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POPULATION DENSITY AND WELL-BEING IN DUTCH
TOWNS AND CITIES

A critical comparison with the results of a
density study in Chicago

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Recently Galle, Gove and McPherson published the results of their study concerning the relationship between population density and social pathology^{*}).

Analogous to the well-known studies of Calhoun and other biologists, in which the effects of overcrowding on the behavior of animals are investigated, the authors correlated a number of density measures with some measures of 'social pathology' of 74 community areas of Chicago (1960).

As their measures happen to be very much like some of the variables included in my study into the relationship between characteristics of the socio-cultural environment and the recorded incidence of illness and deviant behavior, I thought it interesting to repeat their analysis and to compare both findings.

My study concerns 176 municipalities, selected from the total number of 993 municipalities, that existed in 1960 - at the start of my research the latest year for which census data were available (1). Their selection was based on two criteria: size and 'spatial homogeneity' - the last criterion referring to the number of population nuclei (suburbs, villages, hamlets) over which the inhabitants of the municipality are distributed.

As for size the four big cities (>200.000 inhabitants) were left out, because of their typical characteristics (Amsterdam and Rotterdam, for instance, being large sea-ports), and the small municipalities (<5.000 inhabitants), because of the scarcity of several forms of deviancy.

From the remaining municipalities I selected those (176), that had no other nuclei with more than 1.000 inhabitants beside their main population nucleus.

In order to hold the urban condition (Chicago) constant (though in Dutch dimensions), this paper will focus on the urbanized municipalities of the selected subuniverse, being 70 towns and cities, ranging from 5.000 to 170.000 inhabitants (2).

^{*}) Omar R. Galle, Walter R. Gove and J. Miller McPherson: Population density and pathology: what are the relations for man? Science 176, 23 (1972).

Table 1 lists the measures used in the Chicago study in comparison with the variables for the Dutch municipalities, for which ranges and median values are also given.

table 1

Although for some variables the measures are slightly different, their meaning seems to be fairly compatible.

The two studies, however, cannot be compared with regard to the Chicago measures for which I have no data: the number of rooms per housing unit and the public assistance rate. The same holds, of course, for the three measures, included in my study, but not in the Chicago one: the rejection of military conscripts as an indication of the physical health condition of the population, the cardiovascular death rate as a cause of death assumed to be strongly influenced by social factors (5) and the incidence of contagious disease, likely to be affected by the degree of population concentration.

Chicago revisited - some critical remarks

Though explicitly admitting, that not only different species react to density in different ways, but that, as far as human beings are concerned, the effects of density may differ in different cultural and social settings - thus implicitly acknowledging the rather limited value of these analogies in this respect - Galle, Gove and McPherson took the several animal studies concerning the effects of density, as a model for human populations. Using more specifically Calhoun's experiments with rats as a starting point, they selected a number of indices from the Chicago data that serve as 'surrogate measures of Calhoun's pathologies'. Although the findings of those animal studies quite legitimately may lead to the question whether population density and overcrowding will also have effects on human behavior, Galle c.s., in my opinion, carried this analogy of Calhoun's study a bit too far on two points. In the first place they adopted with Galhoun's behavior measures also his level of interpretation. As Galhoun studied the effects of the density conditions for a number of rats on the behavior of those very

rats, the observed relations and their interpretations belong to the same level of analysis. Galle c.s., however, studying the relation between the population density and a number of behavior frequencies of the community areas of Chicago, interpret their findings largely in terms of the feelings, attitudes, characteristics of individuals, unjustly assuming the properties, found to be correlated at the higher level (i.e. community area) to be also correlated at the lower level (i.e. inhabitants of the community area).

Both this ecological fallacy (6) and the extent to which they carry the analogy, are clearly illustrated by their interpretation of the positive correlation of overcrowding with the fertility rate - a result in contrast to the animal studies, which show overcrowding to be associated with a drop in natality.

Basing themselves on the relevance of the animal studies in this respect, Galle c.s. explain this difference in findings in terms of the relation - found among animals - between overcrowding and hypersexuality, among human beings likely to lead to increased natality, as women, unlike female animals, are able to conceive 12 months of the year, on the one hand, and the greater difficulty, assumed to be associated with overcrowding, of planning ahead, perceiving the possibilities of birth-control and/or practising its techniques on the other hand. Besides being 'ecological fallacious', this interpretation underlines the second point I want to stress.

Though, for the sake of convenience, I shall adopt the term 'social pathology' throughout this paper, I have some reserve as to the rather easy way in which Galle c.s. borrowed this term from Galhoun.

However adequately deviant behavior of rats, because of its relatively clear, biological criteria, may be described as pathological, the sociocultural and psychological determinants of human deviancy makes the generalizing application to human behavior of this term somewhat doubtful.

Not only may deviant behavior, as Merton (citing Plant) stresses, often be considered as a 'normal reaction of normal people to abnormal conditions' (7), the definition, or as some authors prefer, the labelling of behavior as deviant is dependent at least as much on the prevailing norms violated and the societal reaction on the behavior as on the act itself (8).

That is why Erikson (9), stressing the role of the 'social audience', defines deviant behavior as behavior, that draws the attention of the 'social control agencies', that is, as behavior about which something has to be done - a definition, especially relevant with regard to the recorded and registered deviant behavior (10).

In this context the admissions to mental hospitals may be seen as an indication of the community's inclination to hospitalize the mentally disturbed, and the juvenile delinquency rate as a reflection of the activities of the official authorities concerned (11), rather than as valid indicators for the incidence of 'pathological behavior'.

And finally, it is not clear at all, at what low or high level the fertility rate is to be considered pathological - as it is influenced by the prevailing norms concerning a desirable family size, family planning, birth control practices rather than by strictly biological factors.

Needless to say, however, that this of course does not make the question, whether or not density and overcrowding do effect the behavioral pattern, or more precisely, its registered frequencies, in the community, less legitimate or important.

Effects of density and overcrowding in Chicago

As to this question Galle, Gove and McPherson report, that they found no relation between the pathology variables and population density as measured by the number of persons per acre.

However, by breaking down population density into its various components, they could account for, though not very high, percentages of the social pathology variances. They conclude then, that "for mortality, fertility, public assistance and juvenile delinquency, the most important component of density is persons per room. Next, but considerably less important, is the number of housing units per structure. For these four pathologies, the other two components of density - rooms per housing unit and structures per acre - appear to be relatively unimportant". As for the admissions to mental hospitals, the most important component of density seemed to be rooms per housing unit.

These findings are in contrast with the results of Schmitt's study of

the 42 census tracts of Honolulu, where he found density to be the most significant variable: the correlations of his various pathology measures with population per net acre, holding constant all other density variables and the social class measures, were consistently higher than their partial correlations with persons per room (12). Galle c.s. based their conclusions on the partial correlations of persons per acre with each pathology, controlled for social class and ethnicity, which "are not significantly different from zero" and on the increment in the variance explained in each of the pathologies, added by persons per room to the amount of variance, already explained by social class and ethnicity.

Re-examination of these data, however, does not confirm their conclusion as to the relative importance of overcrowding (persons per room) to density (persons per acre).

To make this clear, table 2 brings together the partial correlations of persons per acre with each pathology, transformed into the percentages of explained variance they represent, and the percentages of explained variance in each pathology, added by persons per room.

table 2

In my opinion the main conclusion to be drawn from this table is, that not only the percentages of variance in each pathology, explained by persons per acre, but likewise those explained by persons per room, are rather low. On the whole these data indicate neither density nor overcrowding to be very important factors in relation to social pathology.

As to the different effects of persons per acre and persons per room on the social pathologies, the table shows, that, whereas persons per room does explain a somewhat higher percentage of the variance in the fertility rate and the public assistance rate than does persons per acre, it is persons per acre, that explains somewhat higher percentages of the variance in the mortality rate (3.1%) and the juvenile delinquency rate (5.2%) - the percentages of variance explained by persons per room being respectively 1.8% and 0.0% (13).

As far as these two pathology measures are concerned, the results of the Chicago study are more in line with the Honolulu study of Schmitt

than the conclusions of Galle c.s. suggest, density in fact appearing to be the most important factor.

The data in table 2 imply, that, on the level of community areas overcrowding being no more important a factor than density, these two factors - as far as they do have any effect at all - may affect different aspects of human behavior in a different way.

Density and overcrowding in the Dutch municipalities

The questions to be answered for the 70 Dutch urbanized municipalities concern the effect of density and overcrowding on the health and well-being of the population, their relative importance in this respect and their possible different relations with the various measures of health and well-being. The last two questions are induced not only by the actual results of the Chicago study, but by the fact, that for the Dutch municipalities density and overcrowding are negatively correlated ($r = -.28$), and show opposite relations with the measures of social class and sociocultural heterogeneity (14).

Population density, as measured by persons per km^2 , correlating positively with social class and negatively with sociocultural heterogeneity, tends to be higher in the larger towns and cities with a greater variety of economic activities (15) and a slight emphasis on the economic main branch of services (service-, sales- and clerical occupations) - conditions asking for and leading to relatively greater proportions of better salaried, higher educated, white collar workers. The reverse relationships hold for the overcrowding measure: persons per room (16).

This means that, relatively high population density and relatively high overcrowding tend to be found in different municipalities, with different characteristics and may be different patterns of health and well-being. As shown in table 1, the health and well-being of the population are indicated by several measures of the recorded incidence of illness and socially problematic behavior ('social pathologies' for short).

For each of these measures, the correlations with persons per km^2 and persons per room, controlled for social class and sociocultural heterogeneity, are computed separately (table 3).

As the registered frequencies of juvenile delinquency and the admissions to mental hospitals are reported to be influenced, among other things, by respectively the activities of the police and the presence and capacity of medical care facilities, for these two measures indices of respectively the municipal police force and the municipal medical care facilities, have been added to the controlling variables (17).

table 3

The main conclusion to be drawn from table 3 is, that, in relation to the health and well-being of the Dutch municipalities, as far as measured by the 'social pathologies' concerned, neither density nor overcrowding appear to be very important factors. With the exception of the relation of persons per room with the fertility rate, the partial correlations of persons per km² and of persons per room with each of the 'pathologies' are all rather low.

Though on the one hand the positive partial correlations of the contagious disease rate and the conscripts rejection rate with persons per km² are somewhat higher than their - virtually non-existent - correlations with persons per room and on the other hand the positive partial correlation of the admissions to mental hospitals with persons per room is somewhat higher than its partial correlation with persons per km², in my opinion these differences are too small and the correlation coefficients too low to offer solid grounds for a decisive conclusion as to the relative importance of density and overcrowding. In this context the partial correlation of persons per room with the fertility rate ($r = .46$) is surprisingly high - explaining 21.2% of the residual fertility variance.

Taking into account the rather low municipal averages of the number of persons per room (ranging from 0.62 to 0.87 as shown in table 1) - hardly indicating inadequate or poor living conditions -, this relatively strong correlation does raise the question whether persons per room really should be considered as a causal factor in relation to the birth rate. It takes considerably less laborious explaining - if only involving no need to compare the procreative behavior of rats and human beings - to assume the reverse: a greater number of persons per room reflect the prevalence of larger families, larger families being a consequence of higher birth rates (18).

The, much lower, negative partial correlation of the fertility rate with persons per km² may be seen to reflect the more urban attitudes towards family planning and birth control, likely to prevail in the more densely populated municipalities (19).

The effects of the components of density

In order to see whether the other components of density, which are positively correlated with persons per km² (the zero-order correlation coefficients being respectively .48 and .40) i.e. the percentage of dwellings in multi-housing structures and the number of housing structures per hectare, contribute to the variance of the 'social pathologies', I compared the percentages of variances in each 'social pathology' by persons per km² (table 3) with the percentages of variance explained by persons per km², dwellings in multi-housing structures and housing structures per hectare together, holding constant social class and sociocultural heterogeneity. As could be expected, the addition of two more variables did raise these percentages somewhat, adding from 1.9% (mortality rate) to 3.0% (admissions to mental hospitals) of explained residual variance. This, however, does not change very much the picture of, on the whole, rather low correlations of population density with 'social pathology', but for one exception: with the inclusion of dwellings in multi-housing structures and housing structures per hectare the multiple correlation with the cardiovascular death rate increases from .26 to .45, signifying an increment of 13.5% of explained variance. Inspection of the partial correlation coefficients revealed, that dwellings in multi-housing structures ($r = .37$) is to be held responsible for this not only surprising, but rather confusing result. It is rather puzzling why exactly this aspect of population density on the one hand should have such an effect on the cardiovascular death rate, while on the other hand it shows no notable relation with the other 'social pathologies'. Possibly relevant concomitant characteristics of the municipalities with relatively high percentages of dwellings in multi-housing structures, such as age distribution, sex - ratio, population growth,

mobility, change, recreational facilities, do not offer a clue to a possible explanation of this relationship, as the correlations of these factors (as far as could be checked) with dwellings in multi-housing structures do not differ significantly, either in degree or in direction, from those with housing units per hectare and persons per km².

That leaves the possibility of a wide array of speculations, mostly on the (in the context of this study) 'wrong' level of the individual, about the very specific operation of psycho-social stressors (20), induced by the fact of living in municipalities with relatively high percentages of dwellings in multi-housing structures, for which, however, the data of this study do not permit any valid conclusions. The only conclusion to be drawn at this moment is, that this relationship asks for further investigation, both on the level of higher social units and on the level of individuals.

The total effect of the three density measures and overcrowding on the 'social pathologies', holding constant social class and sociocultural heterogeneity (17), as well as the relative importance of these two sets of variables are given in table 4.

table 4

The rather low percentages of total variance, explained in the various 'social pathologies', imply that obviously many more factors play a part in the unequal distribution of these 'pathologies' among the municipalities involved (table 1), which factors, for that matter, may vary from differences in the rules and norms concerning the treatment and registration of the phenomena, indicated by the 'pathology' measures, differences in the quality of the (preventive) social and medical care, to differences in causal characteristics of the municipalities, not directly related to social class or population density.

Nevertheless, social class and sociocultural heterogeneity, together with population density, do show a relationship with the 'pathology' measures, the percentages of total variance explained - with the exception of the fertility rate - ranging from 13.0% (conscripts rejection rate) to 29.2% (admission to mental hospitals).

Of the two sets of variables, the independent effect of social class and sociocultural heterogeneity, with two exceptions, appear to be greater than the independent effect of overcrowding and the three density measures, emphasizing once again the relatively small 'weight' of the density measures.

The two exceptions concern the relatively high percentage of variance explained in respectively the fertility rate, almost entirely due to its relation with persons per room (most likely to be understood as persons per room, through family size, being a consequence of the birth rate) and the cardiovascular death rate, caused by its relatively high correlation with the percentage of dwellings in multi-housing structures.

The complexity of the interrelations

Aside from being rather low, the independent total effect of overcrowding and the three density measures on the remaining 'social pathologies' appears to be the result of a rather complicated pattern of interrelations, as is revealed by the partial correlations of each 'pathology' measure with each density measure, controlled for all the other independent variables - a fact, that does not make it easier to interpret the relationship between the spatial concentration of the population and the indicators of its health and well-being (table 5).

table 5

Admissions to mental hospitals appears to be the one and only 'pathology' measure correlating positively with both overcrowding and all density measures, be it that only its partial correlations with persons per room ($r = .22$) and with housing units per hectare ($r = .14$) are at least of some substance.

Since overcrowding and density, being negatively correlated, as I mentioned before, could rather be expected to correlate with the 'social pathology' measures in opposite directions (as appears to be the case with the mortality rate and the fertility rate), these positive correlations are certainly interesting.

They might indicate, low as they are, that overcrowding and density affect the number of admissions to mental hospitals in quite a different way.

In this respect the study of Linsky (21), concerning the relationship between 'community homogeneity' or 'common culture' and the admissions to mental hospitals in 27 'community areas' of Washington State, may be of interest. He found 'common culture' to be positively correlated with the number of admissions, and interprets this relation in terms of a relatively greater tendency in the 'communities with common cultures' to hospitalize their mentally ill, 'because of a greater consensus as to what constitutes normal and abnormal behavior rather than because of (a stronger) rejection of the mentally ill', his data being more in favor for the first hypothesis.

As a relative higher number of persons per room, in contrast with population density, tends to be a characteristic of the smaller urbanized municipalities with relatively higher birth rates, higher percentages of church-affiliated inhabitants, and higher percentages of autochthonous population (22), in short, a characteristic of the more stable municipalities, likely to have a 'common culture', it might be hypothesized, that its positive correlation with the number of admissions to mental hospitals reflects a greater tendency of those municipalities to hospitalize their mentally ill, either because of a greater consensus or because of a stronger rejection. In contrast, the positive partial correlation of the number of housing units per hectare with the admission rate, might signify an effect of the population concentration on the number of mentally disturbed persons in the municipality, either by causation or by selective migration. In a similar way different mechanisms may underly the contradictory correlations of the density measures with the other 'pathologies'. Whereas the negative partial correlation of juvenile delinquency with persons per room ($r = -.11$) may be hypothesized to be the preventive effect of the relatively stricter social control, likely to prevail in the more stable municipalities, its positive partial correlation with housing units per hectare ($r = .13$) might possibly indicate a slight influence of a delinquency inducing environment (23) - the negative correlation with persons per km², however, remaining somewhat puzzling.

This latter conclusion also applies to the pattern of partial correlations of the overcrowding and density measures with both the contagious disease rate and the conscripts rejection rate. While the positive partial correlations of persons per km² and the number of housing units per hectare with the contagious disease rate (respectively .14 and .18) make sense - as a greater population concentration is likely to enhance the spread of these diseases -, it is not quite clear why dwellings in multi-housing structures should tend to be related negatively to either this disease rate ($r = -.12$) or the conscripts rejection rate ($r = -.18$).

As finally, according to my information from the Military Health Inspection, there is no question of systematic differences in the rules and examination-norms of the several regional military medical boards, and an explanation in terms of a relatively unfavorable distribution of the health care facilities also does not appear to be very likely (24), the positive partial correlation of the conscripts rejection rate with persons per km² ($r = .21$) indeed might suggest a negative effect of density on the health condition of the population, worthwhile to be further investigated (25).

Conclusion

In my opinion, the results of my study of the 70 Dutch urbanized municipalities, in which the relationship of population density and overcrowding with several measures of the recorded incidence of illness and socially problematic behavior has been investigated, suggest two main conclusions.

The first conclusion is, that, as to their effect on human behavior, neither overcrowding nor density appear to be very important factors. In this respect, the results of my study are, on the whole, identical with the data of the Chicago study of Galle, Gove and McPherson, as shown by the comparison of the tables 2 and 3.

In the second place it can be concluded, that, in as much density and overcrowding do correlate with 'social pathology' in the Dutch municipalities, these correlations are of a rather complicated nature. Not only do the various overcrowding and density measures show a differentiated relationship with the 'social pathology' variables,

but, as is revealed by the partial correlations of each density measure with each 'social pathology' measure, controlled for social class and sociocultural heterogeneity, the direction of their correlations proves to be far from identical. Altogether, these findings reveal a complex pattern of relations, for which it is not easy to give clear cut explanations, especially not, if one wants to avoid the fallacy of the wrong level.

In this respect, the results differ from those of the Chicago study, as, implied by the interpretation by Galle c.s., the density measures and the pathology measures were found to vary in the same, that is positive, direction. These results also clearly manifest the limitations of the animal studies concerning the effects of density as a model for human populations. Aside from the problems with regard to the translation of the results of a controlled experiment into an ex post facto designed study, for which the ceteris paribus condition has been guaranteed to only a rather limited extent, and the dissimilarity of the levels of analysis, requiring different and appropriate frameworks of interpretation, the analogy model, adopted by Galle c.s., does not take into account the psychological, social and cultural factors by which the reaction of human beings, unlike those of rats, are being influenced and conditioned.

As the complex pattern of the relationship between density in its various aspects and the 'social pathology', found for the Dutch municipalities, suggest, these factors interfere with the effect of population density on human behavior, turning the one-way causality, found for rats, into a questionable assumption with regard to human beings.

Though assuming this one way causality, Galle, Gove and McPherson mention the possibility of interaction among their highly intercorrelated measures.

As, on the one hand, their data are likely to be influenced by the inclusion of the very affluent and thinly populated community areas at the one extreme, and the very poor, densely populated slum areas at the other extreme, and on the other hand the registered frequencies of public assistance, juvenile delinquency and admissions to (state) mental hospitals tend to be socially biased (26), the results of their study might in fact indicate this latter possibility.

In my opinion, the low independent effects of both the measures of social class and ethnicity and the measures of overcrowding and density, in combination with the high percentages of variance explained in the 'social pathologies' by social class, ethnicity and density together (27), may be interpreted as reflecting an interaction among these community area characteristics - social class, ethnicity, density and recorded 'pathology' being interchangeable indicators of either highly favorable or highly unfavorable living conditions of respectively the affluent and the slum areas of Chicago.

The research necessary, as referred to by Galle c.s., into the relationship of density and overcrowding with the health and well-being of human populations, should therefore be focused, not only on the specific effects of the several components of population density on the various aspects of health and well-being, and the mechanisms, underlying these relations (i.e. social selection or social causation), but also on a problem, not explicitly mentioned before, that is, the specification of the conditions that determine these relationships.

The latter problem involves some pretty important issues, such as:

- the question whether density and/or overcrowding are directly and independently related to 'social pathology' or whether they influence human behavior only on the condition of the presence or absence of other crucial factors, as for instance medical care and recreational conditions, quality of housing, geographical and social mobility, spatial structure of the environment, etc.
- the linearity (implicitly assumed in both this and the Chicago study) or curvilinearity (25) of the correlation between density and 'social pathology', the latter possibility implying, that the effects of density are conditioned by its transgression of certain critical low or high values.
- the question whether the relationship of density and overcrowding with health and well-being is conditioned by the prevailing habits, norms and attitudes concerning density and overcrowding, adequate living space, individual privacy or whether it may be generalized regardless its specific socio-cultural setting, or, to put it otherwise, whether the deprivation with respect to density and overcrowding is absolute or relative (28).

It will be clear, that, to answer these questions, the relationship of

density and overcrowding with the health and well-being of the population preferably should be investigated on several levels of analysis (municipalities, community areas and individuals) simultaneously, with a systematic variation of possible conditions of that relationship, i.e. factors that are concomitant to density, degrees of density and different sociocultural settings.

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References and notes

1. Most data were supplied by the Netherlands Central Bureau of Statistics. But for the mortality-, fertility- and criminality rates, for which special registrations exist - these data came from the 1960 census. The data concerning the admissions to mental hospitals and the contagious diseases were obtained from the Bureau of Health Inspection; the data about the rejections of military conscripts from its military equivalent.
2. The definition of urbanized municipalities is derived from the typology of Dutch municipalities according to their degree of urbanization, by the Central Bureau of Statistics. This typology is based on criteria concerning the socio-economic structure of the economically active male population, the functional aspects and morphological characteristics of the municipalities.
3. S. Lieberman: Measuring population density. Amer. Sociol. Rev. 34, 850 (1969).
This coefficient for diversity within a population is based on the probability, that randomly paired members of the population belong to different categories of one or another characteristic. It is computed as the sum of the squared proportions of people belonging to the respective categories.
The highest possible value always is 1.00 (maximal homogeneity - all people belong to the same category), the lowest possible value (maximal diversity - people are equally distributed over all categories) is determined by the number of categories.
Lowest possible values of the coefficients for religious denominations, political parties and socio-economic groups are respectively: .20, .09 and .10.
4. The patients-registration, from which the admission data were obtained, included all 39 major mental hospitals. Although this registration covers by far the greater part of the admissions, its coverage is not complete, since by the time it started (1967) the psychiatric clinics of the universities, the psychiatric wards of general hospitals and the smaller mental hospitals did not (yet) participate. This incomplete participation in the psychiatric

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- patients registration, however, did not - as far as could be checked with the Office of Health Inspection - cause systematical bias in the admission-frequencies of the municipalities studied.
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 11. A.K. Cohen and J.F. Short Jr.: Juvenile Delinquency (in: R.K. Merton and R.A. Nisbet (eds): Contemporary social problems. Harcourt, Brace and World, New York 1961).
 12. R.C. Schmitt: Density, Health and Social Disorganization. J. Amer. Inst. Planners 32, 38 (1966).
 13. It is surprising to see, that the partial correlation coefficients of persons per acre with each social pathology in table 1 of the article of Galle, Gove and McPherson had to pass a statistical significance test (which they failed to do), whereas the percentages of explained variance in the social pathologies by persons per room (table 5) passed untested. One of the two possibilities has to be true: either in both cases a significance test has to be applied

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or in both cases there is no need for testing. Since it is not quite clear to what universe the findings for the community areas of Chicago (and, for that matter, the findings for the Dutch urbanized municipalities) are to be generalized, the latter possibility should be favored. J. Galtung,)

(ibid, pp 358-370.

A second point, to be mentioned with respect to the interpretation of the data of the Chicago study, concerns the comparison (in table 1 - Galle c.s.) between the multiple correlation coefficients of social class and ethnicity with each social pathology and the partial multiple correlation coefficients of the same measures, controlled for persons per acre. The assumption, underlying this comparison, that differences between those two multiple correlations indicate, whether the relationship of persons per acre with the social pathology measures is to be considered as spurious or not, cannot validly be made, for the partial multiple correlations of social class and ethnicity with the social pathologies are computed on the residual variances of the pathology measures, left after the variance caused by persons per acre has been extracted from their total variance. Regardless of the proportion of the total variance explained by the controlling variable (persons per acre), the partial multiple correlation coefficients of social class and ethnicity with the social pathologies, computed on that residual variance, may assume any value, be it lower or higher than the original multiple correlations, without telling a thing about the strength of the relationship between persons per acre and the pathology measures. This means, that from the comparison between the multiple and the partial multiple correlation coefficients no valid conclusion can be drawn with regard to the spuriousness of the relation of persons per acre with each social pathology. The only inference to be made from the results of this comparison is the fact, that the original relationship of social class and ethnicity with each social pathology measure holds, even if controlled for persons per acre.

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14. The zero-order correlation coefficients of the indices of social class and sociocultural heterogeneity with persons per km² are respectively .47 and -.09, those with persons per room respectively -.52 and .54.
15. The variable 'diversity of economic activity' is measured by the percentage of the economically active population, employed in the five most important classes of economic activity of the municipality, which means, that the higher this percentage, the more the economically active population is concentrated in only a few branches of economic activity.
16. The zero-order correlation coefficients of the number of inhabitants, the diversity of economic activity and the percentage of the economic active population, employed in the main branch of 'services' with persons per km² are respectively .59, -.15 and .15, those with persons per room respectively -.35, .31 and -.50. The measures 'economic diversity' and 'percentage, employed in the main branch of services' correlate with the percentage of males of 14 years or older with secondary education, respectively -.20 and .51, and with the ratio of salaried employees per 100 manual workers respectively -.40 and .68.
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It is also reported, that the number of admissions to mental hospitals is influenced by the distance to the hospitals.
Ø. Ødegaard: The distribution of mental disease in Norway. Acta psychiat. 20, 247 (1945); M. Kramer et al.: Historical Study of the disposition of first admissions to a state mental hospital:

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experience of the Warren State Hospital during the period 1916-1950. (Public Health Monograph, no. 32, Public Health Service Publication no. 45, Government Printing Office, Washington 1955.) For the 70 Dutch municipalities the distance to the nearest mental hospital, the number of available bed-days in general hospitals per 1.000 inhabitants and the number of general practitioners per 10.000 inhabitants correlate with the admission rate resp. .37, -.31 and .22.

The measures mentioned here, are added to the controlling variables throughout this analysis.

All the correlation coefficients reported, are computed on variables transformed into equal interval scales, mostly scored from 1-9.

18. I checked this interpretation by splitting up the general fertility rate into the legitimate birth rate (average number of legitimate births per year 1958-1962 per 1.000 married women of 15-49 years old 1960) and the illegitimate birth rate (average number of illegitimate births per year 1958-1962 per 1.000 unmarried women of 15-49 years old 1960).

It might be assumed, that if persons per room acts as a causal factor in relation to the natality, this measure would correlate positively with both birth rates. If, however, the number of persons per room is to be considered a consequence of the natality, with family size as the intervening factor, it might be expected to show a positive correlation with the legitimate birth rate, but no correlation or a negative one with the illegitimate birth rate.

The actual correlations indeed do support the latter interpretation: the zero-order correlation coefficient of persons per room with the legitimate birth rate is positive (.68) and with the illegitimate birth rate negative (-.34).

19. The zero-order correlation coefficient with the degree of urbanisation (2) with persons per km² is .59 and with the fertility rate -.35.
20. L. Levi, ed.: Society, stress and disease. Vol. I. The psychosocial environment and psycho-somatic diseases. (Oxford University Press, London 1971)

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These proceedings of an international interdisciplinary symposium held in Stockholm, April 1970, review the present state of knowledge concerning the relationship of psychosocial stresses and psycho-somatic diseases.

21. A.S. Linsky: Community homogeneity and exclusion of the mentally ill: rejection versus consensus about deviance. J. Hlth Soc. Behav., 11, 304 (1970).
22. The zero-order correlations of persons per room, persons per km², dwellings in multi-housing structures and housing units per hectare with the number of inhabitants are respectively -.18, .54, .62 and .49, with the percentage of autochthonous population respectively .54, -.07, -.11 and .22 and with the percentage of church-affiliated inhabitants respectively .55, -.27, -.46 and -.29.
23. To a great extent juvenile delinquency consists of small theft, shop lifting and the like. Densely built-up municipalities appear to offer opportunities in this respect, as the measure housing units per hectare shows rather high zero-order correlations with the number of shops (.86) and the number of markets (.77). On the other hand, however, the much lower, but also positive correlations of these variables with persons per km² (respectively .31 and .28) do not offer an explanation for the tendency of a negative relation of juvenile delinquency and persons per km².
24. The zero-order correlation coefficients of persons per km² with the number of general practitioners and the number of available bed-days in general hospitals are respectively .13 and .06.
25. For the selectees examined at the Boston Induction Station during the winter, spring and summer months of 1941 and 1942, Hyde and Kingsley did find a curvilinear association between population density and the percentage of selectees rejected for mental disorder the rejection rates begin highest at the two density extremes. They did not mention, however, any data concerning the total rejection rate.
R.W. Hyde and L.W. Kingsley: Studies in Medical Sociology. II. The relation of mental disorders to population density. New Engl. J. Med. 231, 571 (1944).

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26. J.W. Petras and J.E. Curtis: The current literature on social class and mental disease in America: critique and bibliography Behav. Sci. 13, 383 (1968). H.M. Shulman, *ibid*.
27. According to table 4 in the article of Galle c.s., the independent effect of social class and ethnicity to the standard mortality rate, the general fertility rate, the public assistance rate, the juvenile delinquency rate and the admissions to mental hospitals in respectively 0.4%, 3.2%, 7.0%, 5.3% and 0.4%.
The independent effect of the components of density on these pathology measures is respectively 7.1%, 3.7%, 7.4%, 3.5% and 18.1%.
The total variance of each pathology measure, explained by the two sets of variables together in respectively 75.6%, 76.5%, 85.7%, 89.4% and 47.9%.
28. Urban conglomerates as psychosocial human stressors. General aspects, Swedish trends, and psychological and medical implications. (Royal Ministry for Foreign Affairs, Royal Ministry of Agriculture. Kungl Boktryckeriet, P.A. Norstedt et Söner, Stockholm 1971.)
29. ^FI thank professor H. Philipsen, Department of Sociology, University of Leiden, Professor L. Levy, Department of Preventive Medicine and Community Health, University of Illinois, Chicago and my colleagues *of the NIPC/TNO* H.S. Merens-Riedstra, P.L. Stroink and J. van der Zee for their critical comment on the first draft of this article, P. van Leeuwen and W. van Nooten for their valuable statistical advise, and C. Drop for correcting my abuses of the English language.

F. This study is part of a project of the Netherlands Institute for Preventive Medicine, ^{TNO} Leiden.

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Measures of population density, social class, ethnicity and social pathology for the community areas of Chicago and 70 Dutch urbanized municipalities, including the ranges and median values of the Dutch measures

Measures for the community areas of Chicago	Dutch municipalities		
	Measures	Range	Median
<u>Population density</u>	<u>Population density</u>		
number of persons per acre	number of persons per km ² land 1960	249 - 7904	1332
number of persons per room	number of persons per room 1960	0.62 - 0.87	0.71
number of rooms per housing unit	data not available		
number of housing units per structure	% of dwellings in multi-housing structures 1956	0.1 % - 77.3 %	11.6 %
number of residential structures per acre	number of housing units per residential hectare 1960	3.5 - 45.1	15.8
<u>Social class - weighted index of:</u>	<u>Social class - unweighted index of:</u>		
median family income	average taxable income per capita 1960	f 1987 - f 3090	f 2330.=
median years of school completed	% males of 14 years or older with secondary education 1960	7.2 % - 21.4 %	13.4 %
% of employed males in white collar occupations	number of salaried employees per 100 manual workers 1960	32.2 - 103.9	62.4
<u>Ethnicity - weighted index of:</u>	<u>Socio-cultural heterogeneity - unweighted index of:</u>		
% of negroes	diversity coefficient (3) of % of members of religious denominations 1960	.22 - .94	.32
% of Puerto Ricans	diversity coefficient of % of votes per political party 1959	.18 - .76	.27
% foreign born	diversity coefficient of % of male heads of households per socio-economic group 1960	.15 - .36	.20
	% foreign born 1960	0.8 % - 9.0 %	2.9 %
<u>Social pathologies</u>	<u>Social pathologies</u>		
age-adjusted death rate of population 1960	age-adjusted death rate per 1.000 of population 1958 - 1962	6.5 - 9.6	7.5
birth rate per 1.000 females 15-44 years	birth rate per 1.000 of population 1958 - 1962	16.7 - 29.5	21.5
% of recipients of public assistance under 18 years old 1962	data not available		
% of males 12-16 years brought before the Family Court on delinquency petitions 1958 - 1961	number of juvenile offenders known to the police per 1.000 of population 10-17 years old 1958 - 1962	3.1 - 25.5	10.3
aged-adjusted admission-rates mental hospitals per 100.000 of population 1960 - 1961	number of admissions to mental hospitals per 10.000 of population 1967-1968 (4)	0.0 - 15.5	7.4
	% of conscripts rejected for military service 1959 - 1961	9.5 % - 31.8 %	19.3 %
	reported cases of contagious diseases per 100.000 of population 1958 - 1962	0.2 - 67.2	14.1
	age-adjusted deathrate cardiovascular diseases per 1.000 of population 40-64 years old 1958 - 1962	0.5 - 2.4	1.4

Table 2

Percentages of variance explained in each social pathology by respectively persons per acre and persons per room, controlled for social class and ethnicity, for the community areas of Chicago (1960)

Percentages of explained variance	Measures of social pathology				
	Standard mortality rate	General fertility rate	Public assistance rate	Juvenile delinquency rate	Admissions to mental hospitals
Persons per acre Percentages of variance in each social pathology, explained by the partial correlations with persons per acre, controlled for social class and ethnicity ^{x)}	3.1	0.0	1.4	5.2	2.0
Persons per room Percentages of variance in each social pathology, explained by persons per room, added to the variance explained by social class and ethnicity ^{**)}	1.8	2.1	5.1	0.0	1.6

^{x)} Computed on the partial correlation coefficients from Galle et al. Science 176, 1972, table 1, by means of squaring these partial correlations.

^{**)} From: Galle et al. Science 176, 1972, table 5.

Table 3

Partial correlation coefficients of population density and overcrowding with each social pathology, controlling for social class and sociocultural heterogeneity for 70 Dutch urbanized municipalities (1960)*)

Measures of interrelations	Measures of social pathology						
	Standard mortality rate	General fertility rate	Juvenile delinquency rate	Admissions to mental hospitals	Cardiovascular death rate	Contagious disease rate	Conscripts rejection rate
Partial correlation coefficients of persons per km ² with each social pathology, controlling for social class and socio-cultural heterogeneity	-.10 (1.0)	-.18 (3.2)	-.09 (0.8)	.10 (1.0)	.02 (0.0)	.17 (2.3)	.19 (3.6)
Partial correlation coefficients of persons per room with each social pathology, controlling for social class and socio-cultural heterogeneity	.11 (1.2)	.46 (21.2)	-.08 (0.6)	.21 (4.4)	.09 (0.8)	-.01 (0.0)	.06 (0.4)

*) The numbers in parentheses are the percentages of the residual variance in each social pathology (left after social class and sociocultural heterogeneity (12) have been partialled out), explained by respectively persons per km² and persons per room.

Table 4

Percentages of variance, explained by overcrowding and the three components of density, and by social class and sociocultural heterogeneity in each of the social pathologies, for the 70 Dutch urbanized municipalities (1960)

Comparison of the amount of variance explained by the two sets of variables	Measures of social pathology						
	Standard mortality rate	General fertility rate	Juvenile delinquency rate	Admissions to mental hospitals	Cardiovascular death rate	Contagious disease rate	Conscripts rejection rate
Contribution of social class and sociocultural heterogeneity							
Total 'effect' of overcrowding and the three density measures	18.5	44.9	9.0	9.6	14.4	12.3	4.4
Increment added by social class and sociocultural heterogeneity	6.5	2.7	12.2	19.6	5.9	9.8	8.6
Total variance explained	25.0	47.6	21.2	29.2	20.3	22.1	13.0
Contribution of overcrowding and the three density measures							
Total 'effect' of social class and the three density measures	22.1	29.2	17.6	23.0	6.8	16.8	5.8
Increment added by overcrowding and the three density measures	2.9	18.4	3.6	6.2	13.5	5.3	7.2
Total variance explained	25.0	47.6	21.2	29.2	20.3	22.1	13.0

Table 5

Partial correlation coefficients of each measure of overcrowding and density with each of the social pathology measures, controlled for social class, sociocultural heterogeneity and the other density measures (17), for the 70 Dutch municipalities (1960)

Measures of overcrowding and density	Measures of social pathology						
	Standard mortality rate	General fertility rate	Juvenile delinquency rate	Admissions to mental hospitals	Cardiovascular death rate	Contagious disease rate	Conscripts rejection rate
Number of persons per room	.11	.45	-.11	.22	.01	.03	.12
Number of persons per km ² land	-.01	-.06	-.15	.04	-.08	.14	.21
Percentage of dwellings in multi-housing structures	-.05	-.01	.08	.05	.36	-.12	-.18
Number of housing-units per hectare residential area	-.11	-.16	.13	.14	-.16	.18	.12