Crowding and Human Reproduction

DAVID RICHARD JOHNSON
ALAN BOOTH

Studies of crowding in lower animals repeatedly demonstrate that compressed living conditions depress the ability of the species to reproduce. In a sample of 470 urban Toronto women we examined the effect of neighborhood and household crowding on the probability of a pregnancy and on the probability that any given product of the pregnancy will not survive until one year of age. Crowding did not influence fertility nor fetal and infant survival within the range of crowding found in this sample. If crowding has any influence on reproduction it would more profitably be investigated beyond the range of living density and housing markets found in North American urban areas.

Studies of crowding in lower animals repeatedly demonstrate that compressed living conditions depress the ability of the species to reproduce. Crowded conditions have been shown to affect every aspect of the reproductive process in such a way as to control the size of the population. Compressed environs have been observed to suppress effective copulation, fertilization, fetal development, infant survival, and maternal care (Calhoun, 1962; Christian, 1963; Christian et al., 1965; Davis, 1971; Meyers et al., 1971; Southwick, 1955).

The effect of crowded conditions on human reproduction has been given only cursory examination. Galle et al. (1972), in a comparison of high- and low-density areas, show crowding to be positively related to mortality *and* to fertility. In another ecological analysis, Winsbrough (1965) finds population density to be positively related to infant mortality. And in Colombia, a comparison of expandable single-family-dwelling residents with apartment dwellers (Felson and Solaún, 1975) revealed evidence that space limitations in a tight housing market decreased fertility and family size expectations. The results of these studies suggest crowding has effects on reproduction. The positive effect of crowding on fertility, on the one hand, and on infant mortality on the other, indicates that human population density may at the same time stimulate and impede reproduction or that some of the findings may be artifacts of methodological problems.

In the study reported here, we examine the effect of crowding on human reproduction, using as the unit of analysis the married female (with husband present) of childbearing age (under age 45) who has had at least one child. Moreover, we examine the effect of crowding on: (1) probability of pregnancy and (2) the probability that any given pregnancy will not result in a child that survives until one year of age.

The Effects of Crowding

Crowding refers to the condition where people must engage in verbal and non-verbal communication and accommodate the movements and activities of others more or less constantly in the course of their daily lives. The intense interaction needed to carry out such rudimentary activities as preparing and eating meals, cleaning, tending children, and watching television puts the crowded female, more than the uncrowded one, in the position of competing for the use of space and facilities, being the object of competing demands from spouse and children, and becoming involved in the more strained aspects of intimate relations, such as disciplining children. The strains of household crowding may be exacerbated if the female also lives in a crowded neighborhood. When she leaves the house to shop, travel, or find recreation, extensive communication and accommodation, frequently with strangers whose intentions are unknown, remains a necessity.

The frequent thwarting of household and family activities may overload the senses so as to place the female under more or less constant stress. While humans are adept in handling intermittent or mild stress, they are not well equipped to cope with stress which is intense or prolonged. Hans Selye (1956) has termed the non-specific adaptive reaction to stress the "general adaption syndrome" and detailed the tripartite response leading to structural damage or disease. Such disease would affect the female's ability to conceive. Moreover, while evidence is far from complete, a comprehensive review of research suggests that stress may directly influence uterine dysfunction: stress has been linked to suppressed menstruation cycles, bleeding between periods, excessive vaginal discharges (Gibbons,

1961.) Furthermore, crowding may indirectly affect the number of pregnancies by influencing contraceptive practices, frequency of intercourse, and family-planning decisions. The lack of space in the household may act to retard the decisions to have more children. This is of particular importance when housing with more ample space is either unavailable (Felson and Solaun, 1975) or residential mobility is prevented by economic or ethnic and racial obstacles. Once a pregnancy has occurred, stress may affect the ability of the uterus to hold and nurture the fetus for the full term (Gibbons, 1961). Crowded conditions may also influence the mother's decision to have an induced abortion. Finally, poor maternal endowment stemming from stress-related disease or uterine dysfunction, or the effect of a congestion-related stressful home environment may adversely influence the ability of the infant to survive the first year.

On the other hand, if, as some have argued (Hawley, 1972), the frequent interaction associated with dense living conditions enhances opportunities for access to supportive relationships and other resources, the number of pregnancies and fetal and infant survival should be the same or better than those in uncrowded settings. To test these alternative hypotheses on the effect of crowded conditions, we compared the pregnancy histories of crowded and uncrowded mothers. Using multiple regression analysis we are able to control for a number of other variables which have been shown to be related to reproduction.

Data and Methods

The data for the study came from a stratified probability sample of families in 13 Toronto tracts selected for their potential in yielding a large number of families residing in dwellings in which the number of people exceeded the number of rooms.[1] They were also selected for the range of compressed neighborhood conditions represented. Population per residential acre averaged from 40 in some tracts to 150 in others. Some individual acres exceeded 600 people. While not

[1]The proportions of such households ranged from 12 to 28 percent of the units in the selected tracts. In some cases the number of people exceeded the number of rooms by as many as two and three times.

high by world standards, such densities are typical of the majority of cities in North America.

All of the households in the tracts were enumerated and screened. The population sampled was intact white families of European or North American descent with one or more children, the female of which was under 45 years of age, residing in their present dwelling unit for a period of at least three months. The sample was further stratified so that the number of families residing in dwellings which had one or more persons per room was nearly equal to the number which had fewer people than rooms. By such stratification we were able to control for a number of extraneous factors and, at the same time, to maximize variation in crowded conditions.

Nearly 17,000 screening interviews yielded 862 eligible households. In 560 of these we were able to obtain interviews with one or both of the parents for a 65 percent completion rate.[2] The data for this study comes from the 470 wives who were interviewed in detail regarding each of their pregnancies, use of contraceptives, and sexual behavior. To obtain an indication of their overall health profile they were asked to undergo a physical examination at a nearby community health center. Two hundred ninety-four women were examined.[3] The majority (80 percent) of the household heads were normally employed in blue-collar occupations, typically ones requiring only modest skills. Only 23 percent had completed high school; however, more than half had finished eighth grade. Thus, the sample is basically one of women in blue-collar families.

[2]Of the 302 in which interviews could not be obtained: 72 were too ill to be interviewed; 76 refused to be interviewed; and 214 did not speak English well enough to complete the interview. A comparison of the characteristics of those from whom we obtained interviews with those we did not revealed that the two groups were similar with respect to occupational status, age of the head of the household, and length of residence in their present dwelling unit. The major difference was that many in the latter group had migrated from Western Europe.

[3]To determine whether or not families that consented to be examined differed from those who did not in some way that would bias our results, we systematically compared the two groups with respect to crowding, health information obtained during the interview, and demographic characteristics. Those who received physical examination had slightly higher socioeconomic status, but in all other respects were the same as those who did not. As socioeconomic status was controlled in our analysis, we have eliminated it as a source of bias in any findings,

The Independent Variables

Dwelling-unit density and household crowding do not always occur together. One might live in a crowded household in a low-density neighborhood (Watts is a good example of this combination), a setting of low household crowding and high dwelling-unit concentration (inner-city high-income apartment complexes), low household and dwelling-unit crowding (middle-class suburbia), or a high-density dwelling-unit and household combination (many slum areas). For this reason it was felt that our measures must reflect at least two dimensions: household and neighborhood crowding. Two household and two neighborhood crowding measures were constructed.

One measure of household crowding consisted of the proportion of the respondent's adult years that she had resided in a household where the number of people exceeded the number of rooms. This figure, then, reflects the probability with which she lived in a crowded household during any given pregnancy. The probability of being crowded was used rather than actual conditions at the time of each pregnancy, because the method of recording the data did not permit time matching the two variables.

Because having a child obviously increases the number of people in the household and therefore crowding, we devised a second indicator of household crowding which removes this people component. We termed it the "rooms deficit" measure. It was constructed by regressing the number of rooms on the number of people in three categories: children, parents, and other relatives and non-kin. Thereby, a predicted number of rooms is derived for each household composition type. The rooms-deficit measure consists of the predicted number of rooms minus the actual number. The independence of the measure from the number of people in the household gives the index an advantage over people per room in studies where the number of people may be a contaminating factor (Johnson et al., 1974). Just such contamination may account for the positive association between crowding and fertility found in other studies (Galle et al., 1972). Unfortunately, because of the way in which the data were collected, the rooms-deficit measure could only be used to analyze reproduction in the three years immediately preceeding the interview. However, more than one-third of the women in the sample reported one or more pregnancies in that period, thus providing enough variability in

the dependent variable to test the effect of crowding on fertility (but not pregnancy outcomes) using the rooms-deficit measure. However, we do surmount the time-matching problem associated with the other crowding measures.

The two measures of neighborhood crowding consisted of: (1) the proportion of the respondent's adult years that she resided in a household that was contained in a multiple-dwelling structure (e.g., row house, low rise, high rise, etc.), and (2) the proportion of the female's adult years that she resided in a city with a population exceeding 500,000. The information for these two measures of crowding was obtained from a residential history provided by the respondent.

Dependent Variables

Two dependent variables are used: the first, pregnancy outcomes as reflected by fetal and infant mortality; and the second, the number of pregnancies. During the interview, each woman was asked to give the history of each one of her pregnancies. From this account, the probability of the result of any pregnancy not surviving through age one was computed for each woman. This total infant and fetal mortality rate was separated into four additive sources of non-survival: the induced abortion rate, the spontaneous abortion rate, proportion stillborn, and proportion dying in the first year of life. These four totaled to the proportion of the results of any pregnancy not alive one year after birth.

A measure of fertility was computed by summing the number of pregnancies each woman reported in her reproductive history. This measure was not converted into a pregnancy rate because controls for number of years with present spouse and prior marriage in the regression analysis effectively remove the impact of years of sexual activity on the number of pregnancies.

For purposes of analyzing the effect of the rooms deficit measure, the fertility variable was constructed as follows. If the woman had a pregnancy in the three years preceding the interview, the variable was coded one; otherwise it was coded zero. Women with more than one pregnancy in the time period were also coded one. Thus, the variable reflects the probability of having at least one pregnancy in the three-year time interval.

Four intervening variables related to the probability of becoming pregnant were also assessed and their relation to crowding analyzed. These variables reflect the processes through which crowding may affect behavior. Intercourse frequency was indicated by the woman's report of the number of times she had intercourse in the month preceding the interview. An index of contraceptive effectiveness was developed from the woman's report of the kinds of contraceptives she had used. Each contraceptive was assigned a number ranked on the basis of its use effectiveness per 100 woman-years of exposure (Peterson, 1969:191), and an average effectiveness rating was computed for each woman, based on the contraceptives she reported using. The higher the index score, the more effective the contraception. It is a crude measure, since it is not known how long each contraceptive was used, but it gives a general indication of contraception effectiveness. An indication of unprotected intercourse for those reporting contraceptive use was also obtained. Women were asked about the number of times in their reproductive history that contraceptive use was stopped for reasons other than current pregnancy. Finally, the variable used to assess the mother's health was the presence of disease which was based on information obtained by interview and examination by a nurse and a physician, and data based on tests of urine and blood samples taken at the time of the examination. The medical center staff had no information about the families' household or neighborhood conditions which might bias their examination.

Control Variables

Seven control variables are employed throughout the analysis to adjust dependent variable means for differences reflecting demographic, socioeconomic, and other background differences that may be sources of spuriousness. Husband's occupational status is measured using Blishen's (1967) socioeconomic index. The ethnic origins of the husband and wife are controlled as an ordinal measure of degree of foreign birth and recent ancestry. The wife's educational attainment, the number of years she has lived with her current spouse, and whether she had been previously married are also included as controls. Finally, the religious affiliation of the wife (Catholic or non-Catholic) is included.

Analysis Method

Multiple regression analysis is used to derive the mean of the dependent variable for each category of the independent variable while adjusting for the effect of the controls (Cohen, 1968; Andrews et al., 1967). The crowding measures are treated as dummy variables and categorized into three and four levels of crowding.

Findings

The percentage of life failures due to induced and spontaneous abortion, stillbirth, and death in the first year of life as is total mortality from conception to the age one are shown in Table 1. Of the 1902 reported pregnancies, 11.4 percent did result in an infant that survived through the first year of life.

Comparison of total mortality and mortality by cause for pregnancies to women with different histories of crowding fails to reveal any significant effect of any of the three crowding measures on mortality. The only statistically component is the effect on the induced abortion rate of living in multiple dwellings. Women living between 75 and 100 percent of their adult life in a multiple dwellings report a slightly higher rate of induced abortions than those spending less time in multiple dwellings. However, this increment had no appreciable effect on the overall mortality rate.

Examination of the patterns fails to reveal any overall pattern of relationships supporting the hypothesis. In the 15 relationships between crowding and the five mortality measures, only seven are consistent with the idea that higher mortality is associated with compressed living conditions. In short, this sample of pregnancy histories gives no support to the hypothesis that human crowding has a significant impact on fetal and infant mortality.

Next, we examine the contention that crowded living may affect reproduction by reducing the number of conceptions. In Table 2, the adjusted mean number of pregnancies as well as the adjusted means scores for the four intervening variables are presented for different levels of neighborhood crowding. No significant relationship is found between either crowding measure and the mean number of pregnancies adjusted for the seven control variables. Only one of the intervening variables is statistically significant at the .05 level and

TABLE 1

Adjusted Percentage of Pregnancies Not Surviving by Cause for the Three Crowding Variables[a]

Crowding Measures	Adjusted Percent Not Surviving					N
	Induced Abortion	*Spontaneous Abortion*	*Still-born*	*Total Died First Year*	*Not Alive After First Year*	Pregnancies (Women)
Grand mean	0.89	8.20	0.63	1.68	11.41	1902
Proportion of adult life in cities						
.01 to .49	0.51	4.65	1.11	1.58	7.86	372 (91)
.50 to .74	0.36	9.57	0.35	1.39	11.69	543 (142)
.75 to 1.0	1.32	8.78	0.60	1.88	12.59	987 (246)
Proportion of adult life in multiple dwellings						
None	0.04[b]	9.53	−0.05	1.94	11.46	114 (27)
.01 to .49	0.55	9.43	1.07	1.60	12.66	776 (202)
.50 to .74	0.27	6.90	−0.06	1.01	8.13	560 (141)
.75 to 1.0	2.46	7.38	0.89	2.58	13.32	452 (109)
Proportion of adult life with more than one person per room						
None	1.30	8.51	0.57	2.82	13.20	270 (104)
.01 to .49	0.54	7.56	0.87	1.64	11.02	926 (242)
.50 to .74	0.80	8.71	0.30	0.82	10.63	432 (87)
.75 to 1.0	1.81	7.92	0.40	2.05	12.19	274 (46)

[a]Adjusted for husband's occupation, wife's education, ethnicity of husband and wife, years living with present spouse, marital history, and religious affiliation.

[b]This set of dummy variables significant at .05 level.

TABLE 2
Adjusted Mean Scores for City and Neighborhood Crowding on Number of Pregnancies and Intervening Fertility Variables[a]

Crowding Measures	*Adjusted Mean Number of Pregnancies*	*Adjusted Mean Contraceptive Effectiveness*	*Adjusted Proportion of Times Stopped Contraceptive Use*	*Adjusted Mean Intercourse Frequency*	*Adjusted Mean Number of Diseases*
Grand mean	3.98 *N*	3.40 *N*	0.52 *N*	7.59 *N*	2.25 *N*
Proportion of adulthood living in a city					
.01 to .49	4.29 (85)	3.47 (85)	0.55 (85)	6.34 (41)	2.27 (40)
.50 to .74	3.92 (140)	3.44 (140)	0.58 (140)	7.35 (74)	2.29 (74)
.75 to 1.00	3.91 (228)	3.35 (228)	0.47 (228)	8.16 (120)	2.22 (120)
Proportion of adulthood in multiple dwelling units					
None	4.23 (24)	3.37 (24)	0.49 (24)	7.08[b] (9)	2.14 (9)
.01 to .49	3.88 (200)	3.44 (200)	0.56 (200)	5.83 (87)	2.11 (87)
.50 to .74	3.87 (134)	3.29 (134)	0.47 (134)	8.29 (79)	2.27 (79)
.75 to 1.00	4.31 (95)	3.48 (95)	0.52 (95)	9.28 (60)	2.44 (60)

[a]Adjusted for regression on occupation of head, education, ethnicity of husband and wife, religious affiliation, years living with present spouse, and marital history.

[b]This crowding measure explains a significant proportion of variation above that explained by the controls at .05 level in this dependent variable.

TABLE 3
Adjusted Mean Scores for Rooms Deficit Measure on Proportion with Recent Pregnancy and Intervening Fertility Variables[a]

Crowding Measures	*Adjusted Proportion with Recent Pregnancy*	*Adjusted Mean Contraceptive Effectiveness*	*Adjusted Proportion of Times Stopped Contraceptive Use*	*Adjusted Mean Intercourse Frequency*	*Adjusted Mean Number of Diseases*
Grand mean	0.34 *N*	3.39 *N*	0.51 *N*	7.67 *N*	2.19 *N*
Rooms deficit					
0.75 or more	0.34 (96)	3.49 (96)	0.52 (96)	7.56 (46)	2.23 (46)
0.74 thru 0.00	0.28 (144)	3.29 (144)	0.54 (144)	6.52 (71)	2.41 (71)
−.01 thru −1.00	0.37 (123)	3.51 (123)	0.46 (123)	8.14 (59)	1.92 (59)
Less than −1.01	0.41 (107)	3.30 (107)	0.53 (107)	8.56 (66)	2.17 (66)

[a]Adjusted for regression on occupation of head, education, ethnicity of husband and wife, religious affiliation, years living with present spouse, and marital history. None of the crowding measures are significantly related to the dependent variables at the .05 level.

that effect is not in the expected direction—persons living in multiple dwellings most of their adult lives report a greater intercourse frequency than those living most of their life in a single-family dwellings. The failure of the intervening variables and the number of pregnancies to show a consistent relationship to neighborhood and community density measures does not support the hypothesis that crowding influences fertility behavior.

There is better theoretical basis for expecting household crowding to affect fertility as the linkages to the intervening variables are more direct. In Table 3, the adjusted proportion of women with a recent pregnancy and the intervening variables are related to four levels of rooms deficit. Neither the proportion with a recent pregnancy nor the intervening variables even approach statistical significance. Nor was the directionality of effects consistent with hypotheses that rooms deficits systematically influence reproduction. Findings with this crowding measure parallels those with the neighborhood- and community-crowding indicators. No support for any relationship between fertility or the intervening variables affecting conception and crowding is found.

Discussion

The pattern of findings clearly provides no support for the idea that crowded living conditions depress reproduction within the range of community, neighborhood, and household density found in our sample. Neither do they provide evidence that living in crowded environs may have beneficial effects on fetal and infant survival chances. If crowded conditions have any effects on these variables in human populations, they either occur at levels of density considerably greater than that range normally found in Canadian and American communities or only when there are rapid increments in compressed living conditions.

However, measurement difficulties continue to complicate detection of effects and may also be a basis for some of the negative findings reported. Histories of reproduction and crowding in cross-sectional studies rely on retrospective reports than may introduce systematic or add random error into the analysis. This is particularly problematic when relying on self-report histories of contraceptive use and coital frequency.[4] The negligible relation of these in-

termediate variables in fertility to crowding is consistent with the failure to detect any effects of the density measures on fertility. Since reports on reproductive histories are less likely to be biased by reporting errors, interpretation of the findings primarily as a reflection of reporting biases in unfounded.

While the extensive controls for major structural and socioeconomic differences in households reduces spuriousness, other variables causing crowding conditions may be present. For example, persons living in multiple dwelling units most of their lives may have tended to self-select such housing forms for reasons also affecting reproduction. The failure to replicate the Felson and Solaún (1975) finding of a household-density effect on fertility may reflect differences in the housing markets in Bogotá and Toronto. Felson and Solaún contend that the lack of available housing with ample space for large families causes families living in small apartments to restrict their fertility, since the option of moving to larger quarters is not available. We are not able to assess directly the relative tightness of the Toronto housing market, particularly the one available to people with modest or low incomes. We are confident that the market in most North American urban areas is not as tight as in most Latin American urban settings. The only data we have to bear on this topic is information on moving plans and desires. In 39 percent of the households, the respondent indicated plans to move in the next two years. Of those with moving plans, 37 percent gave a reason related to lack of space or crowding. Dissatisfaction with the amount of available space as a factor in decisions to move found in other North American urban areas (Rossi, 1955; Simmons, 1968) is replicated here. While one-third of the sample have moving plans, two-thirds (68 percent) of those who do not have such plans would like to move in the next two years—36 percent for space reasons. This discrepancy between expectations and desires to move indicates the presence of constraints on residential mobility that could induce the processes described by Felson and Solaún (1975). Failure to detect any effects on the fertility variables questions the efficacy of such an explanation in the types of markets found in North American urban areas.

These measures were only modestly associated with fertility in our data, although the correlations were in the expected direction.

Finally, the persistent potential bias introduced by past fertility on measures of household crowding are difficult to estimate adequately without resorting to extensive longitudinal studies or quasi-experimental approaches (Felson and Solaún, 1975). These shortcomings common to cross-sectional surveys are not sufficiently serious to produce the complete absence of crowding impact found in this study if the actual effects of density on reproduction in the population were substantial. Failure to detect any consistent effects suggests that the probability of compact living conditions having more than very modest effects on fertility and infant and fetal mortality is quite low.

While the findings from this study cannot be used to dismiss once and for all the possibility that the crowding effects on reproduction found among animals is paralleled in human populations, they can serve to establish the direction of future research efforts in this area. These findings suggest that future inquiries may be more fruitful if carried out in populations where the range and level of environmental density exceed those found in North American communities. Failure to detect effects within the range of variation found in our study may suggest that the living environment is not sufficiently dense to produce the deleterious effects noted in animal studies.

Moreover, our findings relating crowding to reproduction are consistent with the results of the larger study of which this is a part. Crowding was found to have impact on only a few of the large number of human health and behavior variables examined (Booth and Cowell, 1976). And then, the effect was primarily among persons whose experience with living in compressed living conditions was very limited. For most dependent measures, no crowding impact was detected.

Finally, we caution future researchers examining the impact of household density on fertility using cross-sectional studies of the methodological problem requiring the separation of crowding effects from those of household size. New measures, such as the rooms-deficit approach used here, are necessary to advance the precision of the research in this area.

Summary

Study of the impact of crowding histories on early fetal and infant

mortality and fertility in a sample of Canadian women failed to find any systematic relationship among these measures. The persistent finding in animal studies of an impact of crowding in reproduction is not confirmed for human populations.

David Richard Johnson, PH.D.
University of Nebraska
Lincoln, Nebraska 68508

Alan Booth, PH.D.
University of Nebraska
Lincoln, Nebraska 68508

The views expressed here are those of the authors and not necessarily those of the Ministry of State for Urban Affairs, Ottawa, which provided the funds for the investigation.

References

Andrews, F.M., J.N. Morgan, and J.R. Sonquist
1967 The Multiple Classification Analysis Program: A Report of a Computer Program. Ann Arbor, Michigan: Institute for Social Resources.

Blishen, B.
1967 "A socio-economic index for occupations in Canada." Canadian Review of Sociology and Anthropology 4 (February).

Booth, A., and J. Cowell
1976 "Crowding and health." Journal of Health and Social Behavior: forthcoming.

Booth, A., and S. Welch
1973 The Effects of Crowding: A Cross-National Study. Ottawa: Ministry of State for Urban Affairs.

Calhoun, John B.
1962 "Population density and social pathology." Scientific American 206 (February): 139–146.

Christian, J.J.
1963 "The pathology of overpopulation." Military Medicine 128:571–603.

Christian, J.J., J.A. Lloyd, and D.E. Davis
1965 "The role of endocrines in the self-regulation of mammalian populations." In Pincus, G. (ed.), Recent Progress in Hormone Research. Vol. 21. New York: Academic Press.

Cohen, J.
1968 "Multiple regression as a general data-analytic system." Psychological Bulletin 70:426–443.

Davis, D.E.
1971 "Physiological effects of continued crowding." In Esser, Aristide H. (ed.), Behavior and Environment: The Use of Space by Animals and Men. New York: Plenum Press.

Felson, M., and M. Solaún
1975 "The fertility-inhibiting effect on crowded apartment living in a tight housing market." American Journal of Sociology 80 (May): 1410–1427.

Galle, O., W. Gove, and J. McPherson
1972 "Population density and pathology: what are the relations for man?" Science 176 (April): 23–30.

Gibbons, J.
1961 "Psychological factors in ovarian and uterine dysfunction." Pp. 201–212 in Gardiner-Hill, H. (ed.), Modern Trends in Endocrinology: Second Series. New York: Paul B. Hoeber.

Hawley, A.
1972 "Population density and the city." Demography 9: 521–529.

Johnson, D.R., A. Booth, and D. Duvall
1974 Social Determinants of Human Crowding. Unpublished manuscript.

Meyers, K., C.S. Hale, R. Mykytowycz, and R.L. Hughes.
1971 "The effects of varying density and space on sociality and health in animals." In Esser, Aristide H. (ed.), Behavior and Environment: The Use of Space by Animals and Men. New York: Plenum Press.

Peterson, W.
1969 Population. Second Edition. New York: Macmillan.

Rossi, P.
1955 Why Families Move: A Study in the Social Psychology of Residential Mobility. Glencoe, Ill.: The Free Press.

Selye, H.
1956 The Stress of Life. New York: McGraw-Hill.

Simmons, J.
1968 "Changing residence in the city: a review of intra-urban mobility." Geographical Review 58:622–651.

Southwick, C.H.
1955 "Regulatory mechanisms of house mouse populations: social behavior affecting litter survival." Ecology 36 (October): 627–634.

Winsbrough, H.H.
1965 "The consequences of high population density." Law and Contemporary Problems 31 (Winter): 120–126.