Original Research

Comparative Study of Dietary Habits, Obesity, and Autonomic Function Among Urban and Rural Populations

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ABSTRACT
Aim: This study aimed to compare dietary habits, obesity markers, and autonomic function among urban and rural populations to evaluate the impact of lifestyle differences on metabolic and cardiovascular health.
Material and Methods: A comparative cross-sectional study was conducted among 200 participants, with 100 each from urban and rural areas. Participants were recruited from community health centers, educational institutions, and workplaces. Dietary intake was assessed using a validated Food Frequency Questionnaire (FFQ) and a 24-hour dietary recall. Anthropometric measurements, including body mass index (BMI), waist-hip ratio (WHR), and body fat percentage, were recorded. Autonomic function was evaluated using heart rate variability (HRV), blood pressure variability (BPV), and deep breathing tests. Statistical analysis was performed using SPSS version 25.0, applying chi-square tests, independent t-tests, Pearson and Spearman correlation, and multiple regression models.
Results: Urban participants had significantly higher BMI (25.8 ± 3.2 kg/m² vs. 24.1 ± 3.0 kg/m², $p = 0.015$), WHR (0.85 ± 0.04 vs. 0.82 ± 0.05, $p = 0.028$), and body fat percentage (28.5 ± 5.1% vs. 26.3 ± 4.8%, $p = 0.035$) than rural participants. Physical activity levels were lower in urban participants (3200 ± 850 vs. 4500 ± 920, $p < 0.001$). Dietary intake analysis revealed higher fat consumption and lower fiber intake among urban participants, while rural participants had greater carbohydrate and protein intake. Autonomic function tests showed increased sympathetic dominance in urban participants, with a higher HRV LF/HF ratio (2.1 ± 0.5 vs. 1.8 ± 0.4, $p = 0.018$) and lower HRV RMSSD (32.5 ± 8.6 ms vs. 37.8 ± 7.9 ms, $p = 0.009$). Multiple regression analysis identified BMI, WHR, and carbohydrate intake as predictors of autonomic dysfunction, while physical activity had a protective effect.
Conclusion: Urban participants exhibited higher obesity markers, lower physical activity, and greater autonomic dysfunction than rural participants. Dietary habits played a crucial role in modulating autonomic function, with high carbohydrate and fat intake linked to sympathetic dominance, while fiber and protein intake showed protective effects. These findings underscore the need for lifestyle interventions promoting balanced nutrition and increased physical activity to mitigate autonomic dysfunction and associated metabolic risks.
Keywords: Obesity, Dietary Habits, Autonomic Function, Urbanization, Cardiovascular Health duration, viral load.

Introduction

Diet and lifestyle play a fundamental role in shaping human health, influencing metabolic processes, cardiovascular function, and overall well-being. In recent decades, rapid urbanization and modernization have significantly altered dietary habits and physical activity levels, leading to an increased prevalence of lifestyle-related disorders such as obesity, diabetes, hypertension, and cardiovascular diseases. These changes are more pronounced in urban populations, where access to processed and energy-dense foods, coupled with sedentary behavior, contributes to metabolic and autonomic dysfunction. In contrast, rural populations often adhere to traditional dietary patterns, characterized by a higher intake of whole foods, fiber, and physical labor, which may offer protective effects against obesity and autonomic imbalance.[1] Obesity is a growing global health concern, with its prevalence steadily rising in both developed and developing nations. It is associated with several metabolic disturbances, including insulin resistance, dyslipidemia, and chronic low-grade inflammation, all of which have implications for autonomic function. The autonomic nervous system (ANS) plays a crucial role in maintaining homeostasis, regulating heart rate, blood pressure, digestion, and energy balance. Autonomic dysfunction, often characterized by increased sympathetic activity and reduced parasympathetic modulation, has been linked to obesity and metabolic disorders. Given the stark differences in dietary patterns, physical activity levels, and environmental exposures between urban and rural populations, understanding their impact on obesity and autonomic function is essential.[2] Urbanization has led to profound changes in dietary habits. Urban dwellers often consume diets rich in refined carbohydrates, unhealthy fats, and processed foods, which are low in fiber, micronutrients, and essential antioxidants. Such dietary shifts contribute to excessive caloric intake, weight gain, and increased adiposity. The widespread availability of fast food, coupled with lifestyle demands that encourage convenience over nutrition, has exacerbated poor eating habits. Moreover, urban populations tend to have lower levels of physical activity due to occupational constraints, reliance on motorized transport, and the increasing adoption of sedentary entertainment, such as television viewing and smartphone usage. These factors collectively contribute to an increased risk of obesity and related autonomic dysfunction.Conversely, rural populations typically consume more home-cooked meals, consisting of whole grains, legumes, fresh fruits, and vegetables. Their diets are generally lower in processed foods and artificial additives, which may reduce the risk of metabolic disorders. Additionally, rural lifestyles often involve higher levels of physical exertion, including farming, manual labor, and active commuting. These factors contribute to a lower prevalence of obesity and may have protective effects on autonomic function. However, with increasing urban migration and globalization, traditional dietary habits in rural areas are also undergoing significant transitions, leading to a rise in obesity and associated health issues.[3] Obesity is known to have a profound impact on autonomic function. Excess adiposity, particularly visceral fat accumulation, is associated with increased sympathetic nervous system activity and reduced vagal tone. This autonomic imbalance leads to cardiovascular complications, including hypertension, increased heart rate variability, and impaired baroreceptor sensitivity. The activation of the sympathetic nervous system in obese individuals contributes to a higher risk of developing metabolic syndrome, a cluster of conditions that includes insulin resistance, hypertension, and dyslipidemia. Additionally, obesity-induced chronic inflammation further exacerbates autonomic dysfunction, increasing the risk of cardiovascular diseases and mortality.Dietary components play a significant role in modulating autonomic function. High carbohydrate intake, particularly from refined sources, can cause fluctuations in blood glucose levels, leading to autonomic disturbances. Diets rich in unhealthy fats, such as trans fats and saturated fats, have been linked to increased sympathetic activity and reduced parasympathetic modulation. On the other hand, fiber-rich diets, which are more prevalent in rural populations, have been associated with better autonomic balance, improved cardiovascular function, and lower risks of metabolic disorders. Understanding these dietary influences on autonomic function is critical for developing targeted interventions to prevent obesity-related autonomic dysfunction.[4] Physical activity is another crucial factor influencing autonomic regulation. Regular exercise has been shown to enhance parasympathetic activity and reduce sympathetic dominance, promoting cardiovascular health. Urban populations, due to their sedentary lifestyles, may experience reduced autonomic flexibility, making them more susceptible to obesity-related complications. In contrast, rural populations, with their higher levels of physical activity, may maintain better autonomic balance, reducing their risk of cardiovascular and metabolic diseases. However, as rural areas continue to undergo socioeconomic transitions, the decline in physical activity levels may contribute to a worsening trend in autonomic dysfunction.Despite the increasing evidence linking dietary habits, obesity, and autonomic function, there remains a gap in understanding how these factors differ between urban and rural populations. Given the rising burden of non-communicable diseases worldwide, it is essential to identify population-specific risk factors and develop effective interventions. This study aims to compare the dietary habits, obesity prevalence, and autonomic function between urban and rural populations, shedding light on how lifestyle and environmental factors contribute to metabolic and cardiovascular health.[5] By assessing dietary patterns, anthropometric measurements, and autonomic function parameters, this study will provide valuable insights into the impact of urbanization on health outcomes. The findings will help in designing public health strategies that promote healthier dietary choices and increased physical activity, ultimately reducing the burden of obesity and its associated autonomic dysfunction. Understanding the differences between urban and rural populations will aid in developing targeted interventions that cater to specific lifestyle challenges faced by each group. The study of dietary habits, obesity, and autonomic function among urban and rural populations is essential for addressing the growing epidemic of metabolic and cardiovascular disorders. As urbanization continues to reshape dietary patterns and physical activity levels, understanding its impact on autonomic function will be crucial for developing effective public health policies. Through comparative analysis, this research seeks to highlight the key differences between urban and rural populations, emphasizing the importance of lifestyle modifications in maintaining autonomic balance and overall well-being.

Material and Methods

This study was a comparative cross-sectional analysis conducted to assess the relationship between dietary habits, obesity, and autonomic function among urban and rural populations.A total of 200 participants were included in the study, with 100 participants recruited from urban areas and 100 from rural areas. Participants were selected from community health centers, educational institutions, and workplaces.

Inclusion and Exclusion Criteria

The study included individuals aged 18–45 years who had been residing in their respective areas for at least five years and were willing to provide written informed consent. Exclusion criteria included individuals with diagnosed cardiovascular, endocrine, or neurological disorders, those taking medications affecting autonomic function such as beta-blockers, pregnant and lactating women, and individuals who smoked or consumed alcohol to minimize confounding factors.

Data Collection Methods

Dietary assessment was carried out using a validated Food Frequency Questionnaire (FFQ) to evaluate intake patterns of macronutrients and micronutrients. Additionally, a 24-hour dietary recall was conducted over three days, including two weekdays and one weekend day. The Healthy Eating Index (HEI) was used to categorize dietary quality. Anthropometric measurements included body mass index (BMI), which was determined using a calibrated weighing scale and stadiometer. Waist-hip ratio (WHR) was measured using a non-stretchable measuring tape, and body fat percentage was assessed through bioelectrical impedance analysis (BIA).

Autonomic function was assessed using multiple tests. Heart rate variability (HRV) was measured using a 3-lead ECG and HRV analyzer in a supine position for five minutes. Parameters such as low-frequency (LF) and high-frequency (HF) power, LF/HF ratio, and root mean square of successive differences (RMSSD) were recorded. Blood pressure variability (BPV) was measured using an automated sphygmomanometer with readings taken at five-minute intervals over 30 minutes in a controlled environment. A deep breathing test was also conducted, where participants performed controlled breathing at six breaths per minute while heart rate response was recorded. Physical activity levels were assessed using the International Physical Activity Questionnaire (IPAQ) to evaluate sedentary behavior and activity patterns.

Statistical Analysis

Data analysis was performed using SPSS version 25.0. Descriptive statistics, including mean and standard deviation, were used to summarize baseline characteristics. Chi-square tests were used to analyze categorical variables such as dietary patterns and obesity categories. Independent t-tests or Mann-Whitney U tests were employed to compare autonomic function parameters between urban and rural participants. Pearson or Spearman correlation analysis was conducted to determine associations between dietary habits, obesity, and autonomic function. A multiple regression model was applied to identify predictors of autonomic dysfunction.

Results

The results from the study provide valuable insights into the relationship between dietary habits, obesity, and autonomic function among urban and rural populations.

Baseline Characteristics of Participants (Table 1)

The mean age of participants in both urban and rural groups was comparable, with no statistically significant difference ($p = 0.312$). However, significant differences were observed in BMI, waist-hip ratio, body fat percentage, and physical activity levels. Urban participants had a significantly higher BMI (25.8 ± 3.2 kg/m²) compared to rural participants (24.1 ± 3.0 kg/m², $p = 0.015$), indicating a higher prevalence of overweight individuals in urban areas. Similarly, urban participants had a higher waist-hip ratio (0.85 ± 0.04 vs. 0.82 ± 0.05, $p = 0.028$) and body fat percentage ($28.5 \pm 5.1\%$ vs. $26.3 \pm 4.8\%$, $p = 0.035$), suggesting a greater accumulation of central obesity in urban populations. Physical activity levels, measured using a physical activity score, were significantly lower in urban participants (3200 ± 850) than in rural participants (4500 ± 920, $p < 0.001$), highlighting a more sedentary lifestyle in urban settings.

Dietary Intake Comparison Between Urban and Rural Participants (Table 2)

Significant differences in dietary intake were observed between urban and rural participants. Rural participants had a significantly higher carbohydrate intake (320 ± 50 g/day) than urban participants (280 ± 45 g/day, $p = 0.002$). Protein intake was also slightly higher in rural populations (75 ± 14 g/day vs. 70 ± 12 g/day, $p = 0.045$), which could be attributed to the consumption of more natural and home-cooked meals. Fat intake, however, was significantly higher in urban participants (85 ± 18 g/day) compared to rural participants (65 ± 15 g/day, $p < 0.001$), suggesting a greater reliance on processed and fast foods in urban areas. Fiber intake was significantly lower in urban participants (18 ± 6 g/day) compared to rural participants (24 ± 7 g/day, $p = 0.008$), indicating a lower consumption of fruits, vegetables, and whole grains. Sodium intake was slightly higher in urban participants, but the difference was not statistically significant ($p = 0.072$), suggesting similar salt consumption patterns between the two groups.

Autonomic Function Parameters in Urban and Rural Participants (Table 3)

Autonomic function assessment revealed significant differences between urban and rural participants. The HRV LF/HF ratio, which indicates sympathetic dominance, was higher in urban participants (2.1 ± 0.5) compared to rural participants (1.8 ± 0.4, $p = 0.018$), suggesting increased sympathetic nervous system activity and reduced parasympathetic control in urban individuals. HRV RMSSD, a marker of parasympathetic activity, was significantly lower in urban participants (32.5 ± 8.6 ms) compared to rural participants (37.8 ± 7.9 ms, $p = 0.009$), further supporting the observation of reduced autonomic balance in urban settings. Blood pressure variability was significantly higher in urban participants (12.5 ± 2.8 mmHg) than in rural participants (11.2 ± 2.5 mmHg, $p = 0.032$), indicating greater fluctuations in blood pressure and increased cardiovascular risk. The deep breathing test, which assesses vagal function, showed a lower heart rate response in urban participants (16.2 ± 3.9 bpm) compared to rural participants (18.7 ± 4.1 bpm, $p = 0.015$), further indicating reduced parasympathetic modulation in urban individuals.

Correlation Between Dietary Components and Autonomic Function (Table 4)

Several significant correlations were observed between dietary components and autonomic function parameters. Carbohydrate intake showed a positive correlation with HRV LF/HF ratio ($r = 0.28$, $p = 0.006$), suggesting that higher carbohydrate intake was associated with increased sympathetic dominance. Protein intake was positively correlated with HRV RMSSD ($r = 0.34$, $p = 0.002$), indicating that higher protein intake was linked to improved parasympathetic activity. Fat intake exhibited a negative correlation with blood pressure variability ($r = -0.22$, $p = 0.021$), suggesting that higher fat consumption was associated with greater fluctuations in blood pressure. Fiber intake showed a positive correlation with the deep breathing test response ($r = 0.30$, $p = 0.004$), indicating that higher fiber intake was associated with better autonomic function and improved vagal tone.

Multiple Regression Analysis Predicting Autonomic Dysfunction (Table 5)

A multiple regression model was used to identify predictors of autonomic dysfunction. BMI was found to be a significant predictor, with a positive beta coefficient ($\beta = 0.32$, $p = 0.002$), indicating that higher BMI was associated with increased autonomic dysfunction. Waist-hip ratio also showed a significant positive association ($\beta = 0.28$, $p = 0.005$), suggesting that central obesity contributed to autonomic imbalance. Carbohydrate intake was another significant predictor ($\beta = 0.21$, $p = 0.019$), implying that excessive carbohydrate consumption was linked to higher autonomic dysfunction. In contrast, physical activity score was negatively associated with autonomic dysfunction ($\beta = -0.35$, $p < 0.001$), highlighting the protective effect of physical activity in maintaining autonomic balance.

Table 1: Baseline Characteristics of Participants

Variable	Urban (Mean ± SD)	Rural (Mean ± SD)	p-value
Age (years)	30.5 ± 5.4	29.8 ± 5.7	0.312
BMI (kg/m²)	25.8 ± 3.2	24.1 ± 3.0	0.015
Waist-Hip Ratio	0.85 ± 0.04	0.82 ± 0.05	0.028
Body Fat (%)	28.5 ± 5.1	26.3 ± 4.8	0.035
Physical Activity Score	3200 ± 850	4500 ± 920	<0.001

Table 2: Dietary Intake Comparison Between Urban and Rural Participants

Dietary Component	Urban (Mean ± SD)	Rural (Mean ± SD)	p-value
Carbohydrate Intake (g/day)	280 ± 45	320 ± 50	0.002
Protein Intake (g/day)	70 ± 12	75 ± 14	0.045
Fat Intake (g/day)	85 ± 18	65 ± 15	<0.001
Fiber Intake (g/day)	18 ± 6	24 ± 7	0.008
Sodium Intake (mg/day)	2800 ± 450	2600 ± 400	0.072

Table 3: Autonomic Function Parameters in Urban and Rural Participants

Autonomic Function Test	Urban (Mean ± SD)	Rural (Mean ± SD)	p-value
HRV LF/HF Ratio	2.1 ± 0.5	1.8 ± 0.4	0.018
HRV RMSSD (ms)	32.5 ± 8.6	37.8 ± 7.9	0.009
BP Variability (mmHg)	12.5 ± 2.8	11.2 ± 2.5	0.032
Deep Breathing Test (ΔHR, bpm)	16.2 ± 3.9	18.7 ± 4.1	0.015

Table 4: Correlation Between Dietary Components and Autonomic Function

Variable	Correlation Coefficient (r)	p-value
Carbohydrate Intake vs HRV LF/HF Ratio	0.28	0.006
Protein Intake vs HRV RMSSD	0.34	0.002
Fat Intake vs BP Variability	-0.22	0.021
Fiber Intake vs Deep Breathing Test	0.30	0.004

Table 5: Multiple Regression Analysis Predicting Autonomic Dysfunction

Predictor Variable	Beta Coefficient (β)	p-value
BMI	0.32	0.002
Waist-Hip Ratio	0.28	0.005
Carbohydrate Intake	0.21	0.019
Physical Activity Score	-0.35	<0.001

Discussion

The findings of this study provide a comparative insight into the dietary habits, obesity markers, and autonomic function of urban and rural populations. The significantly higher BMI, waist-hip ratio, and body fat percentage observed among urban participants indicate a greater prevalence of obesity in urban settings. This aligns with findings from a study by Popkin et al. (2012), which demonstrated that urbanization is associated with increased sedentary behavior and higher calorie intake, contributing to obesity.[1] Similarly, a study by Misra et al. (2018) reported that urban populations in India and other developing countries show higher rates of central obesity compared to their rural counterparts.[2] The significantly lower physical activity scores in urban participants further support this trend, as previous research by Ng and Popkin (2014) found that urban dwellers engage in less physical activity due to mechanized transport, desk-based jobs, and reduced space for outdoor activities.[3]Rural participants had a higher carbohydrate intake, which is consistent with findings from the study by Drewnowski and Popkin (1997), which reported that rural diets are typically rich in staple grains like rice and wheat.[4] However, urban participants showed a significantly higher fat intake, reflecting an increased consumption of processed and fast foods, as noted in a study by Monteiro et al. (2013).[5] The lower fiber intake in urban participants further supports this dietary shift, as urban diets are often low in whole grains and vegetables, as observed in a study by Satija et al. (2015), which highlighted how urban diets in South Asia are increasingly moving toward Westernized food patterns with lower fiber content. These dietary variations contribute to the differences in obesity and metabolic health observed between the two groups.[6]The results showed that urban participants exhibited a significantly higher HRV LF/HF ratio and lower HRV RMSSD, indicating increased sympathetic dominance and reduced parasympathetic activity. This is consistent with the findings of Thayer et al. (2010), who reported that stress and urban lifestyle factors contribute to autonomic imbalance.[7] Blood pressure variability was also higher in urban participants, which is in line with the findings of Singh et al. (2017), who demonstrated that urban populations have a higher prevalence of hypertension due to increased stress, obesity, and dietary habits.[8] The lower deep breathing test response in urban participants suggests reduced vagal tone, which has been previously reported by Pal et al. (2011) in a study comparing urban and rural cardiovascular health parameters.[9]The positive correlation between carbohydrate intake and HRV LF/HF ratio suggests that high carbohydrate consumption may be associated with increased sympathetic activity, supporting findings from a study by Hall et al. (2012), which demonstrated that high carbohydrate diets could lead to increased insulin resistance and autonomic dysfunction.[10]The observed positive correlation between protein intake and HRV RMSSD indicates a potential protective effect of protein on autonomic function, aligning with findings from research by Leitzmann et al. (2004), which suggested that high-quality protein intake is beneficial for metabolic and cardiovascular health.[11] The negative correlation between fat intake and blood pressure variability highlights the adverse effects of excess fat consumption on cardiovascular regulation, as also reported by Mozaffarian et al. (2010).[12] Additionally, the positive correlation between fiber intake and deep breathing test response suggests that fiber may improve autonomic balance, similar to findings from a study by Slavin (2005), which highlighted the cardiovascular benefits of high-fiber diets.[13]The multiple regression analysis indicated that BMI and waist-hip ratio were significant predictors of autonomic dysfunction, which is consistent with findings from a study by Karason et al. (1999), demonstrating that obesity is linked to reduced vagal activity and increased sympathetic dominance.[14] Carbohydrate intake was also a significant predictor, suggesting that excessive carbohydrate consumption negatively impacts autonomic function, as previously reported by Tentolouris et al. (2003).[15] Conversely, physical activity was negatively associated with autonomic dysfunction, reinforcing findings from a study by Buchheit et al. (2007), which found that increased physical activity improves HRV and overall autonomic balance.[16]

Conclusion

This study highlights significant differences in dietary habits, obesity markers, and autonomic function between urban and rural populations. Urban participants exhibited higher BMI, waist-hip ratio, and body fat percentage, coupled with lower physical activity levels and increased fat consumption, contributing to greater autonomic dysfunction. Rural participants, with higher physical activity and fiber intake, demonstrated better autonomic balance. Significant correlations were observed between dietary components and autonomic function, indicating that high carbohydrate and fat intake were linked to sympathetic dominance, while fiber and protein intake showed protective effects.

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