

Article

Beyond the Penrose Hypothesis: Examining the Association between the Availability of Psychiatric Care and National Homicide Rates in 166 Countries

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Abstract: The association between mental illness and violent crimes such as homicide is complex. In 1939, Lionel Penrose hypothesized that the availability of psychiatric hospital beds was inversely related to the prison population, presumably due to the hospitalization of potential offenders with a mental illness. Subsequent studies have found evidence for this association, but questions remain about the contributions of confounding factors. Moreover, there has been a move towards deinstitutionalization and community care of the mentally ill over the past six decades. In this study, the association between national homicide rates and three measures of the availability of psychiatric care—the numbers of psychiatrists, general hospital psychiatric beds, and psychiatric hospital beds per 100,000 population—was examined using a time-lagged correlation analysis. Associations between homicide rates and socioeconomic factors associated with crime were also examined. It was found that the availability of psychiatrists and of general hospital psychiatric beds were both negatively correlated with homicide rates, and that the association with general hospital psychiatric beds remained significant even after correction for confounding factors. These results suggest the need for a more nuanced interpretation of Penrose’s original formulation, involving the interplay of social, economic factors and psychological factors rather than linear causality.

Keywords: mental illness; homicide; violence; psychiatry; Penrose hypothesis; deinstitutionalization



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1. Introduction

The relationship between mental illness and crime, particularly violent crime, is complex. Certain psychiatric disorders are associated with an elevated risk of violence and aggression, which can culminate in homicide in some cases [1–3]. These conditions include psychotic disorders (schizophrenia and related conditions), personality disorders, substance use disorders, and intellectual disability [4–6]. Rates of psychiatric diagnoses in individuals convicted of homicide have been found to vary significantly across studies. For example, a survey of individuals convicted of homicide in the United Kingdom found that 34% met criteria for a mental disorder [7]. On the other hand, a similar study of homicide offenders from Sweden found that 90% fulfilled the diagnostic criteria for at least one psychiatric disorder [8]. In this context, it is important to distinguish between the presence of a psychiatric diagnosis, which is made according to standard criteria developed by health professionals, and the determination of criminal responsibility for homicide, which is a legal judgement. In the study from the United Kingdom referenced above, only 9% of perpetrators received a verdict of “diminished responsibility” on the basis of their psychiatric diagnosis [7]; likewise, in a study of adult homicide perpetrators in Ontario, Canada, less than 4% of individuals were classified as “mentally abnormal homicides” requiring psychiatric treatment [9]. An analysis of data from New South Wales, Australia found that less than 8% (169 of 2159) of homicide offenders brought to trial in the period 1993–2016 received a verdict of “not guilty on the grounds of mental illness”. The most common diagnosis in this subgroup was schizophrenia or a related psychotic disorder

(89%). Most of these offenders had a history of prior contact with mental health services, but only half were receiving pharmacological treatment [10]. A study of 5741 persons facing charges of homicide in the Russian Federation found that only 3% received a diagnosis of schizophrenia. This study also found that rates of homicide related to schizophrenia rose and fell over the period 1981–2020, and this pattern paralleled time trends in homicides not related to schizophrenia, suggesting that social factors may have influenced the risk of homicide in both groups [11]. A similar analysis of time trends in homicide from the United Kingdom found that, while the overall homicide rate decreased in the period 1997–2015, the rate of homicide perpetrated by mentally ill offenders increased slightly, and highlighted the lack of appropriate treatment given to such offenders [12]. The overall picture emerging from this research is that of an increased risk of homicide in individuals with severe mental illness, particularly when associated with substance use, inadequate treatment, and social adversity.

In 1939, the British psychiatrist and geneticist Lionel Penrose identified an inverse correlation between the number of psychiatric in-patients and the prison population in data collected from 18 European countries. Based on this observation, he suggested that decreases in the population of psychiatric in-patients would result in an increase in the number of prisoners, and vice versa [13]. This has subsequently been referred to in the literature as the “Penrose hypothesis” [14], “Penrose effect” [15] or “Penrose’s law” [16]. Penrose’s original proposal included both “insanity” (which would be termed “severe mental illness” or “psychosis” today) and “intellectual insufficiency” (now named “intellectual disability”) as relevant diagnosis, and he also considered the possibility of a gender difference in this association [13,17]. The Penrose hypothesis essentially implies that the availability of in-patient psychiatric case may reduce the rates of incarceration in those whose criminal offences were related to mental illness.

In the eight decades since Penrose’s initial observations and proposal, several researchers have examined the evidence for the Penrose hypothesis at the national and cross-national levels. Studies from the United Kingdom [17], Ireland [18] and Hungary [16] have all reported significant negative correlations between the number of psychiatric beds and the prison population; in all these countries, a reduction in the number of psychiatric beds was associated with an increase in the prison population over time, though no definitive conclusion regarding causality could be drawn from these data. The Hungarian data suggested that this association was confined to the prison population alone; there was no corresponding relationship between the number of psychiatric beds and the crime rate [16]. A study of six South American countries—Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay—found a significant inverse relationship between psychiatric bed number and prison population, even after correcting for the confounding effects of economic growth and inequality [19]; however, a re-analysis of this data found no significant relationship between these variables after adjusting for secular trends in the social factors associated with crime [20]. A subsequent critical appraisal of the above two studies noted that these associations needed to be replicated in further longitudinal studies, and also highlighted the importance of correcting for potential confounding factors, such as government spending on health and the level of urbanization [21]. Research involving larger numbers of countries has also yielded mixed results. A study of thirty Eastern European and Central Asian countries found a significant relationship between a decrease in psychiatric beds and increased prison populations in seventeen of these countries over the period 1990–2019; this effect appeared to be greater in countries with a lower per capita income and those which formerly belonged to the Soviet Union [22]; however, a study of twenty-six European countries, covering the period 1993–2011, found only a modest negative correlation between psychiatric beds and prison populations ($\rho = -0.35$), which was not significant after adjusting for socioeconomic factors [23]. The largest study of this sort, which included data from 158 countries (38 high-income countries and 120 low- and middle-income countries), found a significant effect of income group on the results: prison and psychiatric bed populations were positively correlated in low- and middle-income countries, but were not

significantly correlated—either positively or negatively—in high-income countries [14]. Overall, these results suggest that evidence for the Penrose hypothesis is weak, and is probably confounded by socioeconomic factors. Summarizing the available evidence, Mundt and Konrad concluded that the Penrose hypothesis “is still unresolved”, and pointed out that it might not represent a generally applicable hypothesis, but one that would hold true only in specific geographical or historical periods [24].

An important limitation of the analyses presented above is that they rely on numbers of psychiatric beds. At the time when Penrose formulated his original hypothesis, few effective treatments existed for mental illnesses, and patients were often admitted in psychiatric hospitals or institutions for long periods of time [25]. With the advent of effective pharmacological treatments for major mental disorders, a process of “deinstitutionalization” occurred in many parts of the world, characterized by a reduction in psychiatric bed strength, shorter durations of hospitalization, the integration of psychiatric treatment into general hospital settings, and the provision of treatment in patients’ own communities [26]. Under such an approach to mental health care, even patients with severe or chronic forms of mental disorder are often managed as out-patients, with in-patient care reserved for particularly severe episodes or exacerbations associated with a risk of harm to oneself or to others. Given this trend, a direct examination of the relationship between psychiatric bed strength and crime-related outcomes, such as prison populations or convictions, has limited utility, and would benefit from being supplemented with other indices of the availability of psychiatric care. This would be particularly true in low- and middle-income countries where economic and social pressures may favour community-based treatment over institutional treatment, regardless of concerns related to patient well-being or the risk of offending [27]. However, a linear relationship is unlikely to exist in this case: some authors have argued, based on existing data, that deinstitutionalization was accompanied by an increase in the “criminalization” of mental illness, and that only a high standard of community-based care can reduce the risk of violent offending associated with certain mental disorders [28,29].

Using the prison population as an “outcome” variable also has certain inherent limitations, as policies regarding incarceration vary widely across countries and have little to do with considerations related to mental health [30]. Instead, it might be valuable to examine the relationship between the availability of psychiatric care and the rates of specific offences, such as homicide, which are known to be related to severe mental illness. Such analyses should ideally take into account the confounding effects of social and economic factors that are themselves key determinants of crime [31,32].

The study presented in this paper aims to extend the Penrose hypothesis by examining the relationships between three indices of the availability of psychiatric care—psychiatric bed strength, general hospital psychiatric bed strength, and number of psychiatrists per 100,000 population—and national homicide rates across 166 countries, while correcting both for socioeconomic factors and for available estimates of the prevalence of mental illness in each country.

2. Materials and Methods

The current study is an ecological, time-lagged association study examining the association between three indices of psychiatric care and national homicide rates, after correction for both socioeconomic factors related to crime and national estimates of the prevalence of mental illness.

2.1. Study Variables

The three indices of psychiatric care used in this study are:

- (a) the number of psychiatrists currently involved in providing mental health care, expressed as the rate per 100,000 population
- (b) the number of psychiatric beds—that is, beds in dedicated psychiatric hospitals or institutions—per 100,000 population

- (c) the number of beds allocated for psychiatric care in general hospitals per 100,000 population

These three indices were selected for two reasons: (a) information on these variables is available in the public domain from the World Health Organization's Global Health Observatory (GHO), and (b) examining these variables allows the testing of extended versions of the Penrose hypothesis, involving not just psychiatric beds but the provision of psychiatric treatment in general hospital or community settings.

The estimated national homicide rate, based on data from the 2019 Global Burden of Disease Study, was selected as an index of the level of violent crime in each country. The homicide rate was chosen based on the following factors: (a) as homicide is coded and registered as a cause of death worldwide, estimates of homicide rates are reliably available for all the countries included in this study, and (b) there is little cross-national variation in the definition or legal prosecution of homicide, as opposed to other forms of violent crime such as assault. It is for the same reasons that homicide has been extensively studied in relation to mental illness in prior national surveys [7–9].

Based on Penrose's original suggestions, the following hypotheses were formulated:

H1. *A significant negative correlation exists between the number of psychiatrists per 100,000 population and the national homicide rate.*

H2a. *A significant negative correlation exists between the number of dedicated psychiatric beds and the national homicide rate.*

H2b. *A significant negative correlation exists between the number of psychiatric beds in general hospitals and the national homicide rate.*

As a secondary measure of interest, the associations between the three indices of psychiatric care and the prison population, operationalized as the number of prison inmates per 100,000 population, was also examined; however, this was not the primary objective of the study.

2.2. Confounding Variables

Violent crime is a complex phenomenon that has both psychological and social determinants [33]. Each act of violent crime does not result from a single causal factor, but it the result of an interaction between individual, interpersonal, social and environmental factors [32]. In prior studies of the "Penrose effect", socioeconomic factors appeared to be important confounders of the link between psychiatric bed strength and prison populations. Therefore, it was assumed that these factors would be of comparable importance in the current study.

Earlier studies that were designed specifically to test the Penrose effect found that national income—operationalized as gross national income per capita—was a significant confounder of associations between psychiatric bed strength and the prison population [14,22]. In addition to this, recent review articles on the social determinants of crime were consulted [34–36]. On the basis of these articles, the following socioeconomic variables were also included in the analysis as potential confounders: economic inequality (operationalized as the Gini coefficient of income inequality), social capital (operationalized as the social capital sub-score of the Legatum Prosperity Index), unemployment rate, and average number of years of completed education for each member of the adult population.

Though earlier studies of the Penrose effect have attempted to correct for some of the above economic variables, they did not take into account the actual or estimated prevalence of specific forms of mental illness—particularly schizophrenia and related disorders—that have been previously associated with homicide. Hence, in the current study, the estimated prevalence of schizophrenia and related conditions for the year 2015 was included as a possible confounding variable in the data analysis. Substance use disorders are also frequently associated with homicide [37], and patients with mental illness have high rates of comorbid substance use [38]. Moreover, substance use disorders may increase the risk

of offending in patients with an existing mental disorder [39,40]. Therefore, the estimated prevalence of substance use disorders for each country for the year 2015 was also considered as a possible confounder. Finally, the availability of alcohol and firearms can also increase the risk of interpersonal violence and homicide at a regional or national level [32]; hence, these two variables were also included as potential confounding factors in the analysis.

2.3. Data Sources

Information on indices of psychiatric care was available for the year 2015–16 from the GHO, and this data was used for the current study [41]. Data on at least one of these indices was available for a total of 166 countries, and these countries were included in the subsequent analyses. When considered individually, data availability was as follows: number of psychiatrists—146 countries, number of general hospital psychiatric beds—116 countries, and number of dedicated psychiatric beds—127 countries.

Information on national homicide rates was retrieved through a database query from the website of the Institute of Health Metrics and Evaluation, which provides complete data resources for the Global Burden of Disease (GBD) studies for the period 1990–2019 [42]. For the current study, only homicide rates for the year 2019 were considered. The same data source was used to obtain information on the estimated prevalence of schizophrenia and of substance use disorders for the year 2015.

Information on relevant socioeconomic indicators—gross national income per capita, the Gini coefficient of income inequality, social capital, the average years of completed education for each adult, and the estimated unemployment rate—were obtained for the year 2015 from the World Bank's database [43].

Information on prison populations for each country, defined as the number of prison inmates per 100,000 population, was obtained for all countries included in this study from the World Prison Brief, an online database of global prison- and prison system-related statistics [44].

Information on alcohol use (estimated as per capita alcohol consumption among the adult population) was obtained from the World Health Organization's Global Health Observatory; the most recent values available, which were for the year 2016, were used in the analysis [41]. Information on firearm access (estimated as number of firearms per 1000 population) was obtained from the University of Sydney's Gun Policy database, which provides information on gun ownership for 206 countries and regions; the estimates used in this study were based on data for the year 2017 [45].

2.4. Data Analysis

All study variables were tested for normality prior to data analysis. As they did not conform to a Gaussian distribution ($p < 0.05$ for all principal and confounding variables, Shapiro–Wilk test), a natural logarithmic transformation was applied prior to further data analysis. In the first stage of the data analysis, unadjusted bivariate correlations were computed between all three indices of psychiatric care and national homicide rates for each country. Pearson's correlation coefficient (r) was calculated for this purpose. In the analysis of homicide rates, both the total homicide rate and the gender-specific homicide rates were examined, to assess the possibility of a gender-specific variation. This possibility was considered in view of the apparent predominance of female homicide victims (in the case of domestic homicides) perpetrated by mentally ill offenders reported in an earlier study [46]. Male homicide rate was defined as the number of male homicide deaths per 100,000 male population, and female homicide rate was defined as the number of female homicide deaths per 100,000 female population.

Next, the bivariate correlations between homicide rates (total, male and female) and the confounding variables listed above were examined in a similar manner. On the basis of these analyses, partial correlation coefficients (partial r) were computed for the associations between indices of psychiatric care and homicide rates while controlling for those

confounding factors identified as significantly associated with homicide. All bivariate tests were two-tailed, and a significance level for this study was set at $p < 0.05$.

In the third step, a multivariate linear regression analysis was carried out to examine the robustness and strength of the association between indices of psychiatric care and national homicide rates. All variables that were associated with homicide rates at $p < 0.05$ (uncorrected) in the unadjusted bivariate analyses were included in this model. A step-wise approach was used for the linear regression in view of the possibility of significant multicollinearity between socioeconomic indicators.

Finally, the association between the three indices of psychiatric care and the prison population in each country were examined using a similar procedure.

3. Results

A total of 166 countries were included for analysis in this study, as information on at least one index of psychiatric care was available for each of them. Information on the distribution of the key study variables—indices of psychiatric care and national homicide rates—is summarized in Table 1.

Table 1. Distribution of key study variables across 166 countries.

| Variable | Median (IQR) | Maximum | Minimum |
|---|---------------|------------------------|---------------------------------------|
| National homicide rate (total homicides per 100,000 population) | 3.56 (7.09) | 48.71 (El Salvador) | 0.44 (Singapore) |
| Male homicide rate (per 100,000 male population) | 5.73 (10.99) | 91.92 (El Salvador) | 0.44 (Singapore) |
| Female homicide rate (per 100,000 female population) | 1.33 (2.36) | 36.95 (Eswatini) | 0.22 (Egypt) |
| Number of psychiatrists per 100,000 population | 1.43 (6.65) | 48.04 (Norway) | 0.001 (Marshall Islands) |
| Number of dedicated psychiatric beds per 100,000 population | 11.05 (33.06) | 196.60 (Japan) | 0.001 (Burkina Faso, Brunei) |
| Number of general hospital psychiatric beds per 100,000 population | 1.89 (8.70) | 148.80 (Monaco) | 0.001 (Colombia, Venezuela, Yemen) |

Abbreviations: IQR, inter-quartile range.

Table 2 presents the results of unadjusted bivariate correlations between the three indices of psychiatric care and national total, male and female homicide rates for the countries included in this study. It can be observed that both the number of psychiatrists and the number of general hospital psychiatric beds were significantly and negatively correlated with each of the homicide rates; this association remained significant even after applying Bonferroni's correction for multiple comparisons (for a 6×6 table). This provides preliminary evidence of support for hypotheses H1 and H2b. On the other hand, no significant association was found between the number of psychiatric beds in dedicated hospitals or institutions and the homicide rate; in other words, hypothesis H2a was not supported. On the other hand, when the ratio between dedicated and general hospital beds was examined in relation to homicide rates, no significant association was identified ($r = 0.11$ to 0.17 , $p > 0.1$ for all correlations).

Associations between national homicide rates, indices of psychiatric care, and the confounding variables examined in this study—socioeconomic indices and estimates of the prevalence of schizophrenia and substance use disorders—are presented in Table 3. From these analyses, it can be noted that the Gini coefficient of economic inequality was significantly and positively correlated with all three homicide rates, even after correction for multiple comparisons. Negative correlations with homicide rates were observed for gross national income per capita and for average years of education, but these were not significant after applying Bonferroni's correction. Unexpectedly, the estimated prevalence

of schizophrenia was negatively correlated with national homicide rates; however, this association was insignificant after correction for multiple comparisons, and a strong correlation was noted between the number of psychiatrists per 100,000 population and the prevalence of schizophrenia ($r = 0.85$) suggesting a possible confounding effect. Neither per capita alcohol consumption nor firearm access was significantly correlated with national homicide rates, either overall or when analyzed according to gender; however, both these variables were positively correlated with indices of psychiatric care. (A complete correlation matrix of all study variables is provided in the Supplementary Table; see Table S1).

Table 2. Correlations between indices of psychiatric care and national homicide rates.

| Variable | National Homicide Rate, Total | National Homicide Rate, Male | National Homicide Rate, Female |
|--|-------------------------------|------------------------------|--------------------------------|
| Number of psychiatrists per 100,000 population | −0.32 (<0.001) | −0.32 (<0.001) | −0.28 (<0.001) |
| Number of dedicated psychiatric beds per 100,000 population | −0.10 (0.243) | −0.12 (0.175) | −0.04 (0.676) |
| Number of general hospital psychiatric beds per 100,000 population | −0.43 (<0.001) | −0.44 (<0.001) | −0.33 (<0.001) |

Note: All values are given as Pearson's r (significance level). Values marked in **bold** indicate correlations significant at $p < 0.05$ after applying Bonferroni's correction for a 6×6 table.

Table 3. Correlations between national homicide rates, indices of psychiatric care, and potential confounding variables.

| Variable | National Homicide Rate, Total | National Homicide Rate, Male | National Homicide Rate, Female | Number of Psychiatrists per 100,000 Population | Number of Dedicated Psychiatric Beds per 100,000 Population | Number of General Hospital Psychiatric Beds per 100,000 Population |
|--|-------------------------------|------------------------------|--------------------------------|--|---|--|
| Gross national income per capita | −0.36 (<0.001) | −0.39 (<0.001) | −0.31 (0.001) | 0.81 (<0.001) | 0.50 (<0.001) | 0.52 (<0.001) |
| Gini coefficient of income inequality | 0.58 (<0.001) | 0.57 (<0.001) | 0.51 (<0.001) | −0.38 (<0.001) | −0.38 (<0.001) | −0.31 (0.002) |
| Social capital, Legatum Prosperity Index sub-score | −0.16 (0.093) | −0.18 (0.058) | −0.11 (0.218) | 0.42 (<0.001) | 0.20 (0.047) | 38 (<0.001) |
| Unemployment rate | 0.10 (0.197) | 0.09 (0.267) | 0.15 (0.066) | 0.23 (0.007) | 0.21 (0.022) | 0.21 (0.027) |
| Average years of education | −0.21 (0.007) | −0.22 (0.005) | −0.17 (0.024) | 0.80 (<0.001) | 0.68 (<0.001) | 0.53 (<0.001) |
| Prevalence of schizophrenia and related disorders | −0.35 (<0.001) | −0.35 (<0.001) | −0.33 (<0.001) | 0.85 (<0.001) | 0.56 (<0.001) | 0.49 (<0.001) |
| Prevalence of substance use disorders | 0.01 (0.884) | −0.01 (0.916) | 0.07 (0.368) | 0.70 (<0.001) | 0.53 (<0.001) | 0.46 (<0.001) |
| Alcohol consumption, litres per capita | −0.01 (0.952) | −0.03 (0.711) | 0.10 (0.209) | 0.47 (<0.001) | 0.44 (<0.001) | 0.44 (<0.001) |
| Firearm access, number of firearms per 1000 population | −0.05 (0.502) | −0.06 (0.427) | −0.05 (0.554) | 0.53 (<0.001) | 0.26 (0.002) | 0.19 (0.046) |

Note: All values are given as Pearson's r (significance level). Values marked in **bold** indicate correlations significant at $p < 0.05$ after applying Bonferroni's correction for a 15×15 table.

Based on those associations found to be significant in Table 3, partial correlation analyses were carried out and are summarized in Table 4. Initially, correlations between the two indices of psychiatric care significantly associated with homicide rates were corrected for the Gini coefficient alone, as this variable was independently associated with homicide rates. Subsequently, variables that were correlated with the specific index of psychiatric care were also included as covariates. It was found that the association between the number of psychiatrists and national homicide rates was no longer significant. However, the number of general hospital psychiatric beds per 100,000 population remained negatively correlated with all three homicide rates after correcting for the Gini coefficient; when gross national income per capita was included as an additional confounder, associations between the number of general hospital psychiatric beds and the total and male homicide rates remained statistically significant. When per capita alcohol consumption and firearm ownership were also included as covariates (not shown in the table), the results were unaltered; the number of general hospital psychiatric beds, but not psychiatrists, remained significantly and negatively correlated with all three homicide rates. Thus, while the results of the partial correlation analyses did not support H1 or H2a, they provided significant support for H2b.

Table 4. Partial correlations between national homicide rates and indices of psychiatric care.

| Variable | Variables Corrected For | National Homicide Rate, Total | National Homicide Rate, Male | National Homicide Rate, Female |
|--|--|-------------------------------|------------------------------|--------------------------------|
| Number of psychiatrists per 100,000 population | Gini coefficient | −0.10 (0.236) | −0.11 (0.206) | −0.08 (0.356) |
| | Gini coefficient, social capital, gross national income per capita, average years of education | 0.13 (0.219) | 0.13 (0.222) | 0.16 (0.124) |
| Number of general hospital psychiatric beds per 100,000 population | Gini coefficient | −0.36 (<0.001) | −0.38 (<0.001) | −0.25 (0.011) |
| | Gini coefficient, gross national income per capita | −0.28 (0.005) | −0.28 (0.004) | −0.17 (0.094) |

Note: All values are given as Pearson's *r* (significance level). Values marked in **bold** indicate correlations significant at $p < 0.05$ after correcting for the covariates listed in the second column.

Results of the stepwise multivariate linear regression analysis, with each homicide rate taken as the dependent variable in turn, are presented in Table 5. Regardless of the specific homicide rate being considered (total, male or female), the variables significantly associated with this parameter in multivariate regression were the Gini coefficient, which was positively associated with homicide, and the number of general hospital psychiatric beds per 100,000 population, which showed a negative association with homicide. These results provide further support for H2b. The proportion of variance in homicide rates explained by these two variables ranged from 24–40%, and they were more strongly associated with male than with female homicide rates.

The association between the three indices of psychiatric care, national prison populations and homicide rates was also examined as a test of the original Penrose hypothesis. The results of this analysis are presented in Table 6. In these analyses, prison population was positively correlated with all three homicide rates even after correction for socioeconomic variables (see Table S1). On the other hand, prison population was positively correlated with both the number of psychiatrists and the number of psychiatric beds per 100,000 population, but only the former association retained significance after correction for socioeconomic confounders.

Table 5. Stepwise linear regression analysis of the variables significantly associated with homicide rates.

| Dependent Variable | Variables Included in the Model | Variables Included in the Final Model | Correlation Coefficient | Significance Level | Variance Inflation Factor | Adjusted R ² |
|----------------------|--|--|-------------------------|--------------------|---------------------------|-------------------------|
| Total homicide rate | Number of psychiatrists Number of general hospital psychiatry beds | Gini coefficient Number of general hospital psychiatry beds | 0.48 −0.29 | <0.001 0.001 | 1.08 1.08 | 0.374 |
| Male homicide rate | Gross national income per capita Gini coefficient Average years of education | Gini coefficient Number of general hospital psychiatry beds | 0.49 −0.30 | <0.001 <0.001 | 1.08 1.08 | 0.395 |
| Female homicide rate | Estimated prevalence of schizophrenia | Gini coefficient Number of general hospital psychiatry beds | 0.41 −0.23 | <0.001 0.015 | 1.06 1.06 | 0.244 |

Table 6. Association between indices of psychiatric care, prison populations and homicide rates.

| Variable | Homicide Rate, Total | Homicide Rate, Male | Homicide Rate, Female | Number of Psychiatrists per 100,000 Population | Number of Dedicated Psychiatric Beds per 100,000 Population | Number of General Hospital Psychiatric Beds per 100,000 Population |
|--|-------------------------|-------------------------|-------------------------|--|---|--|
| Prison population, unadjusted | 0.32 (<0.001) | 0.32 (<0.001) | 0.26 (<0.001) | 0.37 (<0.001) | 0.27 (0.002) | 0.11 (0.261) |
| Prison population, adjusted for gross national income, Gini coefficient and average years of education | 0.29 (<0.001) | 0.30 (<0.001) | 0.19 (0.025) | 0.24 (0.006) | 0.07 (0.489) | −0.07 (0.496) |

Note: All values are given as Pearson's *r* or Pearson's partial *r* (significance level). Values in bold indicate correlations significant at $p < 0.05$.

These findings are at variance with the original Penrose hypothesis, but are consistent with the earlier report of such a divergent finding from low- and middle-income countries. To test for this possibility, the associations between indices of psychiatric care and prison populations were repeated separately for high- and for low-/middle-income countries, based on the World Bank income groups for the year 2015–2016 [47]. In high-income countries, there was a trend towards a Penrose-type association between the number of psychiatrists per 100,000 population and the prison population ($r = -0.27$, $p = 0.089$, $n = 42$), but no significant association for the other two indices of psychiatric care. In low- and middle-income countries, all three indices of psychiatric care were significantly and positively correlated with the prison population, replicating the earlier results (number of psychiatrists: $r = 0.60$, $p < 0.001$, $n = 104$; dedicated psychiatric beds: $r = 0.44$, $p < 0.001$, $n = 84$; general hospital psychiatric beds: $r = 0.23$, $p = 0.042$, $n = 80$).

4. Discussion

In this study, a negative association was observed between two measures of the availability of mental health care—the number of psychiatrists per 100,000 population, and the number of psychiatric beds in general hospitals per 100,000 population—and national homicide rates. The strength of this association was weak to moderate ($r = -0.28$ to -0.43) [48], indicating that even in unadjusted analyses, these variables could predict only around 8–18% of the variation in homicide rates. Though there was evidence of a slight effect of gender, with stronger associations noted for male homicide rates, this did not affect the overall statistical significance of the study findings. After correction for socioeconomic and mental health variables, as well as firearm ownership, a significant negative association

was still observed between the number of general hospital psychiatric beds and national homicide rates, with little change in the magnitude of the observed effect ($r = -0.25$ to -0.36 , 6–13% of variance explained). This was confirmed in the multivariate linear regression analyses, where the number of general hospital psychiatric beds per 100,000 population, along with the Gini coefficient of income inequality, remained significant predictors of total, male and female homicide rates.

These findings are consistent with a modified form of the Penrose hypothesis in which the availability of psychiatric care, particularly during acute episodes or exacerbations of psychiatric illness, may represent one of several factors associated with a reduction in homicide risk. The history of psychiatric in the post-World War II period has been characterized by a more or less steady reduction in the number of “dedicated” psychiatric beds in institutions or “asylums”, along with a shift towards care in the community and shorter hospital stays [26,49–53]. In this context, general hospital psychiatric services have often played a complementary role to community-based out-patient services [54,55], particularly in low- and middle-income countries where they often provide in-patient care for acute episodes of severe mental illness [27,56–58]. Therefore, it is plausible that access to psychiatric beds in general hospitals can reduce the risk of harm to others, particularly in patients with severe mental illness who present with an acute exacerbation of symptoms or comorbid substance abuse [59,60]. Though such a hypothesis is supported by the current data, it requires more direct confirmation at the national and regional levels. A similar argument might apply to the observed inverse relationship with the number of psychiatrists: even if these professionals are working in community or hospital-based settings rather than in psychiatric institutions, they may be able to identify clinical predictors of aggression and make appropriate decisions regarding hospitalization [61–63]. However, the magnitude of such an effect, even if it does exist, is probably modest and influenced by both socioeconomic variables and by other factors, such as national policies related to involuntary psychiatric admission [64,65].

The lack of association between the availability of dedicated psychiatric beds and homicide rates is also consistent with the aforementioned trends in the delivery of psychiatric care, including hospitalization and crisis management. Though some authors have expressed concerns about a phenomenon of “reinstitutionalization” (in which mentally ill offenders are confined in other institutionalized structures, such as supported housing” or “criminalization” (in which mentally ill offenders are confined in prisons rather than in psychiatric settings, due to the failure of community-based care), such contentions are not consistently supported by the data [66,67]. The lack of a positive association between the ratio of “dedicated” to “general hospital” psychiatric beds and homicide rates suggests that it is the availability, rather than the specific locus, of psychiatric care which may have a beneficial effect on violent offences. It is also noteworthy that in some countries, particularly in those where deinstitutionalization occurred relatively late, the decrease in dedicated psychiatric beds was not associated with a reduction in general hospital psychiatric beds, perhaps allowing the latter to substitute for the former [68].

Regarding the other variables assessed in this study, the link between economic inequality and violent crimes such as homicide is well documented in the forensic literature as well as in studies of health economics [31–36,69–72]. The mechanisms linking absolute or relative poverty to violence are complex, and include widening inequality over time, disadvantages related to education and employment, exposure to adverse events in childhood, and involvement in subcultures associated with substance misuse or socially deviant behaviour [72,73]. These may be particularly relevant in the case of mentally ill offenders in whom economic adversity can exacerbate pre-existing risks through factors such as non-availability of treatment and comorbid substance use disorders [74]. The correlation coefficient between income inequality and homicide reported in the current study (0.58) is higher than that reported for developed countries ($r = 0.44$) [72] but lower than that reported in a study of former Communist countries ($r = 0.75$) [71], suggesting that this relationship may be modified by other economic and cultural factors. Given the

consistency of this association even after correcting for potential confounders, the current results suggest that a more “fine-grained” examination of the relationship between mental health, economic deprivation and homicide is warranted.

The apparent negative correlation between the estimated prevalence of schizophrenia and homicide rates appears paradoxical, but can be explained in several ways. First, many homicides are committed by individuals with undiagnosed or unidentified mental illness [60]; such cases would not be reflected in estimates of the prevalence of specific mental disorders, particularly in low- and middle-income countries where there is limited epidemiological data. Second, in view of the moderate to strong positive correlation between indices of psychiatric care and the prevalence of schizophrenia ($r = 0.49$ to 0.85 ; Table 3), it is possible that this variable may reflect better rates of diagnosis and treatment at the community or hospital level. Third, though high rates of schizophrenia are reported in some samples of violent offenders, the association is weaker in the other direction: the absolute risk of perpetration of violence in patients diagnosed with this disorder is approximately $<25\%$ in men and 5% in women, and these statistics include not just homicide but all violent offences, such as assault and arson [75,76]. Fourth, even in individuals with severe mental illness, additional social and clinical variables can affect the risk of violent crime [77]. Finally, it should be recalled that regardless of the Penrose hypothesis and related formulations, a significant number of homicides are committed by individuals without a psychiatric diagnosis; based on the most recent literature, only around 4–10% of homicides are committed by individuals with a confirmed diagnosis of a severe mental illness [9–12,46].

Finally, when attempting to replicate Penrose’s original findings, this study did not find a negative correlation between indices of psychiatric care (including the number of “institutional” psychiatric beds) and the prison population. Instead, there was some evidence of a positive association between the two, though this varied according to national income groups and was of marginal to no significance after correcting for socioeconomic factors (Table 6). Though this result contradicts the results of research from high- and high-middle-income countries [19,23], it is consistent with the results of an earlier study similar to the current one [14]. This suggests that the hypothesis advanced by Mundt and Konrad regarding the geographically and temporally restricted nature of the “Penrose effect” merits further consideration [24]. It is possible that the “Penrose effect”, as initially described, is of relevance only to higher-income countries during a period characterized by a greater availability of psychiatric institutional beds [25–29], and may have limited or no applicability following the process of deinstitutionalization, or in countries where the institutionalization of patients with mental illness was never widespread to begin with [27]. The positive correlation between indices of psychiatric care and prison populations in low- and middle-income countries is counter-intuitive and requires further exploration; possible explanations include cultural and economic factors influencing rates of offending, higher levels of stigmatization of mental illness that may delay or prevent appropriate treatment, differences in legislation pertaining both to incarceration and to psychiatric admission, and differences in governmental priorities and investment in the criminal justice and mental health systems [14,30,78–80]. Alternately, this association may reflect a process of cultural change and transition, characterized by a gradual increase in investment in mental health in these countries; if this is the case, the aforementioned association would not remain stable over time, and might even decline as psychiatric care becomes more widely available and accessible [81,82]. Changes in the political landscape can also influence the balance between mental health care and incarceration of mentally ill offenders, as can be inferred from cases of countries where a shift towards a more authoritarian form of government was associated with reduced support for rehabilitation of the mentally ill [83].

It is also important to note that the analysis of country-level data can obscure important differences between regions of the same country. For example, rates of both psychiatric hospitalization and incarceration were found to vary significantly across different states of the United States of America, probably reflecting differences in local culture and demographics

as well as state government policy [84]. Likewise, the marked divide between the availability of mental health in rural and urban regions, particularly in low- and middle-income countries [85], could lead to significant variations in any observed relationship between psychiatric care and homicide when these regions are compared. Similar considerations should be kept in mind when considering specific populations within the same country, particularly ethnic minorities or migrants who are likely to receive a sub-optimal level of mental health care [86,87] and may experience a certain degree of bias or discrimination in encounters with the legal system [88].

When interpreting these results, certain limitations of this study should be kept in mind. First, they are based on country-level data and cannot be used to address individual or regional variations in homicide rates; more specifically, these results cannot be extrapolated to individual offenders in a simplistic manner (the “ecological fallacy”). Second, the data used for the analysis is based on estimates and has a certain inherent margin of error that could affect the magnitude and significance of the results obtained. Third, it is not known if these results apply to other forms of violent crime, such as physical or sexual assault, that may be committed by mentally ill offenders. Fourth, though efforts were made to control for certain socioeconomic factors in the data analysis, it is likely that variations in both homicide rates and the availability of psychiatric care may also be influenced by other economic and cultural factors that do not lend themselves easily to operationalization. Finally, the significance of the study findings should not be overstated; if there is indeed an effect of psychiatric care on homicide rates, it is likely to be modest in magnitude.

5. Conclusions

The current study, despite certain limitations, provides a possible extension of the Penrose hypothesis by suggesting that the availability of psychiatric care is negatively correlated with homicide rates at a national level. As this association remained significant even after correction for potential socioeconomic confounders, it is unlikely to represent a purely chance association. The mechanism by which the availability of psychiatric care could influence the risk of homicide per se remains unclear, but may reflect the availability of treatment for patients in an acute episode or phase of severe mental illness when the risk of aggression and violence is high. In contrast, Penrose’s original findings could not be replicated in this data set, which probably reflects the limited utility of prison populations as a marker of violent offending by the mentally ill. The replication of these results at different levels, after correction for additional variables such as legislation related to involuntary psychiatric admission and incarceration, would allow for a more robust test of the findings and suggestions tentatively advanced in this paper.

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Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/forensicsci2040049/s1>, Table S1: “Complete correlation matrix of all study variables”.

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Data Availability Statement: All data used in this study has been obtained from public domain sources which are cited in the paper (references [41–47] in the text). A complete data sheet for the study is available from the author on request.

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