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Effects of Physical Activity on Depression Among Adults: A Case-Control Study

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ABSTRACT

Background and Objective: Depression affects millions globally, with physical activity proposed as a protective factor. This study aimed to investigate the relationship between physical activity levels and depression among adults in Poonch, AJK, Pakistan, while identifying associated socio-demographic factors. **Materials and Methods:** A case-control study was conducted with 112 adults (56 with depression, 56 controls) at a central military hospital, using purposive sampling. Data were collected through the Patient Health Questionnaire (PHQ-9), Global Physical Activity Questionnaire (GPAQ), and socio-demographic forms. Data were analyzed using R software 4.0.4 (RStudio 1.4.1106), with descriptive statistics, Chi-square tests for categorical variables, t-tests for continuous variables, and significance set at $p \leq 0.05$. **Results:** Cases exhibited significantly higher depression symptoms ($p < 0.0001$) and lower physical activity levels (mean METs/week: 781.28 vs 1048.64, $p = 0.002$) compared to controls. Urban residence was associated with increased odds of depression (AOR = 2.66; 95% CI: 1.03-8.78), while higher physical activity was protective (AOR = 0.998; 95% CI: 0.997-0.999). Age, gender, marital status, education, income, job type, working hours, and BMI showed no significant associations with depression. **Conclusion:** Urban residence emerged as a significant independent risk factor for depression (AOR = 2.66), while higher physical activity levels demonstrated a protective effect (AOR = 0.998). These findings highlight the importance of socio-demographic context and lifestyle factors in depression etiology, suggesting that targeted interventions promoting physical activity and addressing urban-specific stressors may be particularly valuable for depression prevention in this population.

KEYWORDS

Depression, physical activity, PHQ-9, Global Physical Activity (GPAQ), tertiary care hospital

INTRODUCTION

Depression is a leading global mental health disorder, affecting approximately 5% of adults and contributing to over 700,000 suicides annually, with higher prevalence among women and older adults[1]. The substantial burden of depression on individuals and healthcare systems underscores the urgent need for accessible, preventive strategies. Physical activity (PA) has emerged as a robust protective factor against depression, operating through multiple biological and psychosocial pathways, including enhanced

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neurogenesis, regulation of the hypothalamic-pituitary-adrenal axis, reduced inflammation, improved self-esteem, and increased social support[2,3]. Meta-analyses and large-scale cohort studies confirm that higher levels of PA are associated with an 18-25% reduction in depression risk, with benefits observed across age groups, genders, and global regions[4,5]. Even moderate increases in PA, such as regular walking or aerobic exercise, confer significant mental health benefits, and acute bouts of activity can improve affective states in people with depression[6,7].

Despite these well-established benefits, global PA levels remain inadequate, with only 73% of adults meeting WHO guidelines and marked disparities by gender, socioeconomic status, and geography. These gaps are particularly pronounced in conflict-affected and low-resource settings, where the mental health impact of trauma and chronic stress is compounded by limited access to care[8]. Systematic reviews highlight that PA not only reduces depression and anxiety after traumatic events including war, disaster, and pandemic but also promotes resilience, sleep quality, and overall well-being[8]. However, most evidence originates from high-income countries, and little is known about the PA-depression relationship in South Asia, especially in regions like Kashmir, where conflict-related stressors and cultural factors may uniquely shape both PA patterns and mental health outcomes.

Methodological limitations further constrain current knowledge, including reliance on self-reported PA, inadequate adjustment for confounders, and a lack of longitudinal data in young adults a critical period for depression onset[9]. Moreover, depression-specific barriers to PA, such as amotivation and fatigue, are poorly characterized in low- and middle-income countries, where treatment access is severely limited.

This study addresses these critical gaps by investigating the association between physical activity and depression among adults in Poonch, Azad Jammu and Kashmir (AJK), Pakistan, a region with unique sociocultural and environmental stressors. Using validated tools (PHQ-9 and GPAQ) and adjusting for key sociodemographic confounders, this research provides the first evidence on PA-depression dynamics in Kashmiri adults. The findings aim to inform low-cost, scalable interventions and contribute to Pakistan's emerging mental health strategy, particularly as the COVID-19 pandemic has exacerbated both physical inactivity and depression in the region[3,8]. By bridging universal biological mechanisms with local context, this study offers actionable insights for populations facing the dual burdens of conflict and rising depression, where PA represents an accessible, sustainable prevention strategy.

MATERIALS AND METHODS

Study design: An unmatched case-control study was employed to identify factors associated with depression in relation to physical activity levels. This design was selected to efficiently examine the relationship between physical activity and depression by comparing individuals with depression (cases) to those without (controls) within the same population.

Setting: The research was conducted at the Central Military Hospital in Poonch, Azad Jammu and Kashmir (AJK), a 250-bed healthcare facility serving the local population. This setting provided access to both psychiatric services for case identification and general healthcare services for control recruitment within a controlled clinical environment.

Study duration: Data collection was carried out over six months from February 1, 2024, to July 31, 2024. This timeframe allowed for adequate participant recruitment while ensuring consistent data collection conditions throughout the study.

Sample size: The total sample comprised 112 participants, with an equal distribution of 56 cases and 56 controls. The sample size was calculated using the Fleiss method for unmatched case-control studies through Open Epi Version 3. This calculation was based on a global depression prevalence of 5%, physical activity prevalence in Pakistan of 66.5% (as reported by WHO), and a hypothetical physical activity prevalence of 40% among depressed individuals due to the absence of local data.

Sampling technique: A non-probability purposive sampling approach was utilized to select participants who met specific eligibility criteria. Cases were identified through psychiatric clinics and consultations at the hospital, where they underwent initial screening using the Patient Health Questionnaire (PHQ-9). Individuals with depressive symptoms subsequently received a comprehensive psychiatric evaluation by a certified psychiatrist to confirm a depression diagnosis based on DSM-5 criteria. Controls were selected from the same community and healthcare settings to ensure comparable environmental and demographic contexts. They were similarly screened using the PHQ-9 to confirm the absence of depressive symptoms, with a psychiatrist verifying no undiagnosed depression or other psychiatric disorders.

Sample selection: Participants were required to be adults aged 18-40 years of both genders. Exclusion criteria included individuals with Major Depressive Disorder diagnosed more than 30 days prior, those with severe medical conditions limiting physical activity (e.g., cardiovascular diseases, cancer, orthopedic issues), individuals with psychiatric conditions other than depression (such as post-traumatic stress disorder, bipolar disorder, generalized anxiety disorder, adjustment disorder, or eating disorders), and those not engaging in regular physical activity.

Study groups: Cases were defined as individuals clinically diagnosed with Major Depressive Disorder (MDD) within the last 30 days according to DSM-5 criteria. Controls were individuals without a clinical diagnosis of MDD, confirmed through psychiatric evaluation and PHQ-9 screening.

Ethical considerations: The study received ethical approval from the Research Ethics Committee (REC) at the University of Lahore, Pakistan (Reference Number: REC-UOL-/553/08/24, dated 07-05-2024), and was conducted in accordance with the committee's established ethical guidelines. Written informed consent was obtained from all participants after ensuring they fully understood the study's purpose, procedures, and their rights, including the right to withdraw at any time without disadvantages. Participants were informed that the study posed no significant risks, and all data collection procedures were designed to minimize discomfort. Confidentiality was maintained through participant anonymity and secure data storage, which was kept under lock and key with password protection on electronic devices. Data will be securely destroyed after the required retention period, in compliance with data protection regulations and researchers will disclose any potential conflicts of interest.

Data collection procedure: Physical activity levels were assessed using the Global Physical Activity Questionnaire (GPAQ) Version 2, which calculates weekly MET-minutes by combining moderate-intensity activity (minutes×4 MET) and vigorous-intensity activity (minutes×8 MET). Participants were classified into four categories: Physically inactive (<400 MET-minutes/week), mildly physically active (400-599 MET-minutes/week), moderately physically active (600-799 MET-minutes/week), and highly physically active (≥800 MET-minutes/week). Show cards were used to illustrate activity types and assist respondents during questionnaire administration. Participants completed the GPAQ based on their typical weekly routine before MDD diagnosis. Depression was diagnosed according to DSM-5 Criteria for Major Depressive Disorder, requiring at least five symptoms present during two weeks, including either depressed mood or loss of interest/pleasure, along with additional criteria regarding symptom severity, functional impairment, and exclusion of other medical or psychiatric conditions. The GPAQ is a validated tool for estimating physical activity levels[10], while the PHQ-9 and DSM-5 criteria provide reliable methods for depression assessment with established validity and reliability. The data collection process involved participant recruitment through orientation sessions, eligibility screening, physical activity assessment via GPAQ, depression confirmation through psychiatric evaluation, and secure data recording with coding to maintain confidentiality.

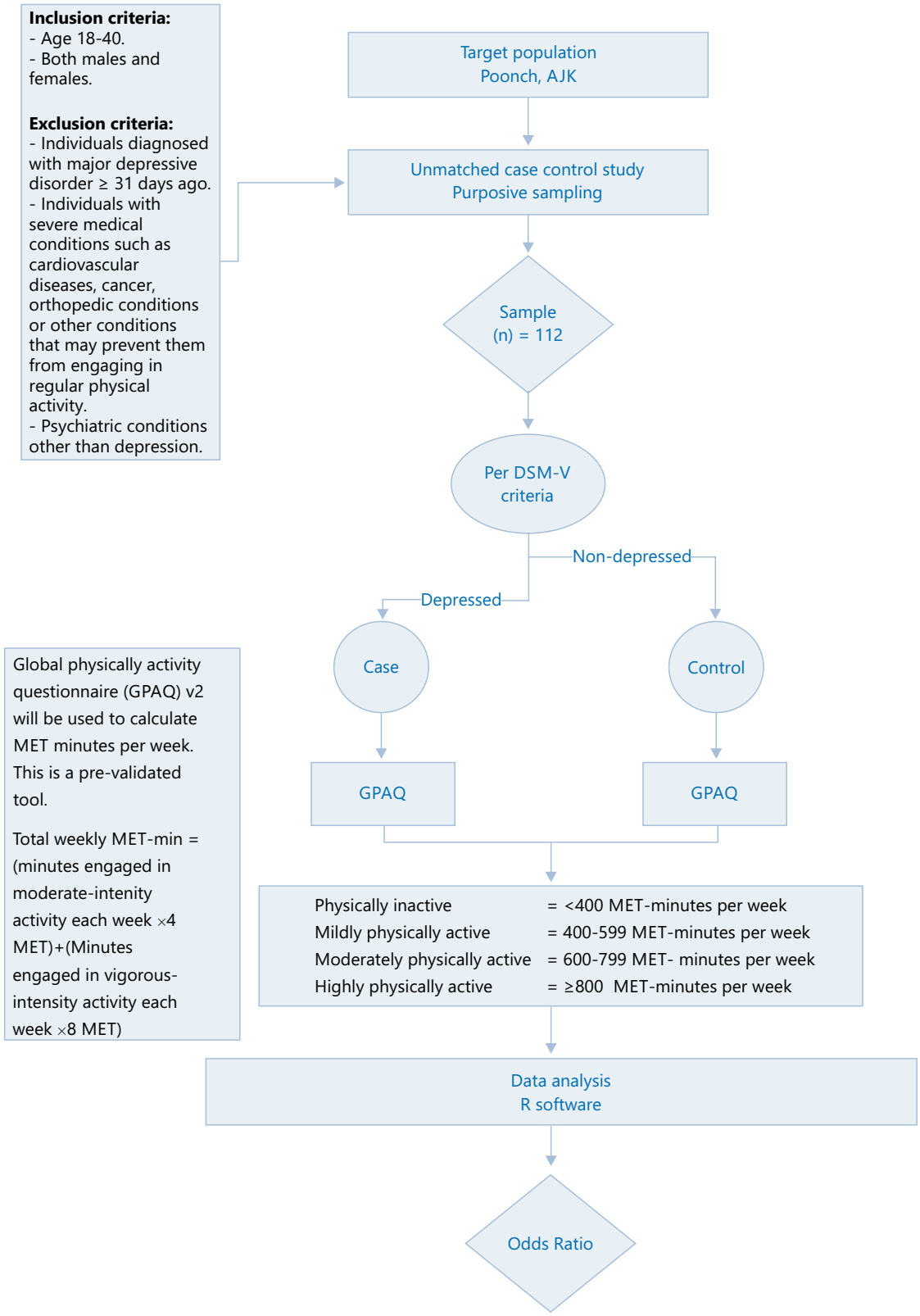

Fig. 1: Conceptual framework and methodological flow for case-control analysis of physical activity and depression

DSM-V: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, GPAQ v2: Global Physical Activity Questionnaire, version 2 and MET (Metabolic Equivalent Task

The conceptual framework and methodological flow of the study are summarized in Fig. 1. Figure 1 illustrates the systematic progression from participant recruitment to statistical inference. The target population comprised residents of Poonch, AJK (n = 112), selected via purposive sampling. Depression

status (Case/Control) was the dependent variable, determined according to DSM-5 criteria, while physical activity (MET-minutes/week) served as the independent variable, measured using GPAQ v2. The framework investigates how varying physical activity levels (<400 to ≥800 MET-minutes/week) correlate with the presence of depression. Data were analyzed using R software, with odds ratios (OR) computed to quantify the influence of physical inactivity on depressive status.

Variables: The dependent variable was Major Depressive Disorder (MDD). Independent variables included physical activity level, age, gender, education, occupation, working hours, and socioeconomic status.

Data analysis procedure: Data were entered and analyzed using R software version 4.0.4 with the RStudio interface (version 1.4.1106). Descriptive statistics were computed for all variables. Frequency and percentages were calculated for categorical variables (e.g., gender, socioeconomic status, and education), whereas mean and standard deviation (±SD) were reported for continuous variables such as age, working hours, and GPAQ (Global Physical Activity Questionnaire) scores.

Group differences between cases and controls were assessed using the Chi-square test for categorical variables and the independent samples t-test for continuous variables. A p-≤0.05 was considered statistically significant.

Variables showing a significant association ($p \leq 0.05$) in the bivariate analysis were included in the multivariable logistic regression model to identify independent predictors of depression. The regression model was fitted using the generalized linear model (glm) function with a binomial family (logit link). Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were computed using the exp function.

To evaluate multicollinearity among predictors, the Variance Inflation Factor (VIF) was calculated, and all variables demonstrated acceptable levels (VIF<2.0). The refined model, including residence and GPAQ score as predictors, showed improvement over the initial model (AIC reduced from 148.11 to 146.26).

RESULTS

Socio-demographic and life style factors: The study included 112 adults (56 cases and 56 controls) with a mean age of 26.72±5.36 years. The majority of participants (77.7%) were aged ≤30 years, with a nearly equal gender distribution (49.1% male, 50.9% female). Over half (56.3%) were married, and education levels varied, with 45.5% holding diplomas and 8.9% having postgraduate degrees. Employment was predominantly in the private sector (50.0%), with a mean monthly income of 37,974.11±10,913.14 PKR. Socioeconomic status was primarily middle class (58.9%), and residence was mainly urban (50.9%). Working hours were ≤8 hours for 57.1% of participants. BMI distribution showed 41.1% normal weight, 31.3% obesity, 19.6% overweight, and 8.0% underweight (Table S1).

Depression symptoms: Cases exhibited substantially higher depression symptoms across all PHQ-9 domains compared to controls ($p<0.0001$). The most prevalent symptoms among cases were loss of interest/pleasure (76.8% nearly every day), depressed mood (66.1%), and sleep disturbances (41.1%). Suicidal ideation was reported by 10.7% of cases versus 1.8% of controls (Table S2). Mean PHQ-9 scores were 8.75±2.06 for cases versus 0.14±0.35 for controls (Table S3).

Physical activity levels: Physical activity levels assessed via GPAQ showed that cases had 21.4% inactive, 3.6% mildly active, 30.4% moderately active, and 44.6% highly active participants. Controls had no inactive or mildly active participants, 44.6% moderately active, and 55.4% highly active. Overall, cases demonstrated lower activity levels than controls. The mean METs/week was 781.28±489.11 for cases and 1048.64±377.81 for controls, with the difference being statistically significant ($p = 0.003$) Fig. 2.

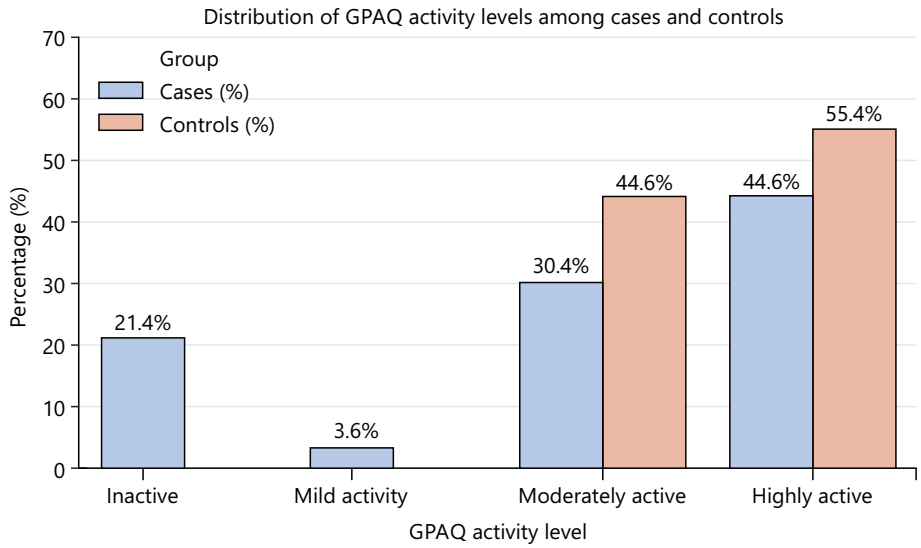

Fig. 2: Distribution of physical activity levels by GPAQ category (n = 112) at Central Military Hospital, Poonch, Azad Jammu and Kashmir

Table 1: Bivariate analysis of socio-demographic and lifestyle factors associated with depression (n = 112) at Central Military Hospital, Poonch, Azad Jammu and Kashmir

Variable	Category/ Measure	Cases n (%)/ Mean±SD	Controls n (%)/ Mean±SD	χ^2/t	p-value	Crude OR (95% CI)
Age (years)	≤30	39 (69.6)	48 (85.7)	4.17	0.041*	0.38 (0.15-0.98)
	>30	17 (30.4)	08 (14.3)			Reference
Gender	Male	26 (46.4)	29 (51.8)	0.32	0.571	0.81 (0.38-1.69)
	Female	30 (53.6)	27 (48.2)			Reference
Education	Diploma Holder	27(48.2)	22(39.3)	0.91	0.341	1.14 (0.68-3.04)
	Other Degrees	29(51.8)	34(60.7)			Reference
Marital status	Married	34 (60.7)	29 (51.8)	0.91	0.341	1.44 (0.68-3.04)
	Unmarried	22 (39.3)	27 (48.2)			Reference
Income (PKR)	≤35 000	29 (51.8)	25 (44.6)	0.57	0.449	1.33 (0.63-2.80)
	>35 000	27 (48.2)	31 (55.4)			Reference
Residence	Urban	28 (50.0)	40 (71.4)	5.39	0.02*	2.5 (1.14-5.46)
	Rural	28 (50.0)	16 (28.6)			Reference
Job type	Private	31 (55.4)	25 (44.6)	1.29	0.257	1.54 (0.73-3.24)
	Others	25 (44.6)	31 (55.4)			Reference
Working hours/day	≤8	29 (51.8)	35 (62.5)	1.31	0.252	0.64 (0.30-1.37)
	>8	27 (48.2)	21 (37.5)			Reference
BMI status	Abnormal	31 (55.4)	35 (62.5)	0.59	0.442	0.74 (0.35-1.58)
	Normal	25 (44.6)	21 (37.5)			Reference
Physical activity (GPAQ)	METs/week (continuous)	781.28±489.11	1048.64±377.81	t = -3.09	0.003*	0.861 (0.773-0.949)

n: Number of participants, SD: Standard deviation, χ^2: Chi-square test, t: Independent samples t-test, OR: Odds ratio, CI: Confidence interval, GPAQ: Global Physical Activity Questionnaire, METs: Metabolic equivalent task minutes per week and Reference: Category used as the baseline for odds ratio calculation. p≤0.05 indicates statistical significance (*). Continuous variables (age, GPAQ METs/week) are presented as mean±SD and analyzed using t-test, Categorical variables are presented as frequency (%) and analyzed using Chi-square test

Table. 2: Multivariable logistic regression analysis of factors associated with depression (n = 112) at Central Military Hospital, Poonch, Azad Jammu and Kashmir

Predictors	Response category	Odds ratio	CI (2.5-97.5%)	p-value
Residence	Urban	2.66	1.03-8.78	0.019
	Rural	Reference		
GPAQ	Continuous	0.998	0.997-0.999	0.003
R^2 Tjur	0.097			

p<0.05 considered statistically significant, CI = Confidence Interval

Association of socio-demographic and lifestyle factors with case control status: Age, residence, and GPAQ showed significant associations with depression in bivariate analysis. Adults >30 years had lower odds of depression (OR = 0.382, 95% CI: 0.149-0.979) compared to younger participants. Urban residents had higher depression odds (OR = 2.500, 95% CI: 1.140-5.460) than rural residents. Physical activity levels were significantly lower in cases (mean METs/week: 781.28±489.11) compared to controls (1048.64±377.81) (p = 0.003). Each unit increase in METs/week was associated with a 13.9% reduction in the odds of depression (OR=0.861, 95% CI: 0.773-0.949). Gender, marital status, education, income, job type, working hours, and BMI status showed no significant associations with depression (Table 1).

In the multivariable logistic regression model (Table 2), urban residence (AOR = 2.66, 95% CI: 1.03-8.78, p = 0.019) and higher physical activity levels (GPAQ METs/week) (AOR = 0.998, 95% CI: 0.997-0.999, p = 0.003) were significant predictors of depression. The model explained 9.7% of the variance (Tjur's R^2). Notably, higher physical activity was associated with lower odds of depression, while urban residence was associated with higher odds of depression in the adjusted model. Age, which was significant in bivariate analysis, was not retained in the final multivariable model.

DISCUSSION

The present study reinforces and expands on the evidence that both urban residence and lower physical activity (PA) levels are independently associated with higher depression risk among adults in Poonch, AJK. These findings are consistent with, but also nuanced by, recent global and regional research.

Recent meta-analyses and large-scale studies confirm that urban residence is often linked to higher depression prevalence, particularly in developed countries and increasingly in rapidly urbanizing regions of Asia. For example, a 2023 meta-analysis found urban residents had significantly higher odds of depression than rural residents in developed countries, though this pattern is less consistent in developing countries, where contextual factors such as social cohesion and access to services may differ[11-13]. In South Korea, urban residents now show higher depression rates than rural residents, a reversal from earlier years, likely due to urban stressors such as social isolation, environmental pollution, and changing lifestyles[12]. However, some studies in India and China report higher depression rates in rural areas, often attributed to socioeconomic disadvantage and limited healthcare access, highlighting the importance of local context[14,15].

The protective effect of physical activity against depression is robust and well-documented across diverse populations and study designs. Large meta-analyses and umbrella reviews consistently show that higher PA levels, especially moderate-to-vigorous activity, are associated with significantly reduced odds of depression, regardless of age, gender, or region[5,16-20]. Even low-to-moderate intensity PA confers substantial benefits, and the effect is observed in both cross-sectional and longitudinal studies[5,17,19]. Biological mechanisms include increased BDNF expression, anti-inflammatory effects, and improved neuroplasticity, while psychosocial mechanisms involve enhanced social support and reduced loneliness, particularly when PA is group-based[21,22].

The urban-rural depression gap may be mediated by differences in physical health, social participation, and environmental exposures. In China, urban-rural disparities in depression among older adults are partly explained by differences in physical health and self-reported health status[23]. In urban settings, lack of green space, noise, and social fragmentation are key stressors, while rural areas may offer protective social networks but also face unique challenges such as poverty and healthcare barriers[12,13,15]. The loss of age significance in multivariable models, as seen in this study, is echoed in recent research showing that the relationship between age and depression is often mediated by PA and social engagement[23].

While obesity rates are high in this sample, the association between BMI and depression remains inconsistent across studies and populations. Some research finds no significant link, especially in South Asian populations, while others report a U-shaped relationship or associations modified by gender and cultural factors[12,24].

This study's strengths include its focus on an underrepresented region of Poonch, the use of validated tools, and comprehensive confounder adjustment. However, limitations such as single-center design, self-reported PA, and the cross-sectional nature of the data are common in the field and underscore the need for longitudinal, multi-site studies to confirm these findings and explore temporal relationships. using objective PA measures and biomarker assessments[5,16]. Future research should incorporate objective PA measures (e.g., accelerometers) and the integration of biomarkers to investigate underlying biological mechanisms. Furthermore, we encourage research into the specific urban stressors, cultural attitudes toward PA, and tailored interventions in conflict-affected or low-resource regions. Such research is vital for closing the treatment gap in Pakistan and informing policy focused on activity-friendly urban environments, integrating mental and physical health services[16,17].

CONCLUSION

This study adds to a growing body of evidence that urban residence and low physical activity are key, modifiable risk factors for depression. Effective prevention in conflict-affected and rapidly urbanizing regions requires concrete, multi-sectoral actions, including the promotion of community-based physical activity programs and the integration of mental health screening into primary healthcare. Furthermore, policy recommendations should prioritize creating activity-friendly urban infrastructure, such as safe public parks and walkable pathways, to address the environmental determinants of mental health. Implementing these context-sensitive strategies is essential for closing the treatment gap and reducing the high depression burden in Pakistan.

SIGNIFICANCE STATEMENT

This study highlights that urban living increases depression risk, while higher physical activity offers protective benefits among adults in Poonch, AJK. Identifying socio-demographic and lifestyle factors associated with depression underscores the need for targeted public health strategies. Promoting physical activity and addressing urban stressors can help prevent depression, guiding policymakers and healthcare providers in designing effective, context-specific interventions.

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Supplementary Data

Table S1: Socio-demographic and lifestyle characteristics of study participants (n = 112)

Variable	Total (n = 112) n (%)	Cases (n = 56) n (%)	Controls (n = 56) n (%)
Age (years)			
Mean±SD	26.72±5.36	-	-
≤30 years	87 (77.7%)	39 (69.6%)	48 (85.7%)
>30 years	25 (22.3%)	17 (30.4%)	8 (14.3%)
Gender			
Male	55 (49.1%)	26 (46.4%)	29 (51.8%)
Female	57 (50.9%)	30 (53.6%)	27 (48.2%)
Marital status			
Single	49 (43.8%)	22 (39.3%)	27 (48.2%)
Married	63 (56.3%)	34 (60.7%)	29 (51.8%)
Highest education			
High school	34 (30.4%)	-	-
Diploma	51 (45.5%)	26 (46.4%)	29 (51.8%)
Undergraduate	17 (15.2%)	-	-
Postgraduate	10 (8.9%)	-	-
Socio-economic status			
Low	38 (33.9%)	-	-
Middle	66 (58.9%)	-	-
High	8 (7.2%)	-	-
Family income (PKR)			
Mean±SD	37,974±10,913	-	-
≤35,000	54 (48.2%)	29 (51.8%)	25 (44.6%)
>35,000	58 (51.8%)	27 (48.2%)	31 (55.4%)
Employment status			
Government sector	25 (22.3%)	-	-
Private sector	56 (50.0%)	31 (55.4%)	25 (44.6%)
Self-employed	22 (19.6%)	-	-
Unemployed	9 (8.0%)	-	-
Residence			
Rural	44 (39.3%)	28 (50.0%)	16 (28.6%)
Urban	57 (50.9%)	28 (50.0%)	40 (71.4%)
Semi-urban	11 (9.8%)	-	-
Dietary pattern			
Home-made	52 (46.4%)	-	-
Fast food	49 (43.8%)	-	-
Outside	11 (9.8%)	-	-
Working hours per day			
≤8 hours	64 (57.1%)	29 (51.8%)	35 (62.5%)
>8 hours	48 (42.9%)	27 (48.2%)	21 (37.5%)
Body mass index (kg/m^2)			
Mean±SD	24.12±4.10	-	-
Underweight	9 (8.0%)	-	-
Normal weight	46 (41.1%)	25 (44.6%)	21 (37.5%)
Overweight	22 (19.6%)	-	-
Obese	35 (31.3%)	31 (55.4%)	35 (62.5%)
Physical activity (GPAQ)			
Mean METs/week±SD	914.96±455.30	781.28±489.11	1048.64±377.81
Inactive	12 (10.7%)	12 (21.4%)	0 (0.0%)
Light activity	2 (1.8%)	2 (3.6%)	0 (0.0%)
Moderate activity	42 (37.5%)	17 (30.4%)	25 (44.6%)
Highly active	56 (50.0%)	25 (44.6%)	31 (55.4%)

-: Not reported separately by group in the original analysis, GPAQ: Global Physical Activity Questionnaire, METs: Metabolic equivalent of task and PKR: Pakistani rupees

Table S2: PHQ-9 symptom-level frequency distribution among cases and controls

	Cases (n = 56) - n (%)				Controls (n = 56) - n (%)	
PHQ-9 Item	Not at all	Several days	>Half days	Nearly every day	Not at all	Several days
1. Little interest or pleasure in doing things	12 (21.4%)	0 (0.0%)	1 (1.8%)	43 (76.8%)	56 (100%)	0 (0.0%)
2. Feeling down, depressed, or hopeless	15 (26.8%)	0 (0.0%)	4 (7.1%)	37 (66.1%)	55 (98.2%)	1 (1.8%)
3. Trouble falling or staying asleep, or sleeping too much	29 (51.8%)	1 (1.8%)	3 (5.4%)	23 (41.1%)	55 (98.2%)	1 (1.8%)
4. Feeling tired or having little energy	38 (67.9%)	5 (8.9%)	5 (8.9%)	8 (14.3%)	55 (98.2%)	1 (1.8%)
5. Poor appetite or overeating	38 (67.9%)	2 (3.6%)	10 (17.9%)	6 (10.7%)	53 (94.6%)	3 (5.4%)
6. Feeling bad about yourself or letting others down	41 (73.2%)	2 (3.6%)	11 (19.6%)	2 (3.6%)	56 (100%)	0 (0.0%)
7. Trouble concentrating on things	46 (82.2%)	4 (7.1%)	1 (1.8%)	5 (8.9%)	55 (98.2%)	1 (1.8%)
8. Moving or speaking so slowly that others noticed	50 (89.3%)	3 (5.4%)	2 (3.6%)	1 (1.8%)	56 (100%)	0 (0.0%)
9. Thoughts of being better off dead or hurting yourself	47 (83.9%)	0 (0.0%)	3 (5.4%)	6 (10.7%)	55 (98.2%)	1 (1.8%)

Values expressed as n (%). Bold text cells indicate ≥10% of cases reporting symptoms nearly every day. Controls reported near-zero symptom burden across all items

Table S3: Mean PHQ-9 score and physical activity level by study group

Measure	Cases (n = 56) Mean±SD	Controls (n = 56) Mean±SD	p-value
PHQ-9 total score	8.75±2.06	0.14±0.35	<0.0001
Physical activity (METs/week)	781.28±489.11	1048.64±377.81	0.002

*Statistically significant ($p<0.05$), PHQ-9: Patient Health Questionnaire-9 and METs: Metabolic equivalent of task, Mean differences were tested using an independent samples t-test