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**Original Research Article**

# Clustering of non-communicable disease risk factors among adolescents in urban and rural Rajasthan

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## ABSTRACT

**Background:** Non communicable diseases (NCDs) are primarily driven by the modifiable risk factors that often emerge during the childhood/adolescence and contribute towards majority of premature deaths during adulthood. This study aimed to assess the prevalence of multiple NCD risk factors and the associated factors among adolescents in urban and rural areas of Rajasthan.
**Methods:** It was a community-based cross-sectional study conducted among 430 school going adolescents. A self-administered questionnaire adapted from STEPS survey format of the WHO and indian adolescent health questionnaire was used; anthropometric measurements were taken using standard procedure. Presence of two or more risk factors in one individual was considered as clustering of NCD risk factors.
**Results:** Prevalence of two risk factors (Dyads) was 48.8% (urban) and 33% (rural), three or more risk factors were found in about 12.1% urban and 7.9% rural adolescents. For "Dyads", males had OR 3.58 (95% CI 1.9- 6.4) and OR 4.1 (95% CI 2.6-7.9) in urban and rural areas, respectively. The risk of clustering was higher with increasing age [Dyad: OR 1.26 (CI 1.1-5.73) in urban, OR 2.2 (CI 1.56-3.7) in rural; ≥ 3 risk factors: OR 2.3 (CI 1.98-4.11) in urban, OR 1.52 (CI 1.21-4.9)].
**Conclusions:** Clustering of the risk factors was prevalent among urban as well as rural adolescents emphasizing the importance of developing primary prevention strategies which can be effective across all demographic and socioeconomic backgrounds.

**Keywords:** Adolescents, Clustering, Non communicable diseases, Risk factors

## INTRODUCTION

Non communicable diseases (NCDs) mainly cardiovascular diseases, respiratory diseases, diabetes, and cancer are top killers in the South-East Asia Region, responsible for about 8.5 million deaths each year. About one third of these deaths are premature and thus affect economically productive individuals. The NCDs are caused to a large extent by four modifiable behavioral risk factors: unhealthy diet, tobacco use, insufficient physical activity, and harmful consumption of alcohol. NCDs disproportionately affect the impoverish families, poor, and place a growing burden on health-care systems.[1] Lack of awareness and insufficient health-care access further exacerbates the problem of increasing burden of NCDs in our country. Most of the risk factors of NCDs are behaviorally acquired during adolescent age group. According to the World Health Organization

(WHO), adolescent is a person of 10 and 19 years of age with rapid growth and development with behavior changes such as self-independence and more exposure to risk behavior.[2] At this age, these risk factors are barely perceived as harmful and continue as the lifestyle of individuals. Epidemiological transition in India, from predominantly communicable diseases to NCDs has occurred over past few decades. Despite extensive diversity in the prevalence of NCD risk factors across different regions, cardiovascular diseases are still the leading cause of deaths in all parts of India, including rural areas and impoverished states.[3]

Since the adoption of the Sustainable Development Goals (SDGs) in 2015, India has shown strong commitment to achieving them. India adopted the WHO Global Action Plan and formed its own national action plan with indicators. The localization of these goals has been emphasized with all the states' allocated responsibility for executing the country's ambitious development agenda.[4]

Although the NCD burden has increased, India still does not have sufficiently detailed data on NCDs for research and policy purposes.[5] In framing the cost-effective strategies for prevention, identification of the risk factors and their quantification is very important.[6] India with its largest ever adolescent and youth population and being the capital of NCDs; this study aims to determine the prevalence and clustering of these risk factors across various socio demographic groups among school going adolescents. The best place to translate the plans concerning prevention of NCDs is in the context of educational institutions.

## METHODS

It was a community-based cross-sectional study conducted in the schools of urban and rural area of Udaipur district, Rajasthan. Selection of the participants was done by cluster randomization.

Keeping the number of clusters as 2 (each in urban and rural area), and the intra cluster correlation coefficient at 0.03, the design effect of 2.5 was considered. Sample size was determined by using a standard formula $Z^2pq/d^2$ (Where Z= confidence limit of 95% or 1.96, p= prevalence, q= 1-p and d= sampling error).[7] The reported prevalence of different risk factors among adolescents in India was taken from a systematic review published in 2014 which showed that about 15-20% adolescents were using tobacco, 3-15% adolescents were consuming alcohol, and 5-10% adolescents were hypertensive.[8] At 95% confidence interval, average prevalence of 15% and a sampling error of 8% (considered after the results of a pilot study conducted among 20 adolescents), the minimum required sample size was 77. After including the design effect (2.5 × 77) and taking 10% non-response rate, final sample size is 212, rounded off to 215 (each in urban and rural area). A total of 430 adolescents, participated in the study. The schools, included in the study were chosen from the field practice area of department of Community medicine department of the medical college. Considering a minimum enrollment of around 100 adolescents in government schools, we needed two schools each in rural and urban area. A list of all government high schools and senior secondary schools within study area was made. Two schools from urban area and two schools from rural area were selected using cluster random sampling. Before commencing the study, the class teachers were explained about the purpose of the study and with the help of them, briefing of the objectives and questionnaires was done to the study population. The study was conducted from June 2020 to June 2021, while taking all the precautions and preventive measures against Coronavirus disease (COVID 19).[9]

*Study instrument:* The stepwise approach of the WHO on NCD risk factors was adapted to collect the data.[10]

### *Questionnaire*

A self-administered structured questionnaire was adapted from STEPS survey format of the WHO and Indian Adolescent Health Questionnaire.[11] This questionnaire was validated by the experts from experts of General Medicine and Community Medicine. After validation, it was translated into Hindi language and pre tested with 15 adolescents and subsequently edited (after taking into account their comments). The final questionnaire had information about socio demographic data, family history and behavioral risk factors such as dietary habits, tobacco use, alcohol use and physical activity. In addition to this, we used B.G Prasad scale to assess socioeconomic status.[12] All behavioral risk factors were based on the Indian adolescent health questionnaire:[11] Physical activity was defined as any activity that increases the heart rate and makes the person get out of breath for some time. The participants, who were physically active for at least 30 minutes per day (for five days in the previous week) were considered as "physically active". Tobacco use was defined as the use of any smoked or smokeless tobacco/ tobacco products in the previous month. Alcohol use was defined as use of any alcoholic beverages such as beer, wine, whiskey, vodka etc. in the last six months. Consumption of less than five servings of fruits and vegetables per day was defined as inadequate.

### *Measurements*

All the measurements were done taking into account WHO standards and precautions. Weight, height and blood pressure (BP) of each adolescent were measured. Weight of participants were taken using a using a standardized stand-on scale nearest to 500 g. Height was measured using a stadiometer, to the nearest millimeter.[13] Based on the weight and height, the body mass index (BMI) was calculated as per the formula BMI = Weight (kg)/Height ($m^2$). Adolescents were classified based on their BMI using WHO reference for adolescents BP was measured using digital sphygmomanometer to screen

adolescents for hypertension.[14] BP reading was taken in the right arm in sitting position after 3 to 5 minutes of resting. Indian Academy of Pediatrics (IAP) reference for BP using height percentile, calculated for each adolescent was used to define hypertension. Hypertension was defined as average systolic and/or diastolic pressure >95$^{th}$ percentile for gender, age and height on >3 occasions. Prehypertension was defined as average systolic or diastolic pressures between 90-95th percentile. The BP level of <90$^{th}$ percentile was considered normal.[15]

Adolescents, who were diagnosed to have hypertension were referred to nearest health center for further evaluation and management. The confidentiality of the study was assured to the study participants. Assent was taken from study participants and written consent from parents were taken.

***Statistical tools***

Data entry and statistical analysis was done using SPSS (Statistical Package of Social Sciences) Version 21. Chi square tests were used to assess associations between the categorical variables and t test were used for quantitative variables. Statistical significance was considered present if the p value was less than 0.05.

Prior permission was taken from relevant school authorities after obtaining clearance from the institutional ethics committee. Informed consent from parents and assent from participants was taken.

## RESULTS

The study population had 60.9% of females and 39.1% of males. Most (54.9%) of the study participants belonged to the age group of 14-16 years, followed by 17-19 years (32.1%) and 10-13 years (13%). Mean age of the participants was 15.6 years (±4.1). Almost all (99.5%) of the students belonged to Hindu religion. Out of all the students, 43.3% were from general caste, 20% were from scheduled caste, 17.7% were from scheduled tribe and rest belonged to other castes (other backward classes etc.). Majority (42.8%) belonged to lower middle socioeconomic status, followed by upper lower status (27.9%), lower status (15.3%) and upper middle (14%). Table 1 shows the sociodemographic variables of study population.

**Table 1: Sociodemographic variables of study population (n=430).**

| Variables | Category | Total (430) | Urban n=215 (%) | Rural n=215 (%) | P value |
|---|---|---|---|---|---|
| **Gender** | Male | 170 (39.5) | 86 (40) | 84 (39.1) | 0.84 |
| | Female | 260 (60.5) | 129 (60) | 131 (60.9) | |
| **Age in years** | 10 -13 | 54 (12.6) | 26 (12.1) | 28 (13.0) | 0.90 |
| | 14-16 | 234 (54.4) | 116 (54) | 118 (54.9) | |
| | 17-19 | 142 (33) | 73 (33.9) | 69 (32.1) | |
| **Class** | 9$^{th}$ -10$^{th}$ | 261 (60.7) | 131 (60.8) | 130 (60.5) | 0.92 |
| | 11$^{th}$ -12$^{th}$ | 169 (39.3) | 84 (39.2) | 85 (39.5) | |
| **Religion** | Hindu | 423 (98.4) | 209 (97.2) | 214 (99.5) | 0.06 |
| | Muslim | 7 (1.6) | 6 (2.8) | 1 (0.5) | |
| **Caste** | General | 200 (46.5) | 107 (49.8) | 93 (43.3) | <0.01 |
| | SC | 69 (16) | 26 (12.1) | 43 (20.0) | |
| | ST | 43 (10) | 5 (2.3) | 38 (17.7) | |
| | Others | 118 (27.4) | 77 (35.8) | 41(19.1) | |
| **Socioeconomic status** | Upper middle | 110 (25.6) | 80 (37.2) | 30 (14.0) | <0.01 |
| | Lower middle | 162 (37.7) | 70 (32.6) | 92 (42.8) | |
| | Upper lower | 110 (25.6) | 50 (23.2) | 60 (27.9) | |
| | Lower | 48 (11.2) | 15 (7) | 33 (15.3) | |

Table 2 shows various risk factors prevalent among the study participants. The most common risk factor was inadequate fruits and vegetable intake (58.6%; 54.9% in urban, 62.4% in rural), followed by physical inactivity (47.4%; 53% in urban, 41.9% in rural), consumption of packed food in last week (50%; 58.1% in urban, 41.9% in rural). About 19.1% (20.9% in urban, 17.2% in rural) had abnormal blood pressure (pre-hypertension/ hyper-tension). About 7.7% (11.2 % in urban, 4.2% rural) participants were overweight, 7% and 7.9% (9.3% and 5.6% in urban, 4.7% and 10.2% in rural) had history of alcohol and tobacco consumption respectively.

The presence of two risk factors was found in about 40.9% (48.8% in urban; 33% in rural) adolescents and 10% (12.1% in urban; 8% in rural) adolescents had three or more risk factors. The distribution of risk factors in the form of dyads in urban and rural adolescents is shown in Figures 1 and 2.

In urban participants, the most common dyad was inadequate consumption of fruits and vegetables and consumption of packed foods (30.5%). Among the rural participants, most common dyad was inadequate consumption of fruits and vegetables and inadequate physical activity (29.6%), followed by inadequate consumption of fruits and vegetables and consumption of packed foods (26.8%). Among NCD risk factor triads, inadequate physical activity, consumption of packaged foods and extra salt intake; inadequate physical activity, inadequate fruit and vegetable intake and consumption of packaged foods; inadequate fruit and vegetable intake, extra salt intake and alcohol intake were among the most common ones. The most common triad was inadequate consumption of fruits and vegetables, consumption of packed foods and inadequate physical activity among both urban and rural adolescents.

**Table 2: Prevalence of non-communicable disease risk factors among the adolescents (n=430).**

| Risk factors | Total (n=430) | Urban (n=215) N (%) | Rural (n=215) N (%) | P value |
|---|---|---|---|---|
| **Fruit and vegetable intake** | | | | |
| Adequate | 178 (41.4) | 97 (45.1) | 81 (37.6) | 0.12 |
| Inadequate | 252 (58.6) | 118 (54.9) | 134 (62.4) | |
| **Consumption of soft drinks** | | | | |
| Up to two times per week | 375 (87.2) | 179 (83.2) | 196 (91.2) | 0.01 |
| At least three times per week | 55 (12.8) | 36 (16.8) | 19 (8.8) | |
| **Overweight** | | | | |
| Yes | 33 (7.7) | 24 (11.2) | 9 (4.2) | <0.01 |
| No | 397 (92.3) | 191 (88.8) | 206 (95.8) | |
| **Physical inactivity** | | | | |
| Yes | 204 (47.4) | 114 (53) | 90 (41.9) | 0.02 |
| No | 226 (52.6) | 101 (47) | 125 (58.1) | |
| **Alcohol consumption** | | | | |
| Yes | 30 (7) | 20 (9.3) | 10 (4.7) | 0.06 |
| No | 400 (93) | 195 (90.7) | 205 (95.3) | |
| **Tobacco use** | | | | |
| Yes | 34 (7.9) | 12 (5.6) | 22 (10.2) | 0.07 |
| No | 396 (92.1) | 203 (94.4) | 193 (89.8) | |
| **Consumption of packed food in the last one week** | | | | |
| Yes | 215 (50) | 125 (58.1) | 90 (41.9) | <0.01 |
| No | 215 (50) | 90 (41.9) | 125 (58.1) | |
| **Normal blood pressure** | | | | |
| Yes | 348 (80.9) | 170 (79.1) | 178 (82.8) | 0.32 |
| No | 82 (19.1) | 45 (20.9) | 37 (17.2) | |

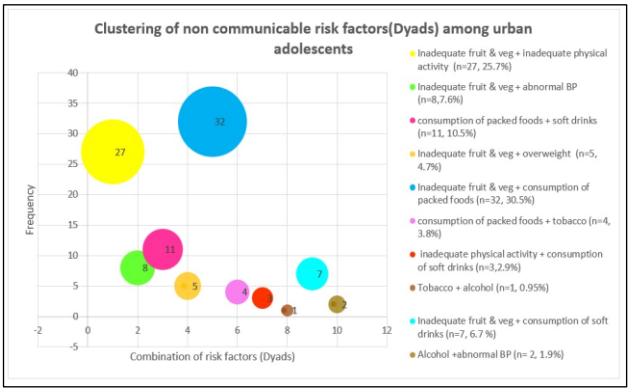


**Figure 1: Distribution of "Dyads" among the urban adolescents.**

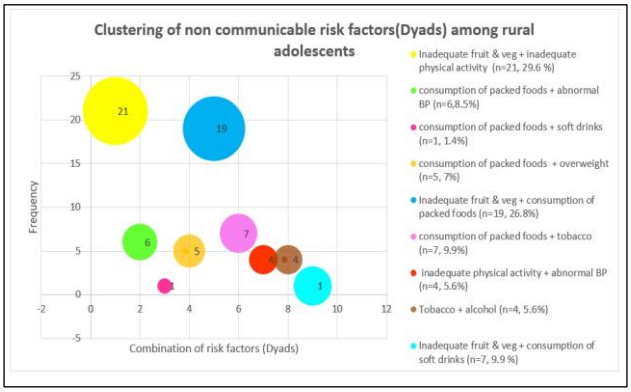


**Figure 2: Distribution of "Dyads" among the rural adolescents.**

After applying the multinomial logistic regression and adjusting the standard error for the clusters, male adolescents in rural areas had higher probability of having risk factor as compared to their female counterparts with OR 2.2 (95% CI 1.73-5.1). Clustering of risk factors (dyads and ≥3 risk factors) was also more associated with the male gender in both urban and rural schools with OR for Dyads: 3.58 (95% CI 1.9-6.43) in urban and 4.1 (95% CI 2.63-7.9) in rural; OR for ≥3 risk factors: 1.62 (95% CI 1.09-4.9) in urban and 1.92 (95% CI 1.31-3.6) in rural. The probability of clustering of two and ≥3 risk factors was found to be higher with older age in urban area: OR 1.26 (95% CI 1.1-5.73) and OR 2.3 (95% CI 1.98-4.11) respectively. The probability of having the risk factors (single and clusters) among rural adolescents increased with age [OR 1.39 (95% CI 1.2-4.56].

## DISCUSSION

This study was done to find the clustering of risk factors of non-communicable diseases such as obesity, high blood pressure, tobacco and alcohol consumption etc. among the adolescents, living in urban and rural area of Udaipur district of Rajasthan. The study showed that majority of urban adolescents had at least two risk factors (dyads) whereas most of rural adolescents had presence of a single risk factor. Almost half (48.8%) of urban adolescents and one third (33%) of adolescents from rural areas had clustering of at least two risk factors (Dyads). The most common clustering in the study population (n= 430) was in the form of Dyads and we analyzed the multiple risk factors, most commonly associated as the combination. In urban participants, the most common dyad was inadequate consumption of fruits and vegetables and consumption of packed foods (30.5%). Among the rural participants, most common dyad was inadequate consumption of fruits and vegetables and inadequate physical activity (29.6%), followed by inadequate consumption of fruits and vegetables and consumption of packed foods (26.8%). Triads among the study population were found to be 26% and 17% among urban and rural adolescents respectively. The most common triad was inadequate consumption of fruits and vegetables, consumption of packed foods and inadequate physical activity among both urban and rural adolescents. A recent study by Mathur et al from north India reported that physical inactivity and inadequate fruit and vegetable intake make up the largest of the behavioral risk factor dyads among adolescents.[16] Another study about clustering of NCD risk factors among school going adolescents done by Sreena et al in Kerala, reported that the most common dyad was "Inadequate fruit and vegetable intake along with consumption of packaged foods" followed by the dyad of "inadequate fruit and vegetable intake plus inadequate physical activity".[17] The combinations of risk factors in our study are comparable to that shown by Shayo et al, which revealed that the most prevalent combination of risk factors for NCDs among school adolescents of Tanzania was physical inactivity and unhealthy diet being reported by 666 (17.6%) participants.[18] Other combinations were unhealthy diet and suicide attempt (4%); unhealthy diet plus tobacco use (2.8%). Dyads and triads of risk factors were found to be significantly more prevalent among males and older age groups (>17 years) in both urban and rural area schools. In rural areas, male gender and older age were found to be significant predictors for the presence of a single risk factor too. The clustering being more common among urban adolescents, was also reported by the study done among adolescents in Kerala: Dyad OR 2.79 (95% CI 2.06-3.78) and Triad OR 3.55 (95% CI 1.57-7.99).[17] The study done by Shayo et al reported that primary in-school adolescents were significantly more likely to have two 1.81 (95% CI 1.42-2.32), three 2.40 (95% CI 1.63-3.54); and more than three, 2.9 (95% CI 1.61-5.13) combinations of risk factors, than secondary in-school adolescents.[18] This finding is quite opposite to what our study revealed, where older age was significantly associated with clustering of risk factors. This difference could be due to cultural variations and lifestyle behavior of majority of people in both the countries.

In our study, out of total participants (430), abnormal blood pressure (pre-hypertension and hypertension) was reported among 19.1% of the adolescents (20.9% of urban and 17.2% of rural participants). This finding is comparable to the results of a study done in urban areas of Ludhiana, Punjab among 849 adolescents by Mohan et al, which revealed that about 16.4% of urban adolescents had prehypertension and hypertension.[19] In our study, as combination of risk factors (dyad), abnormal BP and inadequate physical activity accounted for about 7.6% of the dyads among urban adolescents; while abnormal BP and consumption of packed foods were responsible for 8.5% of dyads among rural adolescents. Patel et al conducted a large cross-sectional study in the city of Indore, Madhya Pradesh to determine the distribution of blood pressure (BP) and the prevalence of hypertension and prehypertension among school going children and adolescents. About 11,312 children belonging to the age of 5 to 15 years, from 80 different government and private schools in equal proportion, were included in study. This study revealed that about 13.8% and 13.4% of participants were hypertensive and pre hypertensive respectively.[20]

Our study also reported that about 7.9% of adolescents had history of tobacco consumption (5.6% in urban; 10.2% in rural). Alcohol consumption was found in 7 % adolescents (9.3%) in urban; 4.7% in rural). The prevalence of tobacco use was comparable to the results of a study done in Kerala, where 6.9 per cent (12.5% males and 1.2% females) of adolescents admitted to tobacco use.[21] Alcohol use in our study was found to be lower than that reported by another study done among adolescents in a district of Kerala state by Jaisoorya et al, which revealed that prevalence of alcohol use was 15% (23.2% among boys and 6.5% among girls).[22] These differences could be due to variations in study design and

sociodemographic features of the people of these two states.

Studies done all over the world, have demonstrated that about 70% of premature deaths among adults are the results of lifestyle risk behaviors acquired during their adolescence period.[23,24]

The monitoring data of NCDs in India reveals that, with the current pace of control of diseases and ongoing coronavirus pandemic challenges, it is very difficult for the country to reach the SDG targets.[25] In addition to this, lack of social inclusion, urban-rural gaps, regional disparities and gender inequality etc. are other roadblocks in the country.[26] Moreover, the disparities in the accessibility, affordability and availability of health services are other eminent concerns that lead to lack of awareness among people, regarding their risk factors or diagnosis of NCDs.[27] Literature shows that the progression of NCDs in India is characterized by the shifting of the socioeconomic gradients, tobacco (smoked and smokeless) use, low fruit and vegetable intake, being more prevalent among people from lower/lower middle socioeconomic backgrounds.[28] Socioeconomic deprivation prepends the delay in receiving the optimal care leading to poorer treatment outcomes among underprivileged individuals. Primary prevention is one of the costs-effective strategies, identified for better control of progression of NCD epidemic.[29] Hence, there is need to emphasize the strategies involving the children, adolescents and young people.

This study has few limitations. Laboratory investigations of the study participants were not performed, which could have provided a comprehensive assessment of the NCD risk factors among the adolescents. It was a questionnaire-based study, in which the risk factors were self-reported by the participants, hence there is possibility of recall bias and incomplete/ hidden information.

## CONCLUSION

This study provides the evidence that multiple risk factors are prevalent in Indian adolescents. The collective impact of multiple risk factors (clustering) increases NCD risk. Our study revealed that clustering of risk factors was common in both urban and rural adolescents. Prevention and control of NCDs is global priority in the Sustainable Development Goals and hence there is need to devise a package of integrated approaches in school health promotion.

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*Ethical approval: The study was approved by the Institutional Ethics Committee*

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