, fasting insulin, triglycerides, total choles-

terol and LDL-cholesterol) n a national population-based sample of young Australian adults [45]. In agreement to this result, several cross-sectional studies also reported that a higher eating frequency is associated with leanness in adults [16,22,54]. Strikingly, no association between eating frequency and body composition in women was demonstrated by Summerbell., *et al.* [48] who reported that in a prospective observational study of 85 premenopausal women, the association between adiposity and eating frequency was no longer significant and obesity is the leading component of metabolic syndrome.

Most of the urban females preferred eating e commercial butter while majority of the rural females were noticed to consume homemade butter (Table 1). The urban females who preferred consumption of commercial butter had been more frequently diagnosed with MS (73.5%) than those who consumed homemade butter (72.8%) and the difference was statistically non-significant ($\chi^2 = 0.04$, df =, $p \geq 0.05$). In addition to this, this non-significant relationship of MS with intake of butter was also affirmed by OR (1.0; 95% CI: 0.740-1.437; $p \geq 0.05$) and RR (1.0; 95% CI: 0.921-1.104; $p \geq 0.05$). In contrast to this, the rural females who preferred ingestion of homemade butter satisfied criterion of MS (63.0%) more often than those who consumed commercial butter (58.3%) and the difference was statistically non-significant ($\chi^2 = 0.5$, df = 1, $p \geq 0.05$) as shown in Table 2. In disagreement to the current findings, prospective studies carried out among Chinese population suggested that dairy consumption leads to significant reduction in the eruption of T2DM and associated with favourable changes of cardio-metabolic features. A recent meta-analysis of nine prospective studies and 12 cross-sectional studies quoted that dairy consumption is inversely associated with both incidence and prevalence of cluster of metabolic aberrations known as metabolic syndrome [27].Only In the Korean population, a bit of evidence reported that increased dairy product ingestion may be defensive against metabolic syndrome [26,31]. In contrast, some studies have suggested positive or null associations between the intake of dairy products and metabolic syndrome [46].

Majority of urban females had habit of skipping breakfast everyday as compared to rural females who did not miss their morning meal regularly (Table 1). Irrespective of the region, the calculated values of odds ratio [urban (OR- 8.3; 95% CI: 5.608-12.508; $p < 0.001$) ; rural (OR- 3.1; 95% CI: 2.260-4.446, $p < 0.001$)] and relative risk [urban (RR-2.3; 95% CI: 1.872-2.977; $p < 0.001$); rural (RR-1.9; 95% CI: 1.626-2.385, $p < 0.001$)] revealed that females who did not consume breakfast every single day had been more frequently diagnosed with metabolic syndrome than those who took their breakfast daily (Table 2). It is extensively understood that breakfast skipping leads to obesity which plays integral role in the occurrence of metabolic syndrome [7]. As in the present study, one of the factors for developing metabolic syndrome by those who usually skip their breakfast could be obesity which comes into existence among breakfast skippers by making poorer and unhealthy food choices over rest of the day and eventually predisposing towards metabolic anomalies. This was confirmed by Ortega., et al. [34]. Previous studies [32,45] elaborated that among morning meal skippers on daily basis the tendency of satisfying metabolic syndrome guidelines got enhanced. Moreover, Deshmukh-Taskar., *et al.* [14] and Dhurandhar., *et al*. [15] reported that breakfast skippers most probably manifest unhealthy dietary habits. Additionally, avoiding breakfast could lead to overeating during day by having one big meal in the afternoon, evening and night. Conversely, breakfast eaters usually consume low fat and sugar drenched eatables rather larger amounts of fiber got ingested by them.

In concordance with current findings, Chung and colleagues [15] encountered higher risk of metabolic syndrome among breakfast skippers due to meagre day-to-day nutrient ingestion. In contrast, breakfast skipping was associated with a reduced risk of elevated serum triglyceride levels was studied among Korean adults [32]. Among participants aged between 21 to70 years, Zhang., *et al.* [55] examined the associations between missing breakfast and metabolic syndrome. Although many studies [11,30,40,42] have emphasized the importance of eating breakfast shown it is an important determinant of a healthy lifestyle In the current study, 82.6% of urban females and 28.5% of rural females showed habit of skipping breakfast which was much higher than the breakfast skippers observed in young American adults there were associated with low nutrient intakes [9].

The prevalence of females who had less than 3 times per week ingestion of fruit and salad was on higher side (urban: 59.0% rural: 78.2%) than their counterparts who eat fruit and salad equal to or more than three times per week (urban: 41.0% rural: 21.8%) according to Table 1. The prevalence of MS was more pronounced among urban [(OR:-2.8, 95% CI: 2.100-3.763, $p < 0.001$) and (RR -1.6, 95% CI: 1.442-1.982, $p < 0.001$)] females who had one or two times per week ingestion of fruit and salad than their counterparts. Similarly, rural females illustrated higher prevalence of MS [(OR-1.9; 95% CI: 1.328-2.731; $p < 0.001$) (RR- 1.4; 95% CI: 1.140-1.726, $p < 0.001$)] who used to consume fruit and salad less than three times per week as shown in Table 2.

The habit of intake of sugar-rich eatable post meal equal to or more than three times per week was depicted by 51.1% of urban females and 31.8% of rural females. Conversely, 48.9% of urban fe-

males and 68.2% of rural females manifested such habit less than three times per week (Table 1). The calculated chi-square value ($\chi 2$ = 8.3, df =, p < 0.01), OR (0.6, 95% CI: 0.471-0.867, p < 0.01) and RR (0.8, 95% CI: 0.797-0.958, p < 0.01) revealed that the urban females were assessed to have higher prevalence of metabolic syndrome (74.6%) who were indulged in the intake of sugar-rich eatable post meal equal to or more than three times per week. Astoundingly, rural females also manifested odds of 0.3 along with 0.7 times relative risk of developing metabolic syndrome in the study group with respect to habit of eating sugar rich eatable after meal equal to or more than three times per week (Table 2).

The prevalence of urban females who take milk at bedtime was 42.9%. On the other hand, 57.1% of urban females avoided intake of milk at night. In case of rural females, most of the females (82.2%) gulp down milk at bight before going to bed while 17.8% females did not take milk at bedtime (Table 2). In urban dwellers, the prevalence of females with metabolic syndrome and without metabolic syndrome with respect to their habit of consuming milk at bedtime was 43.7% and 56.3%, respectively. The corresponding figures for rural females were 49.3% and 50.7%. The association of metabolic syndrome with intake of milk at night was non-significant.

In recent years, reduction in the screening of individual components of metabolic syndrome such as imbalanced lipids [3], hyperglycemia [36], T2DM [50], elevated blood pressure [49] and abdominal obesity [52] has been reported among persons who believe in the consumption of milk. Numerous cross-sectional and prospective studies [20,37,51] from the developed nations documented that dairy product consumption such as milk intake may subsidise to a decreased risk of developing metabolic syndrome. Similar studies have been performed in Asian countries like in Japanese community. An inverse relationship was encountered among dairy product consumption and T2DM among 59,796 middle-aged and older Japanese women [29]. The consumption of milk and dairy products is associated with a prominently reduced prevalence of the metabolic syndrome illustrating dairy items therefore fit well in the array of healthy eating pattern.

The prevalence of urban females with respect to consumption of junk food, fried food and soft drinks equal to more than three times per week was 67.8%, 74.0% and 72.1%, respectively whereas the corresponding figures for rural females were 33.6%, 22.4% and 33.0%. Contradictory to this, ingestion of junk food, fried food and intake of soft drinks one or two times per week was shown by 32.2%, 26.0% and 27.9% of females belonging to urban areas. Additionally, the data also demonstrated that 66.4%, 77.6% and 67.0% of rural females were not indulged in ingestion of junk and fried food along with soft drinks very often i.e. one or two times per week (Table 1). Furthermore, it was noticed among urban females that who preferred junk food consumption equal to or more than three times per week had been more frequently diagnosed with metabolic syndrome than those who did not indulge in junk food consumption very often and the difference was statistically significant ($\chi^2$ = 204.1, df = 1, p < 0.001). The calculated results were further approved by OR and RR analysis which revealed that females indulged in junk food consumption regularly had daunting odds of progression of MS i.e. 0.1 folds (95% CI: 0.068-1.362, p < 0.001) with 0.3 times RR (95% CI: 0.285-0.426, p < 0.001). The chances of falling in the category of MS was predicted to be significantly ($\chi^2$ = 120.8, df = 1, p < 0.001) elevated by 0.1 folds (95% CI: 0.101-0.210; p < 0.001) accompanied by 0.4 times RR (95% CI: 0.396-0.519; p < 0.001) among rural females who favoured ingestion of junk food on a regular basis (79.3%; ≥ 3 times per week) than their counterparts (36.0%; 1-2 times per week).

The calculated odds ratio (0.8; 95% CI: 1.230-1.579; p < 0.001) and relative risk (0.9; 95% CI: 1.041-1.875; p < 0.001) approved the significant relationship between metabolic syndrome and fried food intake equal to or more than three times per week. (Table 2). In rural inhabitants, the calculated chi-square ($\chi^2$ = 1.9, df = 1, p < 0.001), odds ratio (1.2, 95% CI: 1.847-1.904, p < 0.001) and relative risk (1.1, 95% CI: 1.279-1.955, p < 0.001) affirmed this relationship. Apart from this, the data suggests that drinking of soft drinks show significant association with the occurrence of MS among urban females ($\chi^2$ = 17.0, df = 1, p < 0.0001, OR: 1.9, 95% CI: 1.408-2.632; p < 0.001, RR: 1.3; 95% CI: 1.624-1.667, p < 0.001). In case of rural females, the relationship of MS with intake of soft drinks was also acknowledged by OR (1.6; 95% CI: 1.918-3.632; p < 0.001) and RR (1.6; 95% CI: 1.409-1.91; p < 0.001).

Singaporean women (n = 43,176) were followed up and elucidated that intake of fast foods ≥ 2 times per week increased the occurrence of T2DM and coronary heart disease mortality [33].Twenty-year follow-up of women participated in Nurses' Health Study (n = 84 555) documented association between recurrent ingestion of fast food with T2DM [21]. A cross-sectional study attempted among adults enrolled in Michigan Behavioral Risk Factor Survey showed increased risk of obesity accompanied with ingestion of junk food ≥ 3 times per week. A significant association between fast food intake and adiposity in terms of elevated body mass index as well as waist circumference was observed among adults of Singapore [24].

Frying is a fast and convenient method of food processing. In Punjab, frying in oil, ghee or butter is a traditional cooking method over the decades. A critical feature of frying food is the high amount of oil, ghee or butter that is absorbed during the process,

reaching up to 40% of the total food product weight in some cases. The contributing factor for increased figures of metabolic syndrome among Amritsar females could be the traditional Punjabi diet which is cholesterol-rich food, food dripping with ghee, oil or butter and frying in oil, ghee or butter. The overcooking of food results in depletion of nutrients and minerals like folate and zinc. The deep frying in the same oil leads to production of trans fatty acids which are fatal and mainly responsible for emergence of metabolic anomalies like dyslipidemia, hypertension, adiposity and insulin resistance in Punjabi population making them vulnerable towards chronic condition of metabolic syndrome [18]. Individuals drinking one soft drink per day had 50% more chances of falling in the category of metabolic syndrome than those drinking less than one soft drink per day. Frequent consumption of soft drinks make individuals prone to individual components of the metabolic syndrome, including enlarged waist circumference, impaired fasting glucose, elevated blood pressure, hypertriglyceridemia and decreased levels of HDL-C. Alarmingly, the prevalence of metabolic syndrome was significantly (urban- $\chi^2 = 68.7$, df = 1, $p < 0.001$, OR: 3.3, 95% CI: 2.505-4.476; $p < 0.001$, RR: 1.8; 95% CI: 1.557-2.087, $p < 0.001$) (rural- $\chi^2 = 21.7$, df = 1, $p < 0.0001$, OR: 2.2, 95% CI: 1.582-3.116; $p < 0.001$, RR: 1.3; 95% CI: 1.171-4.443, $p < 0.001$) more among urban and rural females who had habit of eating while watching television or using gadgets on regular basis (Table 1 and 2).

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## Conflict of Interest

No conflicts of interest. The authors have no disclosures to make in relation to the content of this manuscript.

## Bibliography

1. Alberti KG., *et al*. "Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity". *Circulation* 120.16 (2009): 1640-1645.

2. Anderson RJ., *et al*. "Blood pressure and cardiovascular disease risk in the Veterans Affairs Diabetes Trial". *Diabetes Care* 34.1 (2011): 34-38.

3. Azadbakht L., *et al*. "Dairy consumption is inversely associated with the prevalence of the metabolic syndrome in Tehranian adults". *The American Journal of Clinical Nutrition* 82 (2005): 523-530.

4. Bahadoran Z., *et al*. "Fast Food Pattern and Cardiometabolic Disorders: A Review of Current Studies" . *Health Promotion Perspectives* 5.4 (2015): 231-240.

5. Bahadoran Z., *et al*. " Fast food consumption and the risk of metabolic syndrome after 3-years of follow-up: Tehran Lipid and Glucose Study". *European Journal of Clinical Nutrition* 67 (2013): 1303-1309.

6. Basciano H., *et al*. "Fructose, insulin resistance, and metabolic dyslipidemia". *Nutrition and Metabolism* (Lond) 2 (2005): 5.

7. Brown AW., *et al*. "Belief beyond the evidence: Using the proposed effect of breakfast on obesity to show 2 practices that distort scientific evidence". *The American Journal of Clinical Nutrition* 98 (2013): 1298-1308.

8. Carlson O., *et al*. "Impact of reduced meal frequency without caloric restriction on glucose regulation in healthy, normal weight middle-aged men and women" . *Metabolism* 56 (2007): 1729-1734.

9. Ceriello A., *et al*. "Is oxidative stress the pathogenic mechanism underlying insulin resistance, diabetes, and cardiovascular disease? The common soil hypothesis revisited". *Arteriosclerosis, Thrombosis, and Vascular Biology* 24 (2004): 816-823.

10. Ceriello A., *et al*. "Meal-induced oxidative stress and low-density lipoprotein oxidation in diabetes: the possible role of hyper glycemia". *Metabolism* 48 (1999): 1503-1508.

11. Cheong HS., *et al*. "Study on breakfast habits of workers and college students in Gyeongnam area". *Korean Journal of Food and Cookery Science* 26 (2010): 791-803.

12. Chung SJ., *et al*. "Breakfast skipping and breakfast type are associated with daily nutrient intakes and metabolic syndrome in Korean adults". *Nutrition Research and Practice* 9 (2015): 288-295.

13. Deshmukh-Taskar P.R., *et al*. "Dietary patterns associated with metabolic syndrome, sociodemographic and lifestyle factors in young adults: the Bogalusa Heart Study". *Public Health Nutrition* 12 (2009): 2493-2503.

14. Deshmukh-Taskar PR., *et al*. "Do breakfast skipping and breakfast type affect energy intake, nutrient intake, nutrient adequacy, and diet quality in young adults? NHANES 1999-2002". *Journal of the American College of Nutrition* 29 (2010): 407-418.

15. Dhurandhar EJ., *et al*. "The effectiveness of breakfast recommendations on weight loss: A randomized controlled trial" . *The American Journal of Clinical Nutrition* 100 (2014): 507-513.

16. Drummond SE., *et al*. "Evidence that eating frequency is inversely related to body weight status in male, but not female, non-obese adults reporting valid dietary intakes". *International Journal of Obesity and Related Metabolic Disorders* 22 (1998): 105-112.

17. Duffey KJ., *et al*. "Regular consumption from fast food establishments relative to other restaurants is differentially associated with metabolic outcomes in young adults". *Journal of Nutrition* 139 (2009): 2113-2118.

18. Enas A.E., *et al*. "Prudent diet and preventive nutrition from paediatrics to geriatrics current knowledge and practical recommendations". *Indian Heart* 55 (2003): 310-338.

19. Fontana L., *et al*. "Long-term calorie restriction is highly effective in reducing the risk for atherosclerosis in humans". *Proceedings of the National Academy of Sciences of the United States of America* 101 (2004): 6659-6663.

20. Fumeron F., *et al*. "Dairy Consumption and the Incidence of Hyperglycemia and the Metabolic Syndrome Results from a French prospective study, Data from the Epidemiological Study on the Insulin Resistance Syndrome (DESIR)". *Diabetes Care* 34 (2011): 813-817.

21. Halton TL., *et al*. "Potato and French fry consumption and risk of type 2 diabetes in women". *American Journal of Clinical Nutrition* 83 (2006): 284-290.

22. Holmback I., *et al*. "A high eating frequency is associated with an overall healthy lifestyle in middle-aged men and women and reduced likelihood of general and central obesity in men". *British Journal of Nutrition* 104 (2010): 1065-1073.

23. Jaaskelainen A., *et al*. "Associations of meal frequency and breakfast with obesity and meta bolic syndrome traits in adolescents of Northern Finland Birth Cohort 1986". *Nutrition and Metabolism Cardiovascular Disease* 23 (2013): 1002-1009.

24. Jeffery RW., *et al*. "Are fast food restaurants an environmental risk factor for obesity?" *International Journal of Behavioral Nutrition and Physical Activity* 3 (2006): 2.

25. Kaur J. "Assessment and screening of the risk factors in metabolic syndrome". *Medical Sciences* 2 (2014): 140-152.

26. Kim D., *et al*. "Dairy consumption is associated with a lower incidence of the metabolic syndrome inmiddle-aged and older Korean adults: The Korean Genome and Epidemiology Study (KoGES)". *British Journal of Nutrition* 117 (2017): 148-160.

27. Kim Y., *et al*. "Dairy consumption and risk of metabolic syndrome: A meta-analysis". *Diabetic Medicine* 33 (2016): 428-440.

28. Kim Y., *et al*. "Factors related to eating breakfast of middle and high school students in Seoul". *Korean Journal of Community Nutrition* 15 (2010): 582-592.

29. Kirii K., *et al*. "Calcium, vitamin D and dairy intake in relation to type 2 diabetes risk in a Japanese cohort". *Diabetologia* 52 (2009): 2542-2550.

30. Lee S., *et al*. "Relationship between nutrient intake and biochemical index with breakfast eating in Korean adults: analysis of data from the 2007 National Health and Nutrition Survey". *Korean Journal of Food Culture* 26 (2011): 94-99.

31. Lee SC., *et al*. "Metabolic syndrome among non-obese adults in the teaching profession in Melaka, Malaysia". *Journal of epidemiology* 27 (2017): 130-134.

32. Min C., *et al*. "Skipping breakfast is associated with diet quality and metabolic syndrome risk factors of adults". *Nutrition Research and Practice* 5 (2011): 455-463.

33. Odegaard AO., *et al*. "Western-style fast food intake and cardiometabolic risk in an Eastern country". *Circulation* 126 (2012): 182-188.

34. Ortega RM., *et al*. "Difference in the breakfast habits of overweight/obese and normal weight school children". *International Journal for Vitamin and Nutrition Research* 68 (1998): 125-132.

35. Pereira MA., *et al*. "Fast food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis". *Lancet* 365 (2005): 36-42.

36. Pereira MA., *et al*. "Dairy consumption, obesity, and the insulin resistance syndrome in young adults—The CARDIA study". *JAMA* 287 (2002): 2081-2089.

37. Pfeuffer M., *et al*. "Milk and the metabolic syndrome". *Obesity Reviews* 8 (2007): 109-118.

38. Prentice AM., *et al*. "Fast foods, energy density and obesity: a possible mechanistic link". *Obesity Reviews* 4 (2003): 187-194.

39. Rizzo NS., *et al*. "Vegetarian dietary patterns are associated with a lower risk of metabolic syndrome- The Adventist Health Study 2". *Diabetes Care* 34 (2011):1225-1227.

40. Ruxton CH., *et al*. "Breakfast: a review of associations with measures of dietary intake, physiology and biochemistry". *British Journal of Nutrition* 78 (1997): 199-213.

41. Shang P., *et al*. "Veganism does not reduce the risk of the metabolic syndrome in a Taiwanese cohort". *Asia Pacific Journal of Clinical Nutrition* 20 (2011): 404-410.

42. Shim JE., *et al*. "Breakfast consumption pattern, diet quality and health outcomes in adults from 2001 National Health and Nutrition Survey". *Korean Journal of Nutrition* 40 (2007): 451-462.

43. Shin S., *et al*. "Association between Milk Consumption and Metabolic Syndrome among Korean Adults: Results from the Health Examinees Study". *Nutrients* 9 (2017): 1102.

44. Sierra-Johnson J., *et al*. "Eating meals irregularly: a novel environmental risk factor for the metabolic syndrome". *Obesity* (Silver Spring) 16 (2008): 1302-1307.

45. Smith KJ., *et al*. "Daily eating frequency and cardiometabolic risk factors in young Australian adults: cross-sectional analyses". *British Journal of Nutrition* 108 (2012): 1086-1094.

46. Snijder MB., *et al*. "Is higher dairy consumption associated with lower body weight and fewer metabolic disturbances? The Hoorn Study". *The American Journal of Clinical Nutrition* 85 (2007): 989-995.

47. Stender S., *et al*. "High levels of industrially produced trans fat in popular fast foods". *The New England Journal of Medicine* 354 (2006): 1650-1652.

48. Summerbell CD., *et al*. "Relationship between feeding pattern and body mass index in 220 free-living people in four age groups". *European Journal of Clinical Nutrition* 50 (1996): 513-519.

49. Toledo E., *et al*. "Low-fat dairy products and blood pressure: Follow-up of 2290 older persons at high cardiovascular risk participating in the PREDIMED study". *British Journal of Nutrition* 101 (2009): 59-67.

50. Tong X., *et al*. "Dairy consumption and risk of type 2 diabetes mellitus: A meta-analysis of cohort studies". *European Journal of Clinical Nutrition* 65 (2011): 1027-1031.

51. Tremblay A., *et al*. "Milk products, insulin resistance syndrome and type 2 diabetes". *Journal of the American College of Nutrition* 28 (2009): 91S-102S.

52. Wang H., *et al*. "Longitudinal association between dairy consumption and changes of body weight and waist circumference: The Framingham Heart Study". *International Journal of Obesity* 38 (2014): 299-305.

53. Whitton C., *et al*. "Fast-food consumers in Singapore: demographic profile, diet quality and weight status". *Public Health Nutrition* 17 (2013): 1805-1813.

54. Yannakoulia M., *et al*. "Association of eating frequency with body fatness in pre- and postmenopausal women". *Obesity (Silver Spring)* 15 (2017): 100-106.

55. Zhang L., *et al*. "The Association between Breakfast Skipping and Body Weight, Nutrient Intake, and Metabolic Measures among Participants with Metabolic Syndrome". *Nutrients* 9 (2017): 384.

56. Zong *et al*. "Dairy consumption, type 2 diabetes, and changes in cardiometabolic traits: A prospective cohort study of middle-aged and older Chinese in Beijing and Shanghai". *Diabetes Care* 37 (2014): 56-63.