

BURDEN AND CORRELATES OF NON-COMMUNICABLE DISEASES AMONG INMATES IN SELECTED PRISONS OF PUNJAB, PAKISTAN: A CROSS-SECTIONAL STUDY

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DOI: <https://doi.org/10.5281/zenodo.22894808>

Keywords

anxiety, behavioural risk, depression, hypertension, incarceration, obesity

Article History

Received: 01 February 2026

Accepted: 17 March 2026

Published: 31 March 2026

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Abstract

Objectives: To determine the prevalence of major non-communicable disease (NCD) outcomes and explore the lifestyle and institutional factors associated with NCDs of inmates in selected prisons of Punjab, Pakistan.

Methodology: An analytical cross-sectional study was conducted among 425 under-trial and convicted inmates aged 18–60 years. Information on lifestyle behaviours, anthropometric measurements, environment in prison and factors in the prison was gathered through questionnaires and the necessary measurements were taken. Depression and anxiety were assessed using PHQ-9 and GAD-7, respectively. Descriptive, bivariate, and multivariable logistic regression analyses were performed. Adjusted odds ratios (AORs) with 95% confidence intervals were reported.

Results: A total of 91.5% of prisoners had at least one NCD. Common NCD outcomes were depression (65.9%), obesity (57.9%), anxiety (55.3%) and high blood pressure (26.4%). The behavioural risk score was independently associated with any NCD (AOR=1.54). Both high blood pressure and age were higher with each strata of legal-status, as well as BMI. Environmental risk was associated with depression among under-trial (AOR=3.51) and convicted inmates (AOR=2.29). Institutional risk was independently associated with anxiety in both strata.

Conclusion: The outcomes of NCD events were frequently reported, and had behavioural, anthropometric, environmental and institutional correlational patterns. The current cross-sectional results suggest that there are be multidimensional differences in NCD morbidity, but they cannot be used to draw causal conclusions.

INTRODUCTION

Non-communicable diseases (NCDs) constitute an important but insufficiently characterized component of the health burden among incarcerated populations. In case of Pakistan and South Asia, local scoping reviews reveal an alarming NCD burden; up to 61% of some inspected prison populations meet the criteria for hypertension, and combined cases of

hypertension and diabetes are prevalent.¹ Inmates may have social determinants of health issues like hypertension, diabetes, overweight and obesity, as well as psychological health and a lack of continuity of health care that can also be exacerbated by living in prison, and that can co-occur. Therefore, to gain an understanding of NCDs in prisons, it is necessary to understand

factors beyond prevalence, such as lifestyle and institutional factors of NCDs.

Further research in prison health in other countries around the world has shown that there is a high prevalence of chronic NCDs among the prison population, albeit with significant different magnitudes and factors between prisons.^{2,4} Especially lifestyle exposures are important. Excess weight, physical inactivity, diet and tobacco use are recognized as being of concern in correctional populations.^{5,7} The results presented herein reveal that the level of NCD morbidity among prisoners is a problem that affects the individual prisoner but cannot be solely interpreted as a problem related to clinical approach and care. It should be embedded in a specific prison context of behaviour and institutions.

Previous research studies have explored patterns around individual NCDs or specific behavioural risk factors, while fewer studies have explored lifestyle and institutional level risk factors for multiple major NCD outcomes. This distinction is important because lifestyle exposures can be combinations and institutional determinants such as access to health care, screening, length of stay and continuity of care, and treatment protocols for chronic diseases. Hewson et al. further demonstrated the importance of prison-based approaches to the detection, monitoring, and management of chronic NCDs, highlighting the relevance of institutional healthcare alongside individual-level exposures.⁸

Available research evidence in Pakistan has identified NCD risk factors among prisoners, including women, while recent studies have highlighted the growing NCD burden and persistent gaps in prison-specific evidence.^{1,9,10} The availability of evidence that includes lifestyle and institutional factors associated with major NCD outcomes within prison setting for inmates from Punjab is now limited. This study is novel in looking at a group of major NCD outcomes, and life style and institutional factors, in a same population of prisoners to see how both these factors are independently associated with the various outcomes after controlling for other factors measured in the study. The results indicate a context-specific evidence of the multidimensional pattern of NCDs among inmates in Punjab, while demonstrating the

most relevant correlates of these morbidities, which does not imply the causal effects observed.

Research Methodology

An analytical cross-sectional study was conducted among 425 adult inmates from selected prisons in Punjab, Pakistan, comprising under-trial and convicted inmates. The age range of the participants eligible was 18-60 years who have stayed in prison for at least 6 months. Relevant data were collected by a structured and pre-tested questionnaire on lifestyle behaviours, food habits, physical exercise and fitness, drug and alcohol consumption, institutional and environmental issues. Body mass index (BMI) and waist circumference were anthropometric measure units. The characterisation of the cardiometabolic outcomes was based on the measurement of blood pressure and available glycaemic indicators. The Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7) scales were used for depression and anxiety symptoms, respectively; and conditions were considered to be clinically relevant if score ≥ 10 . The study variables pertaining to each of the three types of exposure were used to build behavioural, environmental and institutional risk scores, where a higher score indicated a higher exposure burden.

The outcomes of non-communicable disease included high blood pressure, elevation of glycaemic measures, obesity, depression, anxiety and composite non-communicable diseases. Categorical variables were reported as frequencies and percentages and non-normally-distributed continuous variables as median and interquartile range. Comparisons were made between legal status and between NCD-groups using the appropriate tests (chi-square, Fisher's exact test or Mann-Whitney U test). Categorical exposures' crude odds ratios (ORs) with 95% CIs were computed and Cramér's V and rank-biserial correlation were used to measure effect sizes. Analysis of factors independently associated with any NCD, high blood pressure, depression and anxiety were analysed using multivariable logistic regression, stratified by legal status. Due to our small study sample, adjusted odds ratios (AORs) were reported along with 95% confidence intervals (95% CIs) and p-values for statistical significance with set at < 0.05 .

Results

The prevalence analysis showed that there was significant burden of NCD outcomes among the 425 inmates. Overall, 91.5% (95% CI: 88.5–93.8) had at least one NCD. Depression (PHQ-9 ≥ 10) was the most common single outcome (65.9%), and followed by overweight/obesity (57.9%), anxiety (GAD-7 ≥ 10 ; 55.3%) and high blood pressure (26.4%). 16.0% were obese and

13.9% had a high random blood glucose. The percentages of high fasting blood glucose (31.1%, 38/122) and HbA1c $\geq 6.5\%$ (7.4%, 6/81) given to the various subgroups tested are not a reflection of the prevalence in the subgroups and should not be used to infer the true prevalence for the respective subgroups (Table 1).

Table 1. Prevalence of Major Non Communicable Disease Outcomes Overall and by Legal Status

Disease/condition	Overall prevalence n/N (%; 95% CI)	Under-trial n/N (%)	Convicted n/N (%)	Crude OR (Under-trial vs Convicted; 95% CI)	p-value	Effect size
High blood pressure	112/425 (26.4; 95% CI 22.4-30.7)	85/255 (33.3)	27/170 (15.9)	2.65 (1.63- 4.31)	<0.001	Phi/Cramer's V=0.194
High random blood glucose	59/425 (13.9; 95% CI 10.9-17.5)	43/255 (16.9)	16/170 (9.4)	1.95 (1.06- 3.59)	0.030	Phi/Cramer's V=0.106
High fasting blood glucose	38/122 (31.1; 95% CI 23.6-39.8)	27/76 (35.5)	11/46 (23.9)	1.75 (0.77- 4.00)	0.179	Phi/Cramer's V=0.122
High HbA1c $\geq 6.5\%$	6/81 (7.4; 95% CI 3.4-15.2)	4/49 (8.2)	2/32 (6.2)	1.33 (0.23- 7.74)	1.000	Phi/Cramer's V=0.036
Obesity	68/425 (16.0; 95% CI 12.8-19.8)	52/255 (20.4)	16/170 (9.4)	2.47 (1.36- 4.48)	0.002	Phi/Cramer's V=0.147
Overweight/obese	246/425 (57.9; 95% CI 53.1-62.5)	173/255 (67.8)	73/170 (42.9)	2.80 (1.88- 4.19)	<0.001	Phi/Cramer's V=0.247
Depression PHQ-9 ≥ 10	280/425 (65.9; 95% CI 61.3-70.2)	178/255 (69.8)	102/170 (60.0)	1.54 (1.03- 2.32)	0.037	Phi/Cramer's V=0.101
Anxiety GAD-7 ≥ 10	235/425 (55.3; 95% CI 50.5-60.0)	200/255 (78.4)	35/170 (20.6)	14.03 (8.71- 22.59)	<0.001	Phi/Cramer's V=0.570
Any non-communicable disease	389/425 (91.5; 95% CI 88.5-93.8)	247/255 (96.9)	142/170 (83.5)	6.09 (2.70- 13.72)	<0.001	Phi/Cramer's V=0.235

Wasting/malnutrition	40/425 (9.4; 95% CI 7.0- 12.6)	19/255 (7.5)	21/170 (12.4)	0.57 (0.30- 1.10)	0.090	Phi/Cramer's V=0.082
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A clear distinction in status of the crude components was observed based on the legal status. The prevalence of at least one NCD amongst under-trials was higher than that amongst convicts (96.9% vs 83.5%) with a highly significant crude Odds ratio (OR = 6.09 [95% CI: 2.70–13.72]; $p < 0.001$). The most significant difference was with regards to anxiety, reported by 78.4% of under-trial inmates versus 20.6% of convicted inmates (OR= 14.03, 95% CI: 8.71–22.59; $p < 0.001$ - large effect size, Cramér's $V=0.570$). Crude odds of overweight/obesity (OR=2.80), high blood pressure (OR=2.65), obesity (OR=2.47), high random blood glucose (OR=1.95) and depression (OR=1.54) were also significantly higher among under-trial inmates (Table 2).

Inmates with and without NCDs were clearly different though through bivariate lifestyle and anthropometric analysis. The highest continuous variable effect was for inmates with an NCD compared with those without an NCD

who had a higher median BMI (26.6 vs 22.9 kg/m², respectively; $p < 0.001$; $r=0.555$); waist circumference also was greater (88.0 vs 83.5 cm, respectively; $p < 0.001$; $r=0.454$). Compared to inmates without NCDs, inmates with NCDs reported an increase in sitting time for the day (7.7 vs 6.8 hours; $p < 0.001$), decrease in days of vigorous activity (1 vs 2 days/week; $p=0.001$) and an increase in behavioural risk score (3 vs 2; $p < 0.001$). The strongest categorical lifestyle association was that of physical inactivity, with crudely the risk of an NCD being over five times as great for inmates who were physically inactive (OR>5.55, 95% CI: 2.64–11.66; $p < 0.001$). Current tobacco use was also associated with higher odds (OR=2.37, 95% CI: 1.15–4.88; $p=0.016$). The overall association of salty/preserved food consumption with NCD status was present ($p=0.039$) while there was no significant overall association for the other two indicators of poor diet (Table 2).

Table 2. Lifestyle and Anthropometric Determinants of Any Non Communicable Disease

Factor	Category/statistic	No NCD n (%) or summary	Any NCD n (%) or summary	Crude OR (95% CI)	p- value	Effect size
Average cigarettes per day	Median (IQR)	0.0 (0.0-8.2)	5.0 (0.0-14.0)	Not applicable	0.010	Rank-biserial $r=0.245$
AUDIT score	Median (IQR)	20.5 (10.8-32.2)	23.0 (14.0-33.0)	Not applicable	0.273	Rank-biserial $r=0.110$
Fruit servings per day	Median (IQR)	0.0 (0.0-1.0)	1.0 (0.0-1.0)	Not applicable	0.028	Rank-biserial $r=0.200$
Vegetable servings per day	Median (IQR)	0.5 (0.0-1.0)	1.0 (0.0-1.0)	Not applicable	0.072	Rank-biserial $r=0.168$
Vigorous activity days per week	Median (IQR)	2.0 (0.0-2.0)	1.0 (0.0-1.0)	Not applicable	0.001	Rank-biserial $r=-0.304$
Sitting hours per day	Median (IQR)	6.8 (5.8-7.4)	7.7 (6.5-8.8)	Not applicable	<0.001	Rank-biserial $r=0.373$

Body mass index	Median (IQR)	22.9 (21.2-23.9)	26.6 (23.1-28.1)	Not applicable	<0.001	Rank-biserial r=0.555
Waist circumference	Median (IQR)	83.5 (80.8-84.5)	88.0 (83.0-93.3)	Not applicable	<0.001	Rank-biserial r=0.454
Behavioural risk score	Median (IQR)	2.0 (1.0-3.0)	3.0 (2.0-4.0)	Not applicable	<0.001	Rank-biserial r=0.397
Current tobacco use	No	24 (66.7)	178 (45.8)	Reference	0.016	Cramer's V=0.117
	Yes	12 (33.3)	211 (54.2)	2.37 (1.15-4.88)		
Physical inactivity	No	25 (69.4)	113 (29.0)	Reference	<0.001	Cramer's V=0.240
	Yes	11 (30.6)	276 (71.0)	5.55 (2.64-11.66)		
Salty/preserved food intake	Never	8 (22.2)	54 (13.9)	Reference	0.039	Cramer's V=0.141
	Sometimes	13 (36.1)	83 (21.3)	0.95 (0.37-2.43)		
	Often	10 (27.8)	131 (33.7)	1.94 (0.73-5.18)		
	Always	5 (13.9)	121 (31.1)	3.59 (1.12-11.46)		
Hazardous alcohol use	No	4 (11.1)	45 (11.6)	Reference	1.000	Cramer's V=0.004
	Yes	32 (88.9)	344 (88.4)	0.96 (0.32-2.83)		
Poor diet indicator	No	2 (5.6)	37 (9.5)	Reference	0.761	Cramer's V=0.038
	Yes	34 (94.4)	352 (90.5)	0.56 (0.13-2.42)		

There were also differences between inmates with and without NCDs at the bivariate analysis level which were related to institutional characteristics. Time spent in prison was significantly longer for those with NCDs (29 vs 17 months; $p<0.001$; $r=0.392$) and the crude odds of incarceration for 25–60 months were greater than those for incarceration for 6–12 months (OR=4.46, 95% CI: 1.69–11.78). Both psychometric risk scores for institutional level and environmental level were positive with a

relatively larger effect size for the individuals with NCDs ($r = 0.592$ and 0.536 , respectively). The use of traveling practitioners was linked to a greater crude odds for NCDs (higher by a factor of 5.21, 95% CI: 1.81–15.05 compared with access to an on-site clinic). Previous exposure to health professional was also associated with NCD status (OR=2.58, 95% CI: 1.24–5.40) and inmates who had NCDs also visited health professionals more frequently (Table 3).

Table 3. Institutional Determinants of Any Non Communicable Disease

Factor	Category/statistic	No NCD n (%) or summary	Any NCD n (%) or summary	Crude OR (95% CI)	p-value	Effect size
Prison duration	Median (IQR)	17.0 (10.8-23.5)	29.0 (17.0-48.0)	Not applicable	<0.001	Rank-biserial r=0.392
Health visits in past 12 months	Median (IQR)	0.0 (0.0-2.0)	2.0 (0.0-4.0)	Not applicable	0.009	Rank-biserial r=0.246
Institutional risk score	Median (IQR)	2.0 (1.0-2.0)	3.0 (2.0-5.0)	Not applicable	<0.001	Rank-biserial r=0.592
Environmental risk score	Median (IQR)	1.0 (0.0-1.0)	2.0 (1.0-3.0)	Not applicable	<0.001	Rank-biserial r=0.536
Prison duration group	6-12 months	12 (33.3)	70 (18.0)	Reference	<0.001	Cramer's V=0.199
	13-24 months	15 (41.7)	84 (21.6)	0.96 (0.42-2.19)		
	25-60 months	7 (19.4)	182 (46.8)	4.46 (1.69-11.78)		
	>60 months	2 (5.6)	53 (13.6)	4.54 (0.97-21.17)		
Access to medical services	On-site clinic	32 (88.9)	224 (57.6)	Reference	0.001	Cramer's V=0.179
	Visiting doctor	4 (11.1)	146 (37.5)	5.21 (1.81-15.05)		
	No services	0 (0.0)	19 (4.9)	5.65 (0.33-95.78)		
Seen health professional in past 12 months	No	25 (69.4)	182 (46.8)	Reference	0.009	Cramer's V=0.126
	Yes	11 (30.6)	207 (53.2)	2.58 (1.24-5.40)		
Chronic medicines available	Always	21 (58.3)	214 (55.0)	Reference	0.862	Cramer's V=0.026
	Sometimes	9 (25.0)	114 (29.3)	1.24 (0.55-2.80)		
	Never	6 (16.7)	61 (15.7)	1.00 (0.39-2.58)		
Blood pressure measured in past 12 months	No	19 (52.8)	186 (47.8)	Reference	0.569	Cramer's V=0.028
	Yes	17 (47.2)	203 (52.2)	1.22 (0.62-2.42)		
	No	22 (61.1)	223 (57.3)	Reference	0.660	

Blood glucose measured in past 12 months	Yes	14 (38.9)	166 (42.7)	1.17 (0.58-2.35)		Cramer's V=0.021
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Multivariate analysis further clarified a number of these very basic correlations (Table 4). After adjusting for other factors, behavioural risk score was the only independent correlate for all NCDs (AOR=1.54, 95% CI: 1.12-2.11; $p=0.007$), while other factors such as prison duration, environmental risk and institutional risk were reduced. In both legal-status categories, with BP, increasing age was also an independent risk factor, while institutional risk was also statistically significant in individuals who were convicted (AOR=2.11, 95% CI : 1.05 - 4.25).

The variables of environmental risk and behavioural risk were further associated with depression, independently, in both strata, and in combination with environmental risk when only convicted inmate's were analysed. Among the under-trial inmates, anxiety was found to be statistically significantly associated with institutional risk (AOR=2.51, 95% CI: 1.43-4.39) and behavioural risk (AOR=1.88, 95% CI: 1.37-2.58); while, institutional risk remained statistically significant among the convicted inmates (AOR=2.22, 95% CI: 1.15-4.32).

Table 4. Final Adjusted Logistic Regression Models for Major NCD Outcomes

Outcome	Stratum	Predictor	Adjusted OR (95% CI)	p-value	Model n	Events
Any NCD	Overall	Age, per 10-year increase	1.33 (0.89-1.99)	0.157	425	389
		Prison duration, per year	1.10 (0.79-1.53)	0.590		
		Behavioural risk score	1.54 (1.12-2.11)	0.007		
		Environmental risk score	1.56 (0.75-3.27)	0.236		
		Institutional risk score	1.44 (0.75-2.78)	0.276		
High blood pressure	Under-trial	Age, per 10-year increase	1.93 (1.37-2.71)	<0.001	255	85
		BMI, per 5 kg/m ² increase	2.06 (1.41-3.00)	<0.001		
		Behavioural risk score	0.93 (0.72-1.19)	0.550		
		Environmental risk score	0.86 (0.49-1.52)	0.607		
		Institutional risk score	1.29 (0.76-2.18)	0.343		
	Convicted	Age, per 10-year increase	2.64 (1.60-4.35)	<0.001	170	27
		BMI, per 5 kg/m ² increase	2.76 (1.43-5.31)	0.002		
		Behavioural risk score	0.89 (0.61-1.31)	0.562		
		Environmental risk score	0.55 (0.26-1.19)	0.129		
		Institutional risk score	2.11 (1.05-4.25)	0.037		

Depression PHQ-9 ≥ 10	Under-trial	Age, per 10-year increase	0.88 (0.62-1.26)	0.486	255	178
		BMI, per 5 kg/m ² increase	1.19 (0.80-1.76)	0.395		
		Behavioural risk score	1.22 (0.92-1.61)	0.160		
		Environmental risk score	3.51 (1.78-6.91)	<0.001		
		Institutional risk score	0.83 (0.46-1.47)	0.515		
	Convicted	Age, per 10-year increase	0.70 (0.49-1.01)	0.059	170	102
		BMI, per 5 kg/m ² increase	1.09 (0.65-1.82)	0.738		
		Behavioural risk score	1.43 (1.05-1.95)	0.025		
		Environmental risk score	2.29 (1.22-4.28)	0.009		
		Institutional risk score	1.14 (0.66-1.97)	0.639		
Anxiety GAD-7 ≥ 10	Under-trial	Age, per 10-year increase	0.79 (0.53-1.16)	0.231	255	200
		BMI, per 5 kg/m ² increase	0.92 (0.60-1.41)	0.700		
		Behavioural risk score	1.88 (1.37-2.58)	<0.001		
		Environmental risk score	0.82 (0.45-1.48)	0.514		
		Institutional risk score	2.51 (1.43-4.39)	0.001		
	Convicted	Age, per 10-year increase	0.91 (0.59-1.40)	0.662	170	35
		BMI, per 5 kg/m ² increase	1.54 (0.87-2.72)	0.138		
		Behavioural risk score	1.25 (0.87-1.79)	0.224		
		Environmental risk score	0.98 (0.51-1.91)	0.961		
		Institutional risk score	2.22 (1.15-4.32)	0.018		

Discussion

The present study shows high prevalence of NCD outcomes in the prisons of Punjab and different anthropometric, lifestyle, environmental and institutional factors associated with NCD in prisons. The majority (over 90%) of all participants had at least one of the NCD defined by the study, especially depression, anxiety, overweight/obesity. This concentration of physical and psychological-

health issues underscores the fact that there are more than simply a host of different diseases affecting incarcerated individuals. Already, comparable data on the burden of NCDs in prison settings exist in other parts of the world, such as hypertension, diabetes, obesity and mental health morbidity.^{2,11,12} The very high composite prevalence of the current study must, however, be understood within the scope of its rather loose definition considering the broad

prevalence of mental health outcomes as measured with the outcome items on the PHQ-9 and GAD-7.

Crude analyses showed significant legal-status differences in anxiety, any NCD, obesity, and hypertension, with the largest disparity observed for anxiety. These differences might reflect variation in incarceration duration, institutional experiences, and lifestyle. Other variables associated with NCD morbidity were also found, and the same as previous NCD evidence in prisons were three lifestyle and anthropometric factors.^{1,13,14} In particular, behavioural risk was retained as an independent risk factor for the composite NCD outcome upon adjusting the analysis. This provided important insights into the cross-sectional exposure to NCD morbidity but could not inform causality as it was a cross-sectional study.

This was different in the case of high blood pressure. The relationship of age and BMI was also independent of legal status, and was especially strong for BMI. This is aligned with the well recognised importance of adiposity (body fat) for cardiometabolic health and studies indicating that the incarcerated have high fatness and high rates of metabolic disease.^{4,15} A second indicator of legal status, institutional risk, was also associated with high blood pressure in one legal-status stratum, but this was done so with caution because institutional risk may represent multiple constructs, associated with both the legal status and the nature of the health contact and/or of the prison's specific context. Mental-health outcomes showed particularly strong relationships with the prison environment. The environmental risk was independently linked to depression for both legal status groups and the behavioural risk was similarly independently linked in one legal status group. Anxiety was independently correlated with institutional risk in both groups and behavioural risk was also independently correlated amongst the under-trial inmates. This is consistent with the wider body of evidence that shows that a significant amount of the mental and physical morbidity coexist among incarcerated people.^{12,16} They also suggest that depression and anxiety can be associated in different ways and should be not be considered synonymous exposures of the same institution.

The multivariable-adjusted associations for several strong bivariate institutional relationships including duration of incarceration and health care utilization were lessened. Greater healthcare contact among inmates with NCDs may partly represent detection or indication effects, whereby individuals with existing symptoms or diagnosed conditions use services more frequently, rather than healthcare contact contributing to disease. With a cross-sectional research design this temporal ambiguity is intrinsic to its design. In general, this study helped address the presented evidence gap by showing that the existence of anthropometric factors, institutional factors, environmental factors and lifestyle factors in the prison environment suggest more similarities than differences when correlated with NCD morbidity.

Conclusion

This study demonstrates a substantial burden of non-communicable disease outcomes among inmates in selected prisons of Punjab, with 91.5% having at least one NCD. Most significant outcomes were depression, obesity, anxiety and high blood pressure. A positive post hoc test of significant crude differences by legal status was found across a number of conditions, specifically the following: anxiety, overweight/obesity, high blood pressure, and composite outcome of NCDs. Relationship between NCD morbidity and lifestyle, anthropometric, environmental and institutional characteristics were distinctly different from each other. Additional important bivariate correlates were higher BMI, waist circumference, physical inactivity, longer periods of sitting time, tobacco use and higher behavioural risk. Following adjustment, the behavioural risk score was an independent associated with composite NCD outcome. The association between age and BMI with high blood pressure was also present for each legal status and in each case environmental risk was associated with depression independently. Institutional risk was in particular associated with anxiety and behavioural risk was additionally associated with one legal-status group.

References

- Shahzad T, Plugge E, Van Hout MC. Insights into factors impacting on non-communicable diseases in the prisons of Pakistan—a scoping review. *Pak J Health Sci.* 2024;215-222.
- Manna S, Tripathy S, Sah RK, Padhi BK, Kaur S, Nowrouzi-Kia B, et al. The burden of non-communicable diseases among prisoners in India: a systematic review and meta-analysis. *Healthcare.* 2022;10(10):2046.
- Serra RM, Ribeiro LC, Ferreira JBB, Santos LLD. Prevalence of chronic noncommunicable diseases in the prison system: a public health challenge. *Cien Saude Colet.* 2022;27:4475-4484.
- Xavier SP, Motivo NJC, Xavi R, Cote ND, da Silva AMC, Victor A. Prevalence and determinants of chronic non-communicable diseases among prison inmates in the city of Tete, Mozambique: a cross-sectional study. *BMC Public Health.* 2025;25(1):3110.
- Monteiro AR, Schadock I, Aranalde LCR, Martinez DP, Fernandes NR, Lobato RC, et al. Prevalence of overweight and associated factors in a male prison population in the extreme south of Brazil: a cross-sectional study. *Metab Syndr Relat Disord.* 2023;21(1):63-69.
- Verde L, Pagano AM, De Leo M, Vetrani C, Ambretti A, Lucania L, et al. Diet-related risk factors for chronic noncommunicable diseases in Italian prisoners: BACI (Benessere all'Interno delle Carceri Italiane, well-being inside Italian prisons) project by the Italian Society of Penitentiary Medicine and Public Health. *Curr Nutr Rep.* 2023;12(4):709-720.
- Papa V, Tafuri D, Vaccarezza M. Could physical activity have any role in cardiovascular disease prevention in prisoners? A systematic review. *Int J Environ Res Public Health.* 2021;18(5):2307.
- Hewson T, Minchin M, Lee K, Liu S, Wong E, Edge C, et al. Interventions for the detection, monitoring, and management of chronic non-communicable diseases in the prison population: an international systematic review. *BMC Public Health.* 2024;24(1):292.
- Shahzad T. The growing burden of non-communicable diseases in the prisons of Pakistan—a scoping review. *Public Health Inst J.* 2023:44.
- Haq Z, Afaq S, Ibrahim M, Zala, Asim M. Prevalence of communicable and non-communicable diseases, disabilities, and related risk factors in Khyber Pakhtunkhwa, Pakistan: findings from the Khyber Pakhtunkhwa Integrated Population and Health Survey (2016-17). *PLoS One.* 2025;20(2):e0308209.
- Favril L, Rich JD, Hard J, Fazel S. Mental and physical health morbidity among people in prisons: an umbrella review. *Lancet Public Health.* 2024;9(4):e250-e260.
- Njonnou SRS, Boombhi J, Etoa Etoga MC, Tiodoung Timnou A, Jingi AM, Nkem Efon K, et al. Prevalence of diabetes and associated risk factors among a group of prisoners in Yaoundé Central Prison. *J Diabetes Res.* 2020;2020:5016327.
- Leal M, Kerr L, Mota RMS, da Justa Pires Neto R, Seal D, Kendall C. Differences in non-communicable diseases between women in prison and the general population in Brazil. *Sci Rep.* 2023;13(1):18782.
- Lancia M, Tomassini L, Scendoni R, Fanella E, Gili A, Gambelunghe A, et al. Health profiles of inmates: a cross-sectional study of prevalent diseases in a central Italian prison. *Healthcare.* 2025;13(17):2090.
- McLeod KE, Butler A, Young JT, Southalan L, Borschmann R, Sturup-Toft S, et al. Global prison health care governance and health equity: a critical lack of evidence. *Am J Public Health.* 2020;110(3):303-308.

Rajan S, Krishna A, Muliya KP, Chaturvedi SK. Comorbidity of anxiety and depression with hypertension, diabetes, and cardiovascular disease: a selective systematic review from India. EMJ Diabet. 2022;10(10):83-94.

