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# Does household size matter? Crowding and its effects on child development

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**ABSTRACT**

There is very little compelling evidence that household size negatively affects child development. In this study, the effects of household size on child development were analysed using data collected for a sample of 1311 four-year-old Jamaican children. Children's development was assessed using the Griffiths Mental Development Scales across six developmental domains: locomotor, personal-social, language, coordination, performance and practical reasoning. The findings suggest that children's locomotor and personal-social development are negatively affected by household crowding, with no significant effects observed for other domains. Additional results show that these adverse effects are strongest if the child lives in a single room compared to a separately detached house. This evidence speaks to the need to tailor policies towards access to good housing infrastructure and the provision of recreational spaces to encourage play and social interaction among children.

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Housing; children; Jamaica; public policy

## Introduction

The household environment potentially affects many aspects of the lives of individuals including but not limited to privacy, location, health, security, social relations, and resources. Thus, crowded housing conditions may lead to negative consequences for its inhabitants. Adults operating in crowded home environments are often subject to physiological and psychological stressors, and deteriorated personal relationships relative to those operating in uncrowded environments (Baum & Paulus, 1987). Despite these findings, the home environment has garnered little attention. Predominantly, most research on the effects of overcrowding is geared towards adults whose characteristics such as socioeconomic status, health, educational attainment are all affected by experiences at home, their work place or elsewhere (Evans et al., 2003; Newman, 2008). In contrast, there is limited research on the effects of crowding on children who are particularly influenced by their home environment, as they are dependent on adults around them and spend a greater proportion of their time in the home environment. Children may also be more vulnerable in crowded home environments as the home

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environment is critical to their identity formation, socialization and development. Therefore, if the housing environment becomes strained, the aforementioned processes may be negatively impacted.

One reported consequence of over-crowding is deteriorated parent-child relationships as children living in crowded households suffer from limited parent-child support. Additionally, Evans et al. (1998) suggests that it is the missing quality of the parent-child relationship that mediates the linkage between household crowding and adverse developmental outcomes. Children may therefore experience increased vulnerability in crowded environments, if there is little attention being paid to them. As such, their developmental processes may be negatively impacted.

There are various ways in which crowding may impact a child's development. The absence of a comfortable, quiet space compounded with the various schedules of other household members can lead children to experience difficulties studying, and disrupted sleep patterns which impact their ability to concentrate and regulate their behaviour. A lack of privacy and unresponsive parenting skills (Solari & Mare, 2012) is associated with an increase in behavioural problems which may extend to other social settings, further decreasing the child's engagement in activities aimed at increasing their development. Moreover, children living in these environments are more vulnerable to illnesses and other diseases which also interrupt their routines and development (Evans et al., 2003; Saegert & Evans, 2003). Household occupants tend to have a greater effect on children than neighbours because they are physically and socially closer and more homogeneous. Children are therefore socialised by the occupants of their homes and often model their behaviour. Consequently, the degree of crowding may be an important factor in explaining differences in child development across socioeconomic status; these differences tend to persist throughout one's lifetime and can therefore perpetuate social stratification.

Empirical research has shown that children raised in crowded homes take their educational, behavioural, and physical health disadvantages throughout their life cycle. For example, poor performance in school will later decrease their chance of higher educational and socioeconomic attainment (Leventhal & Newman, 2010). Additionally, negative interactions and poor behaviour towards teachers, parents, and peers during childhood are often associated with challenges in forming personal and professional relationships as adults. Leventhal and Newman (2010) therefore posit that ultimately, children exposed to crowded homes have a higher probability of finding themselves in a similar situation as their parents, thus contributing to what is considered an intergenerational transmission of social inequality.

Nonetheless, despite the varied theoretical explanations, research on the effects of household crowding continues to provide mixed results. The disparity in results is often explained by the variety of crowding measures used in analyses; these include number of persons per room, per bedroom, and per square foot thereby making comparability difficult (Baldassare, 1979; Beeghley & Donnelly, 1989). Consequently, some studies have shown that overcrowding is associated with psychological withdrawal (Gove et al., 1979), and with increased depression and loneliness (Makinde et al., 2018), poor parent-child relationships (Baldassare, 1979; Evans et al., 1998), unresponsive parenting (Bradley & Caldwell, 1984), higher probability of not advancing throughout school (Goux & Maurin, 2005), and increased child behaviour problems in various social contexts (Evans et al., 2001). On the

other hand, according to Booth and Johnson (1975), Booth and Cowell (1976) and Gove et al. (1979), while overcrowding can be seen as a socioeconomic indicator (as people who cannot afford the price of private space are more likely to live in crowded households), it remains unclear whether or not crowding, net of other socioeconomic indicators, has an effect on child development.

According to the Jamaica Survey of Living Conditions (JSLC) 2018, a nationally representative household survey conducted annually, 37.1% of households in Jamaica are considered to be crowded with crowding defined as 1.02 or more persons per habitable room; lower income households were generally larger (Planning Institute of Jamaica [PIOJ] & Statistical Institute of Jamaica [STATIN], 2021). Some 78.9% of households lived in detached houses, with marked geographical variability; 95.5% of rural households, 92.4% of households in other urban centres, and 70.6% of households in the Kingston Metropolitan Area (the capital parish of Kingston and the surrounding suburban section of St. Andrew) lived in detached houses. Other housing types were more common in the Kingston Metropolitan Area; with 8.7%, 13.6%, and 7.0% of families living in semi-detached houses, part of a house, townhouses and apartments, respectively.

It is hypothesized that overcrowding will be associated with poorer developmental outcomes in Jamaican children. This study was designed to investigate whether residential crowding across a wide range of densities (varied household sizes) impacted the development of young children in Jamaica as measured by developmental domain scores and to determine whether or not the hypothesized relationship between crowding and development is further impacted by the type of residential facilities.

## Methods

Data were retrieved from the JA KIDS database. JA KIDS is Jamaica's second national birth cohort study. The birth cohort study enrolled 9,700 mothers and children at the children's birth during the period 1 July to 30 September 2011. Some mothers were pre-enrolled at 20–28 weeks of pregnancy. Subsets or full samples were contacted when children were 9–12 months, 18–22 months and 48–54 months old. Participants at the post-birth contacts have been shown to be socio-demographically similar to the birth cohort enrolled in 2011 (Reece et al., 2020). Details of the methods of the study are published elsewhere (Samms-Vaughan et al., 2023). At the 48–54 month contact, mothers of 1311 children, who had been seen at three or four previous contacts, completed interviews. At this contact children also had comprehensive developmental assessments.

### *Outcome variables*

Developmental assessment was conducted using the Griffiths Mental Development Scales (GMDS)- Extended Revised Edition. The original GMDS was developed in 1954 in the UK and is an instrument used to measure child development from birth until the age of 8 years. As with most developmental instruments, the GMDS has undergone a number of revisions; it has been extensively researched and has been previously evaluated and utilised in research studies South Africa (Luiz et al., 2001)

and in Jamaica (Grantham McGregor & Smith, 2016). Development is assessed in six domains. Sub-scale A (Locomotor) Locomotor assesses gross motor skills including the ability to balance and to co-ordinate and control large movements. Sub-scale B (Personal-Social) measures the developing abilities that contribute to independence and social development, including dressing, feeding and toileting and interactions with peers. Sub-scale C (Hearing and Language) assesses active listening, receptive and expressive language. Sub-scale D (Eye and Hand Co-ordination) focuses on fine motor skills, manual dexterity and visual monitoring skills. Sub-Scale E (Performance) focuses on non-verbal reasoning, while also assessing speed and precision. Sub-scale F Practical (or Verbal) Reasoning (is administered to children over 2 years and assesses practical and mathematical skills.

### *Main explanatory variables (household variables)*

Each household varies in its need for space and in its perceptions of crowding. Living arrangements are dynamic and will differ as a result of cultural differences; sleeping arrangements are cultural constructs based on notions of the value of physical and emotional privacy (Pader, 1994). The level at which a house is considered crowded has been variously set at more than 1.5 or 2 people per bedroom (Crothers et al., 1993) or at more than 2–3 persons per bedroom (Maclennan, 1994). According to Morrison (1994), household size is a more useful index as it incorporates both the number of rooms and the number of bedrooms in a residential unit. Mothers were asked the total number of persons living in their household when the child was 4–5 years old. Mothers were also asked about the type of housing, for example whether they lived in a detached home or an apartment or other housing.

### *Other explanatory variables*

A number of other explanatory variables were considered for inclusion in the analysis as control variables based on knowledge of their impact on child development. Saha et al. (2009) has provided evidence suggesting that having an older father is associated with subtle impairments in neuro-cognitive outcomes during both infancy and childhood. Poverty, defined as those receiving welfare and those living in low-income neighborhoods was associated with impaired school readiness and increased risk for health and behavioural disorders (Roos et al., 2019) in early childhood. Receipt of financial support from the Government of Jamaica's cash transfer programme primarily, but also through other supports systems, was used as a proxy measure for lower income families. Votruba-Drzal (2006) posits that income during a child's preschool years has a greater impact on their development than income in later periods. Additionally, according to Gottfried et al. (1988), employed mothers are often more interested in the educational attainment for their children from as early as their pre-school years. Safe drinking water and hygienic behaviour impact children's lives and are often linked to better health, nutrition, and children's development; particularly stunting among infants where access to improved water was associated with a lower risk of mild or severe stunting (Chirande et al., 2015).

Demographic data (parental age), socio-economic data (receipt of financial aid, parental education) and data on household water facilities, were obtained from parental interview.

## Analysis

To estimate the impact of household size on different development sub-scales, the following simple regression equation was used.

$$y_{n,t} = z_{n,t}\beta + \varepsilon_{n,t}, n = 1, 2, ..N \quad (1)$$

where the dependent variable $y_{n,t}$ is the raw score for each developmental sub- scale in year $t$. A value of $n$ of 1, 2, 3, 4, 5, and 6, this refers to the development sub- scales Locomotor, Personal Social, Language, Eye-Hand Coordination, and Performance and Practical Reasoning, respectively. The row vector of exogenous variables $z_n$ are all explanatory factors that are thought to have an influence on each sub-scale through the vector of parameters $\beta$ to be estimated. The error term $\varepsilon_n$ is approximately normally distributed as given by N(0, $\sigma^2_\varepsilon$) where $\sigma^2$ is the variance.

**Table 1.** Descriptive statistics of dependent and explanatory variables.

| Variable | Observations | Mean | Standard Deviation |
|---|---|---|---|
| *GMDS Locomotor* | 1305 | 67.25 | 10.21 |
| *GMDS Personal-* | 1305 | 76.73 | 7.26 |
| *Social GMDS Language* | 1305 | 64.77 | 14.44 |
| *GMDS Coordination* | 1305 | 56.37 | 11.89 |
| *GMDS Performance* | 1305 | 49.28 | 9.62 |
| *GMDS Practical* | 1305 | 58.05 | 11.30 |
| *Reasoning Maternal Age* | 1284 | 26.58 | 6.81 |
| *Paternal Age* | 1241 | 32.05 | 8.57 |
| *Household size Maternal Education* None | 1217 39 | 2.94 | 2.29 |
| Primary | 60 | | |
| Secondary | 656 | | |
| Tertiary | 433 | | |
| Other *Paternal Education* None | 109 180 | | |
| Primary | 92 | | |
| Secondary | 634 | | |
| Tertiary | 346 | | |
| Other | 45 | | |
| *Child Gender* Male | 665 | | |
| Female | 577 | | |
| *Financial Aid* Yes | 728 | | |
| No *Employment Status* Employed | 577 781 | | |
| Unemployed | 536 | | |
| *Water Source* Piped (home) | 729 | | |
| Piped (Yard) | 287 | | |
| Standpipe | 54 | | |
| Stream | 23 | | |
| Catchment | 179 | | |
| Other | 34 | | |
| *House Type* Detached | 789 | | |
| Shared yard | 397 | | |
| Duplex | 54 | | |
| Apartment | 43 | | |
| Room | 22 | | |

## Results

### Griffiths Mental Development Scales (GMDS)

The dependent variable was constructed from the six sub-scales of the Griffiths Mental Development Scales. As shown in Table 1, the mean locomotor score was 67.25; the mean personal-social score was 76.73 and the mean language score was 64.77. The mean eye-hand co-ordination, performance and practical reasoning scores were 56.37, 49.28 and 15.71, respectively.

### Housing variables

In this sample, the mean house size was 2.94 persons with a minimum of 2 children (mother and child only) and a maximum of 12 (particularly for persons living in shared yards) (Table 1). Households included spouse, mothers, fathers, in-laws, children of mother and partner together, mother's children only, other children (relatives) and non- relatives, grandparents, friends and housemates and other family members or individuals.

Some 60.4% lived in a detached house with a yard, 30.4% lived in a separate house in a shared yard (which requires the sharing of other facilities), 4.2% lived in semi-detached (duplex) houses, 3.3% lived in self-contained apartments, and 1.7% lived in a room in someone else's house.

### Other explanatory variables

The mean age of mothers and fathers was 26.5 and 32.1 years, respectively. In this study 53.5% of mothers were employed and 46.5% were unemployed. A total of 55.8% mothers received financial aid; this was primarily through the Government of Jamaica's conditional cash transfer programme. Other sources of financial aid include other poor relief and government agencies, political representatives, friends and relatives in Jamaica or overseas, churches, and employers. The main source of water was piped in house systems (55.8%), but there were also piped systems in yards (22%) and standpipes, streams/river, catchment areas or tanks (15%).

### Regression analyses

#### Household size and type

The coefficients for the regression models in Equation (1) are reported in Table 2. The results suggest that an increase in household size will have a significantly negatively impact on language and practical reasoning development. With an increase of one additional household member, a child's language and practical reasoning scores decreases by 0.28, and 0.23 points ($p < 0.01$), respectively at the 10% level of significance. While an increase in household size was also associated with lower locomotor, eye-hand coordination, and performance scores, these results were not significant. This was also true for the positive effect on personal-social development.

Additionally, an analysis of the varied types of housing structures had effects on some of the developmental scores of children. Compared to detached homes, children living in

**Table 2.** Regression estimates of development sub-scales on overcrowding.

| Variable | A Locomotor | B Personal Social | C Language | D Co-ordination | E Performance | F Practical Reasoning |
|---|---|---|---|---|---|---|
| *Constant* | 68.98*** | 80.13*** | 65.38*** | 58.90*** | 48.98*** | 61.30*** |
| | (2.68) | (1.73) | (3.47) | (2.95) | (2.06) | (2.59) |
| *Household size* | −0.05 | 0.04 | −0.28* | −0.25 | −0.09 | −0.23* |
| | (0.14) | (0.07) | (0.17) | (0.16) | (0.09) | (0.13) |
| *Maternal Age* | −0.03 | −0.09** | 0.08 | −0.02 | 0.01 | −0.01 |
| | (0.05) | (0.04) | (0.07) | (0.06) | (0.04) | (0.06) |
| *Paternal Age* | −0.04 | −0.00 | −0.04 | 0.01 | −0.00 | −0.01 |
| | (0.04) | (0.03) | (0.05) | (0.04) | (0.03) | (0.04) |
| *Education (Maternal)* | | | | | | |
| Primary | −0.81 | −2.02 | −1.29 | −1.77 | −0.65 | −4.90** |
| | (2.56) | (1.58) | (3.28) | (2.99) | (2.06) | (2.46) |
| Secondary | −1.86 | −2.18 | −1.84 | 0.38 | −0.50 | −2.35 |
| | (2.13) | (1.42) | (2.73) | (2.48) | (1.87) | (2.01) |
| Tertiary | −1.74 | −1.62 | −0.79 | 1.85 | 0.04 | −0.80 |
| | (2.11) | (1.42) | (2.77) | (2.51) | (1.87) | (2.03) |
| Other | −1.52 | −0.40 | 2.67 | 4.97* | 2.84 | 0.59 |
| | (2.29) | (1.49) | (2.97) | (2.66) | (2.03) | (2.28) |
| *Education (Paternal)* | | | | | | |
| Primary | −0.60 | 0.41 | 1.25 | 0.82 | 0.77 | 0.30 |
| | (1.60) | (1.14) | (1.93) | (1.63) | (1.18) | (1.53) |
| Secondary | 1.40 | 1.09 | 3.71*** | 2.40** | 1.90** | 2.48** |
| | (1.05) | (0.77) | (1.29) | (1.14) | (0.76) | (1.04) |
| Tertiary | 1.60 | 0.92 | 4.88*** | 2.51** | 2.34*** | 2.98*** |
| | (1.11) | (0.80) | (1.40) | (1.24) | (0.83) | (1.16) |
| Other | 3.70** | 1.89 | 7.85*** | 3.06 | 3.67** | 6.05*** |
| | (1.60) | (1.25) | (2.38) | (2.06) | (1.44) | (2.03) |
| *Gender* | 2.00*** | −1.89*** | −2.21*** | −5.26*** | −0.96** | −2.91*** |
| | (0.56) | (0.39) | (0.78) | (0.65) | (0.48) | (0.62) |
| *Aid* | 0.35 | 0.51 | −0.78 | −1.31** | −0.61 | −0.24 |
| | (0.58) | (0.40) | (0.80) | (0.66) | (0.49) | (0.64) |
| *Employed* | 0.23 | 0.78* | 2.88*** | 1.33** | 1.28** | 1.57** |
| | (0.60) | (0.41) | (0.81) | (0.68) | (0.50) | (0.64) |
| *Water Source* | | | | | | |
| Piped in yard | −0.86 | −0.29 | −5.61*** | −2.39*** | −2.47*** | −3.16*** |
| | (0.74) | (0.53) | (1.01) | (0.79) | (0.58) | (0.79) |
| Standpipe | −0.16 | 0.17 | −5.64** | −1.67 | −1.02 | −2.67 |
| | (1.40) | (0.97) | (2.20) | (1.75) | (1.04) | (1.65) |
| Stream | - 4.85** | 1.82 | −4.09 | 0.87 | −0.21 | −1.10 |
| | (2.05) | (1.42) | (2.59) | (2.16) | (1.71) | (2.22) |
| Catchment | 0.27 | 0.48 | −2.54** | −0.30 | −0.53 | −1.35 |
| | (0.89) | (0.69) | (1.22) | (1.12) | (0.76) | (1.00) |
| Other | 2.12 | 0.68 | −1.83 | 2.74 | 0.49 | 1.33 |
| | (1.68) | (1.09) | (2.43) | (2.02) | (1.91) | (2.19) |
| *House Type* | | | | | | |
| Shared yard | 0.53 | 0.18 | −0.66 | −1.10 | −0.43 | −0.28 |
| | (0.61) | (0.44) | (0.85) | (0.70) | (0.51) | (0.68) |
| Duplex | −1.48 | −1.44 | 2.20 | −3.72** | −0.35 | −0.32 |
| | (1.44) | (1.01) | (1.94) | (1.63) | (1.27) | (1.71) |
| Apartment | 0.15 | 0.08 | 0.84 | −1.78 | 0.77 | 1.56 |
| | (1.71) | (0.74) | (2.31) | (1.61) | (1.574) | (1.70) |
| Room | 0.65 | −3.76** | −1.73 | −4.27* | −3.67** | −2.16 |
| | (1.90) | (1.60) | (3.51) | (2.37) | (1.43) | (2.32) |
| Observations | 1217 | 1217 | 1217 | 1217 | 1217 | 1217 |
| Prob>F | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| R-squared | 0.03 | 0.05 | 0.11 | 0.11 | 0.07 | 0.09 |
| JarqueBera | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 | 0.81 |
| RamseyReset | 0.94 | 0.97 | 0.90 | 0.89 | 0.95 | 0.98 |
| Mean V.I.F | 3.52 | 4.12 | 2.57 | 3.76 | 4.63 | 3.84 |

Robust standard errors are in parentheses to correct for the presence of heteroskedasticity.

***,**,* denote statistical significance at 1%, 5% and 10% respectively. The p-value of each post estimation test is given. The F-test generates the overall significance of the model. The Jarque Bera tests for normality of the variables, (whether the data have skewness and kurtosis matching a normal distribution). The Ramsey Reset test tests the null hypothesis that there are no omitted variables in the model. The Variance Inflation Factor (V.I.F) highlights the presence of multicollinearity within the model where a VIF > 5 suggests multicollinearity.

duplex homes had lower eye-hand coordination scores by 3.72 points. This effect is significant at the 5% level; all other effects were insignificant. In comparison to detached homes, children living in single rooms had lower personal-social and performance development scores by 3.76 and 3.67 points, respectively, with significance at the 5% level. Additionally, eye-hand coordination scores were lower by 4.27 points, at the 10% level of significance. The results also indicated that in comparison, living in a detached house, shared yard or apartment house had no significant effect on any of the child development sub-scales that were tested. Also, living in a single room had no significant effect on a child's locomotor, language or practical reasoning score.

Given the results in Table 2, an interaction between household size and type was investigated Significant differences were identified among different types of households for locomotor and personal-social development but not for other sub-scales (Table 3). Furthermore, there was evidence of a negative relationship between housing size and locomotor and personal-social development; as more persons are added to the household, these developmental scores deteriorate. A one unit increase in household size for persons living in separately detached housing resulted in a 0.09 point increase in locomotor scores. However, locomotor scores declined by 1.03 points when a child lives in a single room compared to a separately detached house. These effects are significant at the 10% level. A one unit increase in household size for persons living in separately detached housing resulted in a 0.15 point increase in the personal-social development score. However personal-social development scores decline by 0.77 points when a child lives in a single room compared to a separately detached house. These effects are significant at the 1% level.

### *Other explanatory variables*

Girls had higher scores for all domain sub-scales than boys, with the exception of the locomotor sub scale; significance was at the 5% or 10% level. Boys' locomotor scores were 2 points higher than that of girls.

Increasing maternal age is associated with decreasing child personal-social development scores, at the 5% level of significance. Paternal age had no significant effect. Maternal education had fewer significant associations than paternal education. Children of mothers who had no formal education had performance scores 5 points lower than those whose mothers' highest educational level was the primary level. At the 10% level of significance, children of mothers who had vocational (skills) training had eye-hand co-ordination scores 5 points higher than those whose mothers had primary level education. In comparison, the higher the father's level of education, the higher were children's scores in all domains. For example, children of fathers who had secondary school education had language scores 3.81 points higher, coordination scores 2.41 points higher, performance scores 1.92 points higher, and practical reasoning scores 2.52 points higher than children with fathers who had less than primary education. Children of tertiary educated father had language scores 5 points higher, coordination scores 2.52 points higher, performance scores 2.36 points higher, and practical reasoning scores 3.02 points higher than children with fathers who had less than primary education.

Receipt of financial assistance was associated with lower eye- hand coordination points by 1.3 points. Children of employed mothers had higher developmental scores

in all domains than those of unemployed mothers with significance varying from the 1 to 10% levels. In comparison to children with in-house piped water facilities, children with external piping facilities had lower language, coordination, performance and practical reasoning scores by 5.58, 2.39, 2.47 and 3.15 points, respectively. Those whose water source was from a standpipe or catchment had lower language scores by 5.6 and 2.50 points, respectively and those whose water source was from a stream or river had lower locomotor scores than those with in-house piped water by 4.77 points.

### *Regression diagnostic tests*

The first assumption of linear regression requires that the relationship between the independent and dependent variables is linear whilst checking for outliers. This was confirmed by scatterplots. The second assumption of the linear regression analysis requires all variables to be multivariate normal and was tested with the Jarque-Bera goodness of fit test. The null hypothesis is that of normality. However, the Prob (chi2) value obtained for each regression was less than 0.05 with the exception of the Practical Reasoning and Eye-Hand Coordination sub-scales. As such we failed to accept the null hypothesis. However, with large enough sample sizes greater than 30, the violation of the normality assumption may not cause major problems and so the distribution of the data may be ignored, based on the Central Limit Theorem which states that in large samples, the sampling distribution tends to be normal, regardless of the shape of the data. Third, linear regression assumes that there is little or no multicollinearity in the data. Multicollinearity was tested by the Variance Inflation Factor (VIF) and the Breusch-Pagan test was used to test for heteroskedasticity in the model. Given that all the p-values were greater than 0.05, heteroskedasticity was assumed. As heteroskedasticity causes the standard errors to be biased, robust standard errors were used as a method of diagnosis.

## Discussion

This study has shown that after controlling for demographic and several socio-economic variables, household size has a significantly negative effect on the locomotor and personal-social development of Jamaican children. The mean household size in this study was consistent with that of 2.9 obtained in the JSLC (Planning Institute of Jamaica and Statistical Institute of Jamaica, 2021). The presence of more persons in the household may lower frequency and intensity of parent-child interactions, with resulting impairment in children's development. Previous studies have documented the impact of crowding on children's social development, mental health and behaviour. For example, overcrowding has been associated with increased social withdrawal among children (Aiello et al., 1985). Additionally, the lack of social and emotional support also appears to deteriorate between parents and children as residential density increases (Evans & Lepore, 1993). According to Bradley and Caldwell (1984), residential crowding has been associated with reduced parental responsiveness to infants thereby elevating conflict and hostility among parents and children, with children displaying relatively more anger and conflict (Saegert, 1982). Moreover, parents in crowded homes are thought to be less accepting and more critical of their children leading to emotional distress (Bradley & Caldwell, 1984). This study has added to the literature on the effects of residential density

**Table 3.** Regression estimates of development sub-scales on overcrowding including interaction variable.

| Variable | A Locomotor | B Personal Social | C Language | D Co-ordination | E Performance | F Practical Reasoning |
|---|---|---|---|---|---|---|
| *Constant* | 67.65*** | 79.03*** | 64.71*** | 58.85*** | 48.87*** | 60.99*** |
| | (2.81) | (1.79) | (3.54) | (3.13) | (2.18) | (2.70) |
| *Household size* | 0.37 | 0.38*** | −0.08 | −0.23 | −0.06 | −0.13 |
| | (0.27) | (0.15) | (0.35) | (0.29) | (0.17) | (0.26) |
| *House Type* | | | | | | |
| Shared Yard | 2.50** | 1.81** | 0.33 | −1.02 | −0.27 | 0.18 |
| | (1.16) | (0.72) | (1.73) | (1.23) | (0.88) | (1.26) |
| Duplex | 2.37 | 1.74 | 4.13 | −3.57 | −0.02 | 0.58 |
| | (2.45) | (1.51) | (3.49) | (2.59) | (1.95) | (2.68) |
| Apartment | 5.49* | 4.49** | 3.51 | −1.57 | 1.23 | 2.81 |
| | (2.96) | (1.75) | (4.42) | (3.01) | (2.42) | (3.26) |
| Room | 9.45* | 3.52 | 2.68 | −3.92 | −2.91 | −0.11 |
| | ((4.88) | (2.73) | (7.19) | (5.17) | (3.53) | (5.50) |
| *Household* | −0.28* | −0.23*** | −0.14 | −0.01 | −0.03 | −0.07 |
| *(Size*Type)* | (0.14) | (0.08) | (0.22) | (0.15) | (0.10) | (0.15) |
| *Maternal Age* | −0.03 | −0.08** | 0.08 | −0.02 | 0.01 | −0.01 |
| | (0.05) | (0.04) | (0.07) | (0.06) | (0.04) | (0.06) |
| *Paternal Age* | −0.04 | −0.01 | −0.04 | 0.01 | −0.0036 | −0.01 |
| | (0.04) | (0.03) | (0.05) | (0.04) | (0.03) | (0.04) |
| *Education (Maternal)* | | | | | | |
| Primary | −0.68 | −1.90 | −1.22 | −1.76 | −0.64 | −4.86** |
| | (2.56) | (1.59) | (3.29) | (3.00) | (2.08) | (2.47) |
| Secondary | −1.77 | −2.10 | −1.79 | 0.38 | −0.49 | −2.33 |
| | (2.13) | (1.44) | (2.75) | (2.49) | (1.88) | (2.02) |
| Tertiary | −1.61 | −1.52 | −0.73 | 1.86 | 0.05 | −0.77 |
| | (2.12) | (1.44) | (2.78) | (2.52) | (1.88) | (2.05) |
| Other | −1.34 | −0.25 | 2.76 | 4.98* | 2.86 | 0.63 |
| | (2.30) | (1.51) | (2.97) | (2.67) | (2.04) | (2.29) |
| *Educational (Paternal)* | | | | | | |
| Primary | −0.46 | 0.52 | 1.31 | 0.83 | 0.78 | 0.33 |
| | (1.60) | (1.15) | (1.94) | (1.63) | (1.18) | (1.53) |
| Secondary | 1.60 | 1.25 | 3.81*** | 2.41** | 1.92** | 2.52** |
| | A | B | C | D | E | F |
| | (1.06) | (0.78) | (1.30) | (1.14) | (0.76) | (1.04) |
| Tertiary | 1.76 | 1.05 | 4.96*** | 2.52** | 2.36*** | 3.02*** |
| | (1.11) | (0.80) | (1.40) | (1.24) | (0.83) | (1.16) |
| Other | 3.90** | 2.05* | 7.95*** | 3.07 | 3.69** | 6.10*** |
| | (1.58) | (1.25) | (2.39) | (2.06) | (1.43) | (2.03) |
| *Gender* | 2.00*** | −1.88*** | −2.21*** | −5.25*** | −0.96** | −2.91*** |
| | (0.56) | (0.39) | (0.78) | (0.65) | (0.48) | (0.62) |
| *Financial Aid* | 0.34 | 0.51 | −0.78 | −1.31** | −0.61 | −0.24 |
| | (0.58) | (0.40) | (0.80) | (0.66) | (0.49) | (0.64) |
| *Employed* | 0.28 | 0.82** | 2.91*** | 1.33* | 1.28** | 1.58** |
| | (0.60) | (0.41) | (0.82) | (0.68) | (0.50) | (0.64) |
| *Water Source* | | | | | | |
| Piped in yard | −0.79 | −0.24 | −5.58*** | −2.39*** | −2.47*** | −3.15*** |
| | (0.74) | (0.53) | (1.01) | (0.79) | (0.58) | (0.79) |
| Standpipe | −0.08 | 0.24 | −5.60** | −1.67 | −1.01 | −2.65 |
| | (1.39) | (0.97) | (2.20) | (1.75) | (1.04) | (1.65) |
| Stream | - | 1.89 | −4.05 | 0.87 | −0.20 | −1.08 |
| | 4.77** | | | | | |
| | (2.08) | (1.42) | (2.60) | (2.16) | (1.71) | (2.22) |
| Catchment | 0.34 | 0.54 | −2.50** | −0.30 | −0.52 | −1.33 |
| | (0.89) | (0.69) | (1.22) | (1.12) | (0.76) | (1.00) |
| Other | 2.07 | 0.64 | −1.86 | 2.74 | 0.49 | 1.32 |
| | (1.67) | (1.09) | (2.43) | (2.02) | (1.91) | (2.19) |
| Observations | 1217 | 1217 | 1217 | 1217 | 1217 | 1217 |

(*Continued*)

**Table 3.** (Continued).

| Variable | A Locomotor | B Personal Social | C Language | D Co-ordination | E Performance | F Practical Reasoning |
|---|---|---|---|---|---|---|
| Prob>F | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| R-squared | 0.03 | 0.05 | 0.11 | 0.11 | 0.07 | 0.09 |
| JarqueBera | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 | 0.82 |
| RamseyReset | 0.98 | 0.93 | 0.89 | 0.94 | 0.92 | 0.87 |
| Mean V.I.F | 3.31 | 3.31 | 3.31 | 3.31 | 3.31 | 3.31 |

Robust standard errors are in parentheses to correct for the presence of heteroskedasticity.
***,**,* denote statistical significance at 1%, 5% and 10% respectively. The p-value of each post estimation test is given. The F-test generates the overall significance of the model. The Jarque Bera tests for normality of the variables, (whether the data have skewness and kurtosis matching a normal distribution). The Ramsey Reset test tests the null hypothesis that there are no omitted variables in the model. The Variance Inflation Factor (V.I.F) highlights the presence of multicollinearity within the model where a VIF > 5 suggests multicollinearity.

on child development. In addition this study has introduced the impact of house type on children's development. Children living in homes with less space, such as single rooms also had lower locomotor and personal scores than children in detached homes.

There are additional findings in this study that have been validated by previous studies. For example, boys' locomotor skills are more advanced than girls at the same age. Gurian (2010) states that males tend to be more physically aggressive and impulsive and that the pleasure centre of their brains are more activated when they take risks as opposed to females. Research has indicated that boys and girls react differently to human beings possibly as a result of their genetic and hormonal disparities (Gurian, 2010; Maccoby, 2000). Boys for example are often late talkers with limited vocabularies in comparison to girls. Additionally, girls are more able to read non-verbal signs (expressions, vocal tones) than males making them better communicators due to their quicker emotional attachments and ability to learn words.

There are policy implications for household findings. To improve children's personal-social and locomotor development, adequate housing is necessary, particularly in the most urban areas where detached housing is less common. According to the JSLC, home ownership in Jamaica is relatively low at 60%, according to the (PIOJ & STATIN, 2021). A standardised definition of crowding suitable for the culture could be developed and this, along with population based data, be used to guide the development of housing solutions for persons from lower income groups. Another consideration is the use of subsidized housing, a form of government economic assistance, given to lower income earners, particularly those with young children, to assist them in affording housing suitable to their family sizes. Where space limitations for housing exist in communities with crowding, green spaces should be identified for mini parks to allow for, locomotor and social recreation activities for children and their parents. Housing policy should ensure that for new communities, particularly in densely populated areas, parks and recreational spaces are allocated.

There are a number of study strengths. First the sample is representative of the population of Jamaican children and second, the comprehensive data collection undertaken in the JA KIDS study permitted a range of socioeconomic factors impacting child development to be controlled for, allowing for the effect of crowding to be better isolated.

Further study on crowding and child development is recommended. For example, the specific mechanisms through which crowding impacts development was theorised but was not evaluated in this study. As most children who live in crowded households reside in developing countries such as Jamaica (Lim et al., 1984), the study findings may be of interest to other developing countries. Replication of the study and its findings would provide further validation.

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## Ethical approval

Ethical approval was granted by the Ethics Committee for the Ministry of Health – Jamaica (approval #198; 2011) and the University of the West Indies (approval # ECP 122 10/11). All participants provided written informed consent.

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