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Impact of Socioeconomic and Environmental Factors on Adolescent Dietary Diversity in Lower Dir, Khyber Pakhtunkhwa, Pakistan

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Abstract
The study assesses the impact of socioeconomic and environmental factors on the dietary diversity of adolescents in Lower Dir, Khyber Pakhtunkhwa, Pakistan. The findings reveal significant disparities between rural and urban adolescents, with socioeconomic status, parental education, and environmental factors influencing dietary patterns. Rural adolescents, particularly those from households earning less than 20,000 PKR per month, had significantly lower dietary diversity scores (DDS), averaging **3.5**, compared to **4.2** in urban areas. Adolescents from households with monthly incomes over 40,000 PKR had the highest DDS (**6.2** in urban areas, **4.5** in rural areas). Parental education was also a key determinant, with adolescents of parents with secondary or higher education showing better dietary diversity (rural: **4.5**, urban: **6.2**) compared to those with uneducated parents (rural: **3.0**, urban: **4.0**). Environmental barriers, such as market accessibility, were more pronounced in rural areas; rural adolescents living more than 5 kilometers from a market had the lowest DDS (**3.2**), compared to **5.1** for those within 1 kilometer. In contrast, urban adolescents, though benefiting from better market access, exhibited higher consumption of processed foods, with **45.0%** consuming sugary snacks daily. Gender-based disparities were also noted, with male adolescents having higher DDS than females, especially in rural areas (male: **4.0**, female: **2.8**). These findings emphasize the need for targeted interventions to improve food access, parental education, and dietary habits in both rural and urban settings to promote healthier nutrition among adolescents.

Keywords: Adolescent nutrition, dietary diversity, socioeconomic factors, environmental barriers, rural-urban disparities, parental education, gender differences, Lower Dir.

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Introduction

Adolescence is a transformative period in human development, characterized by rapid physical, cognitive, and emotional changes. During this phase, proper nutrition plays a pivotal role in ensuring optimal growth, cognitive development, and long-term health outcomes (Khan & Waheed, 2021). Dietary diversity, a measure of the variety of food consumed from different food groups, is a key indicator of nutritional adequacy. It reflects an individual's ability to access a diverse range of nutrients essential for maintaining good health and preventing malnutrition (Soofi et al., 2023).

The global challenge of adolescent malnutrition manifests in various forms, including undernutrition, micronutrient deficiencies, and over nutrition. In developing regions such as South Asia, these challenges are further compounded by socioeconomic and environmental disparities (Tariq & Iqbal, 2018). Adolescents, especially in rural areas, often face limited access to nutrient-dense foods, exposing them to a double burden of malnutrition simultaneously experiencing undernutrition and a growing prevalence of obesity (Nabi & Riaz, 2016).

The Importance of Dietary Diversity

Dietary diversity is critical for adolescents as it ensures adequate intake of essential vitamins and minerals. Studies have shown that diets lacking diversity are often dominated by staple foods, which provide energy but fail to meet the micronutrient requirements necessary for growth and cognitive development (Ersado et al., 2023). The World Health Organization (WHO) emphasizes the importance of dietary diversity as a strategy to combat malnutrition, particularly in vulnerable populations.

In Pakistan, dietary diversity among adolescents is influenced by various factors, including income levels, parental education, cultural practices, and regional disparities (Khan & Waheed, 2021). Adolescents from low-income households often have limited access to diverse food groups, relying on cereals and starchy foods to meet their energy needs. Conversely, urban adolescents may have greater access to diverse foods but face challenges related to the consumption of processed and unhealthy options (Sibhatu & Qaim, 2015).

Socioeconomic Factors Influencing Dietary Diversity

Socioeconomic status (SES) significantly impacts dietary diversity, as it determines an individual's ability to access and afford a variety of foods. Higher household incomes are associated with increased consumption of nutrient-dense foods such as fruits, vegetables, and proteins (Soofi et al., 2023). Parental education also plays a crucial role; parents with higher educational attainment are more likely to prioritize their children's nutrition and make informed dietary choices (Tariq & Iqbal, 2018).

In rural areas of Lower Dir, the lack of economic opportunities often limits household incomes, restricting access to diverse and nutritious foods (Nabi & Riaz, 2016). Additionally, traditional gender roles in rural communities may prioritize the dietary needs of male adolescents over females, further exacerbating nutritional inequalities (Khan & Waheed, 2021).

Environmental Barriers to Dietary Diversity

Environmental factors, such as market access, food availability, and infrastructure, also influence dietary diversity. In rural settings, limited market access often results in a reliance

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on locally produced foods, which may lack variety and essential nutrients (Ersado et al., 2023). Urban areas, while offering greater access to diverse foods, are not without challenges. The high availability of fast-food outlets and processed foods often undermines the nutritional quality of diets among adolescents (Sibhatu & Qaim, 2015).

In Lower Dir, Khyber Pakhtunkhwa, disparities in infrastructure and market access between rural and urban areas highlight the environmental challenges affecting dietary diversity. Rural households often face long travel distances to access markets, limiting their ability to purchase perishable and nutrient-dense foods. Urban households, while having better access, must navigate the economic and cultural factors that influence food choices (Soofi et al., 2023).

The Role of Schools in Promoting Dietary Diversity

Schools play a critical role in shaping dietary habits during adolescence. Nutrition education programs and the provision of healthy meals can significantly improve dietary diversity among students. However, in Lower Dir, the lack of structured school meal programs in rural areas contributes to poor dietary diversity among adolescents (Nabi & Riaz, 2016). Urban schools, in contrast, often have better resources and policies to support students' nutritional needs, although these benefits are not universally accessible (Khan & Waheed, 2021).

Gender Disparities in Dietary Diversity

Gender disparities in dietary practices are well-documented in South Asia, including Pakistan. Cultural norms often prioritize the nutritional needs of male adolescents over females, leading to significant differences in dietary diversity (Tariq & Iqbal, 2018). Female adolescents in rural areas face additional challenges, such as limited autonomy in food choices and restricted access to resources, further widening the nutritional gap (Soofi et al., 2023).

Methodology

Study Design and Population

This study adopted a comparative cross-sectional design to investigate the impact of socioeconomic and environmental factors on adolescent dietary diversity in Lower Dir, Khyber Pakhtunkhwa. Adolescents aged 10-15 years were recruited from both rural and urban areas. The study population included 200 participants, with an equal representation of 100 adolescents from rural and urban areas, ensuring a comprehensive understanding of the dietary diversity in the district. Stratified random sampling was employed to account for the demographic and socioeconomic diversity of the region (Nabi & Riaz, 2016).

Research Variables

The primary focus of the study was to analyze the influence of socioeconomic and environmental factors on adolescent dietary diversity. The dependent variable was the Dietary Diversity Score (DDS), which was measured based on the consumption of various food groups within a 24-hour period. Independent variables included socioeconomic factors such as household income, parental education, and occupation, as well as environmental factors like market access, food availability, and school policies (Tariq & Iqbal, 2018).

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Inclusion and Exclusion Criteria

The inclusion criteria ensured that the study targeted school-going adolescents aged 10-15 years who had been residing in Lower Dir for at least six months. Only those attending public or private schools were included. Adolescents with chronic illnesses, disabilities, or cognitive impairments that could affect their nutrition were excluded. Additionally, participants who had recently moved to the district or whose guardians did not consent to the study were excluded (Soofi et al., 2023).

Data Collection Tools and Procedures

The data collection process involved a combination of structured questionnaires, dietary assessments, and anthropometric measurements.

Questionnaire Design

A structured questionnaire was developed to collect data on dietary diversity, socioeconomic factors, and environmental influences. The questionnaire included sections on household income, parental education, access to markets, and food consumption patterns. The design was culturally tailored and validated through a pilot study to ensure clarity and appropriateness for the target population (Sibhatu & Qaim, 2015).

Dietary Assessment

The dietary diversity of participants was assessed using a 24-hour dietary recall method. Participants were asked to recall all foods and beverages consumed within the previous 24 hours. The Dietary Diversity Score (DDS) was calculated based on the Food and Agriculture Organization (FAO) guidelines, which categorize foods into distinct groups such as cereals, fruits, vegetables, proteins, and dairy products. A higher DDS indicated better dietary diversity (Ersado et al., 2023).

Socioeconomic and Environmental Data

Data on socioeconomic factors included household income, categorized into three brackets: less than 20,000 PKR, 20,000-40,000 PKR, and more than 40,000 PKR. Parental education and occupation were also recorded to assess their influence on dietary habits. Environmental data focused on market accessibility, food availability, and the presence of school-based nutrition programs (Nabi & Riaz, 2016).

Anthropometric Measurements

Anthropometric data were collected to evaluate the nutritional status of participants. Measurements included height, weight, and Body Mass Index (BMI), which were assessed using World Health Organization (WHO) growth standards. These measurements helped classify participants as underweight, normal weight, overweight, or obese, providing insights into the nutritional challenges faced by adolescents (Khan & Waheed, 2021).

Pilot Study

A pilot study was conducted with 20 participants to validate the questionnaire and refine data collection procedures. The pilot phase helped identify ambiguities in questions and

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ensured the reliability of the data collection tools. Feedback from the pilot study was incorporated into the final questionnaire design to improve its effectiveness (Soofi et al., 2023).

Ethical Considerations

Ethical approval for the study was obtained from the Department of Food & Nutrition, University of Peshawar. Informed consent was secured from all participants and their guardians, ensuring that participation was voluntary. Confidentiality and anonymity were maintained throughout the research process, and participants were informed about their right to withdraw at any stage (Tariq & Iqbal, 2018).

Data Analysis

Data were analyzed using SPSS Version 25. Descriptive statistics, including means, standard deviations, and frequencies, were used to summarize demographic, socioeconomic, and dietary data. Comparative analyses were conducted to examine differences in dietary diversity between rural and urban participants. Chi-square tests assessed the relationship between categorical variables, while multiple regression analysis identified the key predictors of dietary diversity, focusing on socioeconomic and environmental factors (Nabi & Riaz, 2016).

Challenges and Limitations

This study faced several challenges, including the reliance on self-reported dietary data, which introduced potential recall bias. The cross-sectional design limited the ability to establish causation, providing only a snapshot of the dietary diversity and influencing factors at a single point in time. Additionally, the sample size of 200 participants, while adequate for descriptive purposes, may not fully capture the variability across different socioeconomic and environmental contexts in Lower Dir, Khyber Pakhtunkhwa, Pakistan (Ersado et al., 2023).

Validation and Reliability

To ensure the reliability and validity of the data, rigorous measures were implemented. Questionnaires were pre-tested during the pilot phase, and anthropometric measurements adhered to standardized protocols. Double-entry of data was performed to minimize transcription errors. Furthermore, consistent training of data collectors ensured uniformity in administering questionnaires and taking measurements (Khan & Waheed, 2021).

Results

Overview of Findings

The results of the study express significant disparities in dietary diversity among adolescents in Lower Dir, Khyber Pakhtunkhwa shaped by socioeconomic and environmental factors. Rural households were found to have significantly lower dietary diversity scores (DDS) compared to urban households. These differences were closely linked to household income, parental education, market accessibility, and cultural practices influencing food distribution within families. The following sections provide a detailed analysis of these findings.

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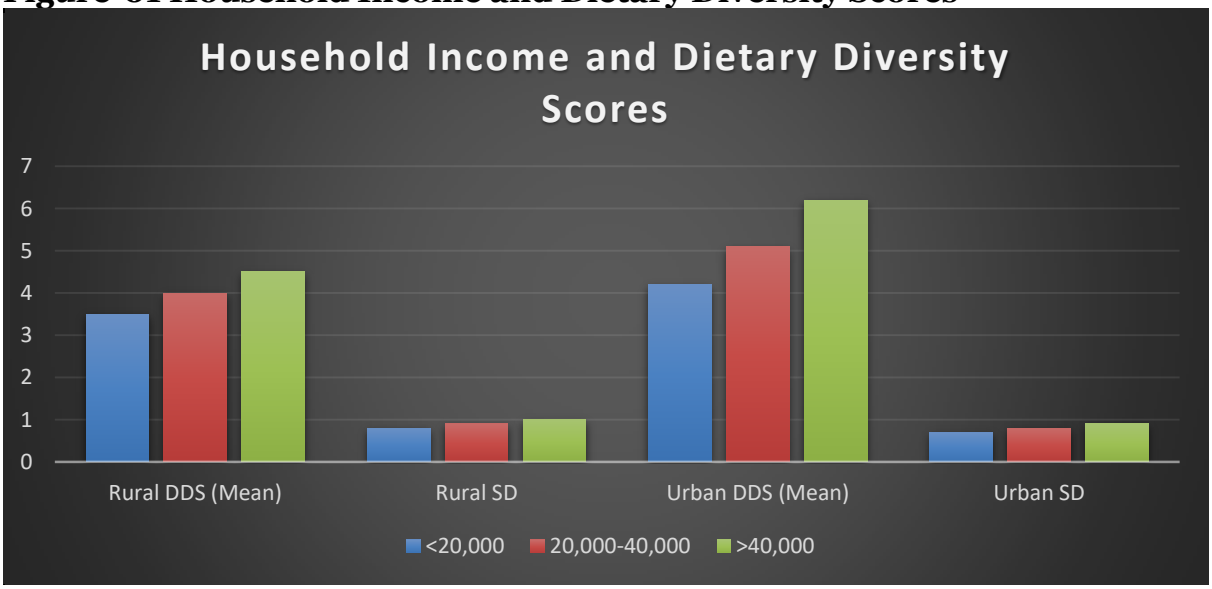
Socioeconomic Disparities in Dietary Diversity

Household income was a critical determinant of dietary diversity. As illustrated in **Table 1** and **Figure-01** rural households with incomes below 20,000 PKR per month had a mean DDS of 3.5, compared to 4.2 in urban households within the same income bracket. Adolescents from households earning more than 40,000 PKR per month exhibited the highest DDS, with urban adolescents achieving a mean score of 6.2 compared to 4.5 in rural areas. This highlights the role of economic resources in accessing diverse and nutrient-rich foods.

Table 1: Household Income and Dietary Diversity Scores

Income Status **(PKR)**	**Rural DDS (Mean ± SD)**	**Urban DDS (Mean ± SD)**
<20,000	3.5 ± 0.8	4.2 ± 0.7
20,000-40,000	4.0 ± 0.9	5.1 ± 0.8
>40,000	4.5 ± 1.0	6.2 ± 0.9

Figure-01 Household Income and Dietary Diversity Scores



Parental education further influenced dietary diversity. **Table 2** demonstrates that adolescents with parents having secondary or higher education had significantly better DDS in both rural (4.5) and urban (6.2) settings compared to those with uneducated parents (3.0 in rural areas and 4.0 in urban areas). This finding underscores the importance of education in shaping dietary choices and promoting nutritional awareness.

Table 2: Parental Education and Dietary Diversity

Parental Education	**Rural DDS (Mean ± SD)**	**Urban DDS (Mean ± SD)**

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No formal education	3.0 ± 0.9	4.0 ± 0.8
Primary	4.0 ± 0.8	5.0 ± 0.9
Secondary or above	4.5 ± 1.0	6.2 ± 0.8

Environmental Challenges to Food Access

Environmental barriers, particularly in rural areas, severely restricted access to diverse foods. As shown in **Table 3**, rural adolescents living more than 5 kilometers from the nearest market had the lowest DDS (3.2), compared to 5.1 for those within 1 kilometer. Urban adolescents generally benefitted from better market accessibility, with a DDS of 6.0 for those within 1 kilometer of a market.

Table 3: Market Accessibility and Food Diversity

Accessibility	**Rural DDS (Mean ± SD)**	**Urban DDS (Mean ± SD)**
Within 1 km	5.1 ± 0.8	6.0 ± 0.9
1-5 km	4.0 ± 0.7	5.2 ± 0.8
>5 km	3.2 ± 0.9	4.5 ± 0.7

Despite better access, urban households faced challenges associated with the availability of unhealthy processed foods, which contributed to higher consumption of sugary and low-nutrient items, as indicated in **Table 4**. This dual burden highlights the need for targeted interventions to address both undernutrition in rural areas and unhealthy eating patterns in urban settings.

Table 4: Food Group Consumption across Regions

Food Group	**Rural Consumption (%)**	**Urban Consumption (%)**
Cereals	90.0	85.0
Fruits	40.0	60.0
Vegetables	45.0	70.0
Protein-rich foods	30.0	55.0
Sugary foods	20.0	50.0

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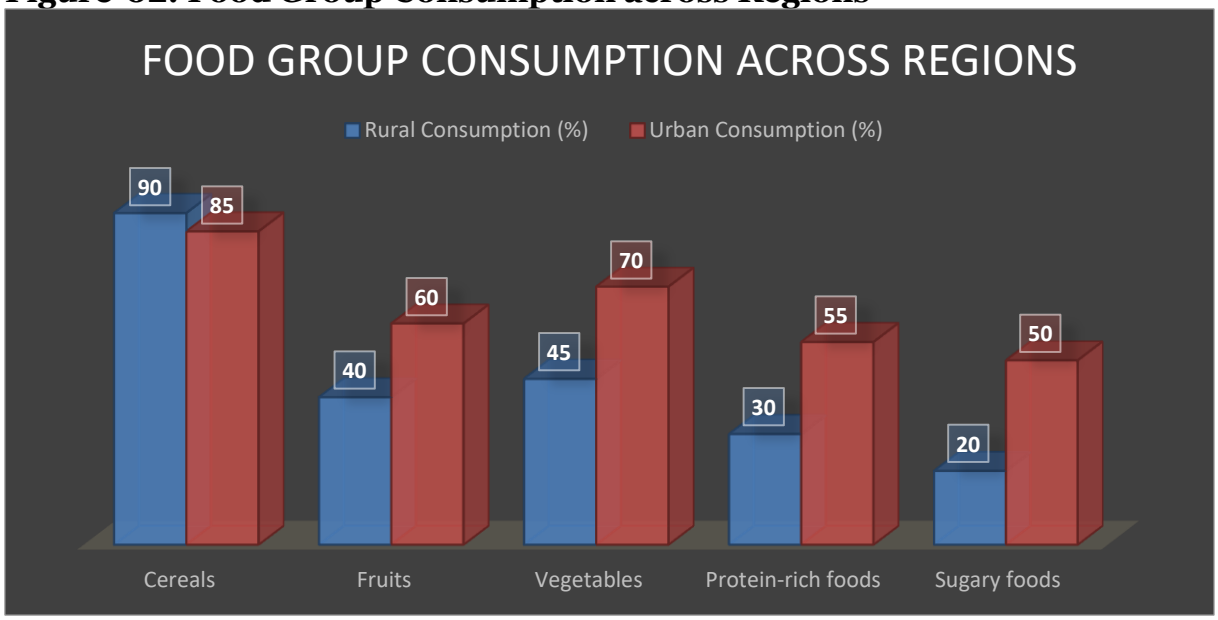
Figure-02: Food Group Consumption across Regions



Gender Differences in Dietary Patterns

Cultural practices favoring male adolescents were evident in the dietary patterns observed. **Table 5** reveals that male adolescents had higher DDS than females in both rural and urban settings. This disparity was more pronounced in rural areas, where traditional gender roles often prioritized the nutritional needs of boys over girls.

Table 5: Gender Differences in Dietary Patterns

Gender	Rural DDS (Mean ± SD)	Urban DDS (Mean ± SD)
Male	4.2 ± 0.8	5.5 ± 0.9
Female	3.8 ± 0.7	4.9 ± 0.8

Comparative Analysis of Food Group Consumption

The consumption patterns of key food groups varied significantly between rural and urban adolescents. **Table 4** shows that while urban adolescents had higher consumption rates of fruits, vegetables, and protein-rich foods, rural diets were dominated by cereals and starchy staples. The limited intake of nutrient-dense foods among rural adolescents reflects both economic constraints and limited market access.

Summary of Results

The study highlights stark socioeconomic and environmental inequalities influencing adolescent dietary diversity in Lower Dir, Khyber Pakhtunkhwa, Pakistan. Rural adolescents, constrained by lower household incomes, limited parental education, and poor

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market access, exhibited significantly lower DDS compared to their urban counterparts. Environmental barriers such as long distances to food markets further exacerbated these disparities, limiting the availability of diverse and nutritious foods.

On the other hand, while urban adolescents had higher dietary diversity, their increased consumption of processed and sugary foods raises concerns about emerging dietary risks. The findings underscore the need for multifaceted interventions, including policies to improve rural market infrastructure, enhance parental education, and promote balanced diets in both rural and urban areas. Addressing these challenges is crucial for ensuring equitable nutritional outcomes and fostering healthier futures for adolescents in Lower Dir, Khyber Pakhtunkhwa.

Discussion

Socioeconomic Factors and Dietary Diversity

The findings of this study align with existing literature, emphasizing the critical role of socioeconomic factors in shaping dietary diversity among adolescents. In Lower Dir, Khyber Pakhtunkhwa, Pakistan household income was a significant determinant, with higher incomes enabling access to diverse and nutrient-rich foods. This aligns with the observations of Tariq and Iqbal (2018), who reported that financial resources directly influence food purchasing power and dietary choices. In rural households, lower incomes restricted access to essential food groups, forcing reliance on cereals and starchy staples. Conversely, urban households benefitted from higher incomes, which facilitated better dietary diversity, although often at the cost of increased consumption of processed foods.

Parental education emerged as another key factor influencing dietary diversity. Adolescents with better-educated parents demonstrated higher DDS, as educated parents were more likely to prioritize nutrition and make informed dietary decisions. This is consistent with findings by Nabi and Riaz (2016), who highlighted the role of education in promoting nutritional awareness and healthy eating habits. The disparity in educational attainment between rural and urban parents further exacerbated the nutritional inequalities observed in this study.

Environmental Challenges and Food Accessibility

Environmental constraints were a prominent barrier to achieving dietary diversity, particularly in rural areas. Limited market access significantly restricted the availability of diverse and perishable food items, as rural households often traveled long distances to purchase such foods. This finding aligns with Sibhatu and Qaim (2015), who reported similar challenges in rural settings, where market proximity directly influenced dietary diversity.

Urban households, despite better market access, faced a different set of challenges. The widespread availability of processed and sugary foods in urban markets led to higher consumption of unhealthy food items among urban adolescents. This dual burden of undernutrition in rural areas and unhealthy eating patterns in urban areas underscores the need for context-specific interventions. As suggested by Soofi et al. (2023), improving rural market infrastructure and regulating urban food environments are essential steps to address these challenges.

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Gender Disparities in Nutrition

The study revealed significant gender disparities in dietary diversity, with male adolescents generally achieving higher DDS than females. This reflects cultural norms prevalent in South Asia, where male children often receive preferential treatment in food distribution within households. Such practices have long-term implications for the nutritional status and overall well-being of female adolescents. As highlighted by Khan and Waheed (2021), addressing gender-based nutritional inequities requires targeted awareness campaigns and community-based interventions to promote equitable food distribution practices.

Policy Implications and Interventions

The findings of this study have several implications for public health policy. Enhancing rural market infrastructure is critical to improving access to diverse and affordable food options. Additionally, implementing school-based nutrition programs in rural areas can play a significant role in bridging the dietary diversity gap. These programs, as recommended by Tariq and Iqbal (2018), should focus on providing balanced meals that include all essential food groups.

Nutrition education campaigns targeting parents and adolescents are also essential for fostering healthier eating habits. Such campaigns should emphasize the importance of dietary diversity and the risks associated with excessive consumption of processed foods. Subsidies for nutrient-dense foods can further support low-income households in improving their dietary diversity.

Conclusion

This study provides a comprehensive analysis of the socioeconomic and environmental factors affecting dietary diversity among adolescents in Lower Dir, Khyber Pakhtunkhwa, Pakistan revealing significant disparities between rural and urban households. The results underscore the complex interaction between income, parental education, and market accessibility, all of which significantly influence the dietary patterns and nutritional outcomes of adolescents in this region.

Rural adolescents, facing lower household incomes and limited access to markets, demonstrated markedly lower Dietary Diversity Scores (DDS) compared to their urban counterparts. Specifically, households with incomes below 20,000 PKR per month had the lowest DDS, reflecting the financial constraints that limit their ability to purchase a variety of nutritious foods. Furthermore, the distance from markets in rural areas, often exceeding 5 kilometers, compounded the challenge of accessing fresh, perishable foods, further restricting dietary variety. These findings align with existing literature, which emphasizes how economic hardship and poor market access in rural areas can result in reliance on basic, starchy staples, with limited inclusion of fruits, vegetables, and protein-rich foods.

In contrast, urban adolescents, while benefiting from higher household incomes and better market access, faced a different set of challenges. The increased availability of processed and sugary foods in urban markets led to higher consumption of unhealthy food items. This situation reflects a "dual burden," where urban adolescents face the risks of both undernutrition (through poor dietary diversity) and over nutrition (due to the high consumption of calorie-dense, nutrient-poor foods). This urban dietary paradox highlights the importance of promoting balanced diets that emphasize nutrient-dense foods while

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addressing the widespread consumption of unhealthy processed foods.

The role of parental education emerged as another critical factor influencing dietary diversity. Adolescents with educated parents, particularly those with secondary or higher education, showed significantly higher DDS in both rural and urban areas. This underscores the importance of educational attainment in shaping nutritional awareness and healthy eating habits. In rural areas, where educational levels are generally lower, this lack of knowledge may contribute to the limited diversity in adolescent diets. Thus, improving parental education, particularly in rural areas, could play a pivotal role in enhancing dietary choices and nutritional outcomes.

Gender disparities in food distribution within households were also evident in this study, with male adolescents consistently having higher DDS than their female counterparts. This discrepancy, especially pronounced in rural settings, reflects deeply ingrained cultural norms that prioritize the nutritional needs of male children over females. Such practices not only contribute to gender-based nutritional inequities but also have long-term implications for the health and well-being of female adolescents. To address these disparities, targeted awareness campaigns and community-based interventions are essential, focusing on equitable food distribution and promoting gender-sensitive approaches to nutrition.

The findings of this study reveal that socioeconomic factors such as household income, parental education, and market access are critical determinants of dietary diversity among adolescents in Lower Dir. Rural adolescents, in particular, are disadvantaged due to their lower socioeconomic status and limited access to diverse food options. Meanwhile, urban adolescents face the dual challenge of poor dietary diversity coupled with an increasing intake of unhealthy foods. Gender-based disparities in food allocation further exacerbate the inequalities observed.

These challenges, a multifaceted approach is necessary to improve dietary diversity and nutritional outcomes for adolescents in Lower Dir, Khyber Pakhtunkhwa, Pakistan. First, improving rural market infrastructure is critical to ensuring that all households, regardless of location, can access a variety of nutrient-rich foods. This can be achieved through better transportation networks and the establishment of local markets that provide fresh produce and other essential food groups. Second, nutrition education programs aimed at both parents and adolescents can help promote healthier eating habits and raise awareness about the importance of balanced diets. These programs should be designed to address the specific needs of rural communities, where access to information may be limited.

Limitations and Future Directions

Although this study provides valuable insights into the factors influencing dietary diversity in Lower Dir, Khyber Pakhtunkhwa, Pakistan certain limitations must be acknowledged. The cross-sectional design precludes causal inferences, and the reliance on self-reported dietary data may introduce recall bias. Future research should consider longitudinal designs to establish causal relationships and explore additional factors, such as cultural practices and food security that influence dietary diversity.

Policy interventions are essential to regulate the availability of processed and unhealthy foods in urban areas. Implementing measures such as food labeling, taxation on sugary foods, and the promotion of healthy alternatives in markets can help curb the rising consumption of unhealthy foods in urban settings. Subsidies for nutrient-dense foods,

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especially in low-income households, could also provide much-needed support to improve dietary diversity in both rural and urban areas.

Ultimately, this study emphasizes the need for coordinated efforts across multiple sectors to address the nutritional challenges faced by adolescents in Lower Dir. By improving access to nutritious foods, promoting education, and addressing gender disparities, stakeholders can help ensure that all adolescents, regardless of their socioeconomic background or geographic location, have the opportunity to achieve optimal nutrition and health. This approach will contribute to fostering healthier, more resilient communities and ensuring a better quality of life for future generations in Lower Dir, Khyber Pakhtunkhwa, Pakistan.

Implications for Public Health Policy

Addressing the socioeconomic and environmental factors influencing dietary diversity requires targeted public health interventions. Policies aimed at improving market infrastructure, promoting nutrition education, and implementing school-based meal programs can help mitigate disparities in dietary diversity. Additionally, community-based initiatives that engage parents and adolescents can foster better understanding and practices related to nutrition (Sibhatu & Qaim, 2015).

The findings from this study highlight the need for a holistic approach to improving dietary diversity among adolescents in Lower Dir, Khyber Pakhtunkhwa, Pakistan. By addressing the underlying socioeconomic and environmental challenges, policymakers can contribute to better health outcomes and reduced nutritional inequalities in the region.

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Conflict of Interest

The authors hereby declare that there are no financial, personal, or professional conflicts of interest that could have influenced the research findings or interpretation presented in this study.

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