

Effects of psychosocial stimulation and dietary supplementation in early childhood on psychosocial functioning in late adolescence: follow-up of randomised controlled trial

Susan P Walker, Susan M Chang, Christine A Powell, Emily Simonoff, Sally M Grantham-McGregor

Abstract

Objective To determine whether dietary supplementation or psychosocial stimulation given to growth retarded (stunted) children age 9-24 months has long term benefits for their psychosocial functioning in late adolescence.

Design Sixteen year follow-up study of a randomised controlled trial.

Setting Poor neighbourhoods in Kingston, Jamaica.

Participants Of 129 stunted children identified at age 9-24 months, 103 adolescents aged 17-18 were followed up.

Intervention Supplementation with 1 kg milk based formula each week or psychosocial stimulation (weekly play sessions with mother and child), or both, for two years.

Main outcome measures Anxiety, depression, self esteem, and antisocial behaviour assessed by questionnaires administered by interviewers; attention deficit, hyperactivity, and oppositional behaviour assessed by interviews with parents.

Results Primary analysis indicated that participants who received stimulation had significantly different overall scores from those who did not ($F = 2.047$, $P = 0.049$). Supplementation had no significant effect ($F = 1.505$, $P = 0.17$). Participants who received stimulation reported less anxiety (mean difference -2.81 , 95% confidence interval -5.02 to -0.61), less depression (-0.43 , -0.78 to -0.07), and higher self esteem (1.55, 0.08 to 3.02) and parents reported fewer attention problems (-3.34 , -6.48 to -0.19). These differences are equivalent to effect sizes of 0.40-0.49 standard deviations.

Conclusions Stimulation in early childhood has sustained benefits to stunted children's emotional outcomes and attention.

Introduction

Growth retardation or stunting affects 30% of children under 5 years globally and is associated with poor development.^{1 2} Limited evidence suggests that cognition and school achievement are affected up to late adolescence,³ but we found no studies of psychosocial functioning in people who were stunted in early childhood.

Stunted children show behavioural changes in early childhood—they are less happy, more apathetic, and more fussy.⁴ Children who were admitted to hospital for severe malnutrition in early childhood show aggressive behaviour, attention deficits, and poor social relationships when they reach school age.⁵⁻⁷ These findings suggest that stunted children have psychosocial problems.

In high risk children in developed countries, psychosocial stimulation in early childhood reduces antisocial behaviour and delinquency in adolescence.^{8 9} Other psychosocial outcomes have rarely been assessed.

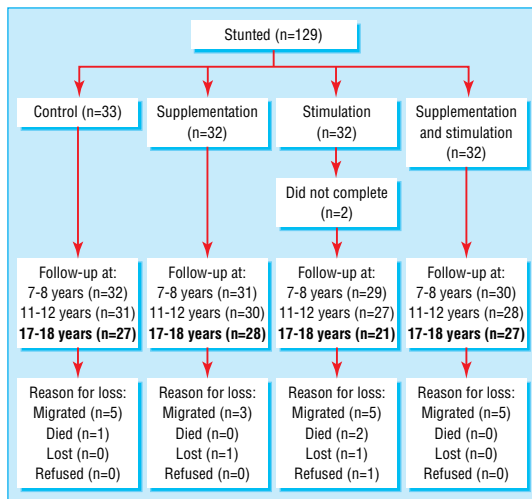
We conducted a two year randomised trial of dietary supplementation and psychosocial stimulation in stunted Jamaican children aged 9-24 months. Each treatment benefited development.² When assessed at 7 and 11 years, stimulation significantly benefited cognitive function.¹⁰ Small benefits from supplementation seen at 7 years were not detected at 11 years. Parents of stunted children reported more problems with conduct than parents of non-stunted children at 11 years, and in a subgroup observed at 9-10 years stunted children were more inhibited and less persistent than non-stunted children.^{11 12} We conducted a follow-up study of the participants at 17-18 years to determine any benefits from the interventions in early childhood on their current psychosocial functioning.

Methods

Initial study

In 1986-7 we identified children aged 9-24 months by house to house survey of poor neighbourhoods of Kingston, Jamaica. We assigned all 129 stunted children identified (length for age less than -2 standard deviations of the National Center for Health Statistics references¹³) to one of four groups—control, supplementation, stimulation, or both interventions. The order of group assignment was determined randomly. Other enrolment criteria have been reported previously.² We calculated the sample size to have 80% power at 5% significance to detect a 5 point difference (equivalent to 0.5 standard deviation, as in our population the standard deviation of the test is typically 10 points) in developmental levels from either intervention.

We visited all participants weekly for two years. Supplementation comprised 1 kg milk based formula each week.¹⁴ Stimulation comprised weekly one hour visits to the home that focused on enhancing interactions between mother and child. Trained community health workers demonstrated play techniques to the mother and involved her in a play session with her child. Mothers were encouraged to talk to their child and to use praise and positive reinforcement. Physical punishment was discouraged. Home made toys and simple picture books were left with the families, and mothers were encouraged to play with their children between visits and to incorporate play activities into daily routines. One hundred and twenty seven children completed the study. We re-examined the children at 7 and 11 years.



Flow of participants through the study

Follow-up at 17-18 years

We assessed the psychosocial functioning of the cohort in 2002-3 when participants were aged 17-18 years. The aim was to assess symptoms and we did not try to diagnose specific disorders. We interviewed 103 participants, 80% of those who started the trial (figure). Written informed consent was obtained from the participants and their parents.

Psychosocial functioning

We assessed self esteem (how I think about myself questionnaire), anxiety (what I think and feel questionnaire), depression (short mood and feelings questionnaire), and antisocial behaviour (behaviour and activities checklist).¹⁵⁻¹⁸ Questionnaires were administered in a private interview at our research unit. Table 1 shows the number of items in each scale, range of scores, and sample questions.

By age 17, young people are thought to be valid informants for many behaviours, but not attention deficit. Thus, to obtain information on this condition we questioned the mothers or primary carers by using the Conners' parent rating scale (short form).¹⁹ This scale also provides scores for cognitive problems and lack of attention, hyperactivity, and oppositional behaviour (such as anger and resentment).

We piloted and reworded the questionnaires as necessary so that they were easily understood. Table 1 shows internal consistency (Chronbach's α) and test-retest reliability (intraclass correlation coefficient) after a two week interval. Different interviewers

(who were unaware of the participants' group) administered the questionnaires to the participants and parents. Inter-observer agreement with another trained interviewer in 23 interviews was $\geq 97\%$ for all items. Higher scores indicate worse psychosocial functioning except for the self esteem scale, where higher scores indicate better self esteem.

Social behaviours

We used a questionnaire to obtain information on education, sexual relationships, pregnancy, contact with the police, and exposure to violence.

Socioeconomic background

We asked participants about the frequency of hunger due to lack of food at home during the previous year. Homes were visited and information obtained on water and toilet facilities (each rated on a 1-6 scale), crowding (number of people per room), and number of household possessions from a list of 11 items. A housing score was derived by factor analysis of these variables. We recorded the mother's or primary carer's education and occupation. We assessed the mother's verbal intelligence with the Peabody picture vocabulary test when the children were 11 years old.

Statistical analysis

We screened outcome variables for normality and used square root transformations to normalise the depression and antisocial behaviour scales. Effects of the interventions were determined by intention to treat. For the primary analysis, we used multivariate ANOVA to determine whether the interventions had significant overall effects on the outcomes; in secondary analyses, we used multiple regression to examine the effects of interventions on individual outcomes. The interventions were coded as: supplementation: supplemented and both interventions = 1, control and stimulation = 0; stimulation: stimulation and both interventions = 1, control and supplementation = 0.

Results

Loss from study

Most children (75%) were lost from the study because of migration (figure), and the proportion lost was similar in all groups. Enrolment measures were similar in participants and children who were lost except that in the non-stimulated groups children lost from the study had lower weight for height ($P=0.014$) and younger mothers ($P<0.001$) than those who were assessed. Mother's age was not associated with any of the outcome

Table 1 Details of questionnaire on psychosocial measures given to 17-18 year olds in Jamaica

Measure	Sample item	No of items	Range of scores*	Chronbach's α	Correlation between test and retest results†
Anxiety	You often worry that something bad is going to happen to you	28	0-28 (5-28)	0.84	0.92
Depression	You felt sad or unhappy	13	0-26 (0-23)	0.83	0.70
Self esteem	You have a lot to be proud of	8	0 to 32 (13-32)	0.55	0.80
Antisocial behaviour	Have you ever started a fight with another young person?	18	0-36 (0-21)	0.68	0.82
Attention deficit‡	Inattentive, easily distracted	12	0-36 (0-30)	0.85	0.70
Cognitive problems or lack of attention‡	Does not finish things that he or she is given to do	6	0-18 (0-17)	0.77	0.81
Hyperactivity‡	Restless, moves about a lot	4	0-12 (0-12)	0.69	0.74
Oppositional behaviour‡	Angry or resentful	6	0-18 (0-18)	0.83	0.85

*Possible range of scores (range of scores in study sample).

†18 participants were given repeat interviews two weeks later.

‡For these items we asked the parent whether the statement described the participant's behaviour; for all other measures we interviewed the participant.

Table 2 Trial of supplementation and stimulation in stunted children in Jamaica. Characteristics of participants at enrolment (9-24 months) and follow-up (17-18 years). Values are number (%) unless stated otherwise

Characteristics	Control (n=27)	Supplemented (n=28)	Stimulated (n=21)	Both interventions (n=27)
Enrolment				
Male	15 (56)	17 (61)	10 (48)	16 (59)
Age (months)*	18.6 (4.8)	18.6 (3.7)	19.5 (4.2)	18.5 (3.7)
Height for age (z score)*	-2.9 (0.6)	-2.9 (0.7)	-2.9 (0.5)	-3.0 (0.7)
Weight for height (z score)*	-0.8 (0.6)	-1.0 (0.8)	-1.2 (0.6)	-1.2 (0.8)
Housing rating*†	7.7 (1.7)	7.3 (1.8)	7.7 (1.0)	6.8 (1.6)
Score on Caldwell home observation, HOME (measures home environment)*	17.6 (4.8)	15.7 (4.2)	16.1 (4.4)	15.5 (3.7)
Mother ≤19 years old	9 (33)	2 (7)	5 (23)	8 (30)
Follow-up*				
Age (years)	17.5 (0.4)	17.5 (0.2)	17.5 (0.2)	17.5 (0.3)
Height for age (z score)	-0.8 (1.0)	-0.6 (0.9)	-0.8 (0.8)	-0.9 (0.9)
Housing score‡	0.03 (0.9)	-0.16 (0.9)	-0.07 (1.0)	0.23 (1.0)
Mother's Peabody picture vocabulary test score	84.0 (20.2)	89.4 (22.8)	83.3 (23.9)	88.9 (24.0)
Mother's occupation				
None or unskilled	5 (19)§	12 (43)	4 (19)	4 (15)
Semi-skilled	11 (42)	12 (43)	11 (52)	15 (56)
Skilled	10 (38)	4 (14)	6 (29)	8 (30)
Hungry in past year				
Never	12 (44)	17 (61)	14 (67)	16 (59)
Less than once a week	8 (30)	4 (14)	6 (29)	9 (33)
At least once a week	7 (26)	7 (25)	1 (5)	2 (7)
Witnessed violent crime in past year				
Never	15 (56)	14 (50)	10 (48)	16 (59)
1-6 times	10 (37)	9 (32)	8 (38)	7 (26)
≥7 times	2 (7)	5 (18)	3 (14)	4 (15)
Participant or family member (or both) ever victim of crime				
No	10 (37)	10 (36)	12 (57)	14 (52)
1 person affected	14 (52)	15 (54)	7 (33)	9 (33)
2-3 people affected	3 (11)	3 (11)	2 (10)	4 (15)

*Values are mean (standard deviation).

†Sum of ratings of toilet and water facilities, crowding, and possessions.

‡Derived from factor analysis of toilet and water facilities, crowding, and possessions.

§Information missing for one mother.

variables and weight for height was associated with antisocial behaviour only. In analyses of antisocial behaviour we therefore controlled for initial weight for height.

Background characteristics

Table 2 shows the characteristics of the participants at enrolment and follow-up. At follow-up, we found no significant differences between the groups. When we combined the groups in which the children received psychosocial stimulation and compared them with those who did not, the stimulated group reported less hunger ($P=0.03$). We found no significant differences by intervention status (stimulation or supplementation) in age, proportion of males and females, or any other social background variables.

Effects of treatment

Table 3 shows the psychosocial outcomes by group. Multivariate ANOVA with all outcomes as the dependent variables and sup-

Table 3 Psychosocial outcomes in trial of supplementation and stimulation in stunted children in Jamaica. Values are mean (95% confidence interval)*

Measure	Control (n=27)	Supplemented (n=28)	Stimulated (n=21)	Supplemented and stimulated (n=27)
Anxiety	15.8 (13.6 to 18.0)	16.9 (14.6 to 19.2)	13.5 (10.6 to 16.4)	13.7 (11.8 to 15.6)
Depression†	7.3 (5.8 to 9.0)	6.8 (4.8 to 9.0)	4.4 (2.6 to 6.8)	5.8 (4.8 to 6.8)
Self esteem	25.2 (23.8 to 26.6)	23.2 (21.9 to 24.5)	26.3 (24.2 to 28.3)	25.1 (23.6 to 26.6)
Antisocial behaviour†	5.8 (4.4 to 7.3)	4.8 (3.2 to 6.8)	4.4 (3.2 to 5.8)	4.4 (2.9 to 6.3)
Attention deficit	15.0 (11.3 to 18.7)	13.6 (10.4 to 16.8)	9.6 (6.3 to 13.0)	12.0 (9.3 to 14.7)
Cognitive problems or lack of attention	7.1 (5.1 to 9.1)	6.4 (4.7 to 8.2)	5.9 (3.8 to 8.0)	5.4 (4.1 to 6.8)
Hyperactivity	4.6 (3.2 to 6.0)	4.8 (3.6 to 6.1)	4.8 (3.0 to 6.5)	4.3 (3.0 to 5.6)
Oppositional behaviour	7.4 (5.6 to 9.3)	7.9 (5.8 to 9.9)	6.0 (3.9 to 8.1)	6.0 (3.9 to 8.2)

*Higher scores indicate worse psychosocial functioning except for self esteem where higher scores indicate better self esteem.

†Variables normalised using square root transformation; the values shown are squares of the transformed data.

plementation and stimulation as factors indicated a significant effect of stimulation ($F=2.047$, $P=0.049$) but not supplementation ($F=1.505$, $P=0.17$). In secondary analyses, we performed regressions for the individual outcomes to determine which outcomes differed between participants who had or had not received stimulation. Because of the factorial design of our study we included dummy variables for stimulation and supplementation, but the results for supplementation are not shown owing to the overall lack of significance in the multivariate analysis. Participants who received psychosocial stimulation in early childhood reported significantly less anxiety, fewer symptoms of depression, and better self esteem than non-stimulated stunted participants (table 4). They were also rated as having fewer attention problems by their parents. If, however, we use a more stringent level of significance ($P<0.01$, because of the multiple comparisons) only the difference in reported anxiety is statistically significant. We found no significant interactions between stimulation and supplementation. We entered hunger (which differed by stimulation status) as a factor and re-analysed the outcomes that had been significantly affected by stimulation. Hunger was not a significant predictor of any of the variables.

Social behaviour

The groups did not differ regarding contact with the police or law. Apart from being stopped for questioning by the police (reported by 47.6% of participants), few contacts were

Table 4 Multiple regression analysis of the effects of early childhood stimulation on psychosocial functioning at age 17-18 years

Measure	Mean difference (95% confidence interval)	P value
Anxiety	-2.81 (-5.02 to -0.61)	0.01
Depression*	-0.43 (-0.78 to -0.07)	0.02
Self esteem	1.55 (0.08 to 3.02)	0.04
Antisocial behaviour*†	-0.11 (-0.44 to 0.23)	0.53
Attention deficit	-3.34 (-6.48 to -0.19)	0.04
Cognitive problems or lack of attention	-1.07 (-2.79 to 0.65)	0.22
Hyperactivity	-0.20 (-1.57 to 1.17)	0.77
Oppositional behaviour	-1.64 (-3.60 to 0.32)	0.10

*Square root transformation used in analyses.

†Initial weight for height entered in regression.

reported—five participants were detained and one was convicted of an offence. The groups did not differ in sexual behaviour (having had sex, number of partners, having been pregnant) or in use of alcohol, cigarettes, and marijuana. Participants who had received stimulation were less likely to have been suspended from school (stimulation 31.3%, no stimulation 47.3%; $P=0.10$) or expelled (stimulation 2.1%, no stimulation 10.9%; $P=0.08$) than participants who did not receive stimulation.

Discussion

Psychosocial stimulation in early childhood had sustained benefits for the psychosocial functioning of stunted children. We found no sustained benefits from dietary supplementation.

In our study, supplementation had small benefits to height during the intervention, and supplementation only increased the net energy intake by 440 kJ/day.¹⁴ A higher level or longer duration of supplementation may have led to greater benefits.

Stunted children who participated in the stimulation programme reported fewer symptoms of depression and anxiety and better self esteem and attention than those who did not receive the intervention. The changes in scores for anxiety, depression, and self esteem were 0.4-0.49 of a standard deviation. At an individual level, these effects are not large (although in line with some mental health treatment outcomes). However, at a population level, these changes could have an important role in reducing emotional disorders.

Loss to follow-up was modest, and the interviewers were blind to the participants' group. The only enrolment characteristics that differed between stunted children lost to follow-up and those assessed were weight for height and mother's age. Mother's age was not related to any of the outcomes and weight for height was related only to antisocial behaviour, so the intervention was probably responsible for the benefits seen.

Few long term studies have evaluated interventions in early childhood in disadvantaged but adequately nourished children.²⁰ The main benefit reported in psychosocial functioning is reduction in antisocial behaviour.^{8,9} In our study, participants in the stimulated group were suspended or expelled from school less often, but we found no benefits to self reported antisocial behaviour.

We found no previous reports of interventions in early childhood with long term benefits to internalising problems or attention, but these behaviours were rarely assessed. Intervention studies in the United States have shown that children who are more disadvantaged benefit most.⁸ The Jamaican children studied here were undernourished and came from very poor families, and this may have contributed to the wide ranging benefits of intervention, which include cognitive and educational benefits.²¹

The intervention was aimed at improving the mother-child relationship; it emphasised listening and chatting to the children, allowing them to experience success, praising their actions, and reducing punishment. Any change in these behaviours could help improve psychosocial functioning, particularly self esteem. In another recent trial with a similar intervention, mothers in the intervention arm had reduced symptoms of depression.²² Thus, improved psychosocial functioning in the mothers may also have been beneficial to the children. The benefits of stimulation to the educational achievement of the participants may also have contributed to better emotional outcomes.

Much attention has been paid to poor cognition and school achievement of undernourished children, but changes in their psychosocial functioning may be as important to their quality of

life. Stimulation in early childhood produced sustained improvements to the psychosocial functioning of stunted children. The next challenge is to develop interventions that can meet the needs of the enormous number of stunted children.

Thanks to Amika Wright and Sydonnie Shakespeare for conducting the interviews and the participants and their parents for their continued cooperation.

Contributors: All authors conceived and designed the study. SC and SW conducted the study. SW and SGM analysed the data and SW drafted the manuscript. All authors critically reviewed the paper and approved the final draft for publication. SW is guarantor.

Funding: Supported by a grant from the Wellcome Trust (066088). The funders approved the study design but had no involvement in data collection, analysis, interpretation, or writing the report.

Competing interests: None declared.

Ethical approval: Ethics committees of the University of the West Indies and the Institute of Child Health, University College, London.

- 1 United Nations System SCN. *Fifth report on the world nutrition situation*. Geneva: SCN, 2004.
- 2 Grantham-McGregor SM, Powell CA, Walker SP, Himes JH. Nutritional supplementation, psychosocial stimulation, and mental development of stunted children: the Jamaican study. *Lancet* 1991;338:1-5.
- 3 Grantham-McGregor SM. Linear growth retardation and cognition. *Lancet* 2002;359:542.
- 4 Gardner JM, Grantham-McGregor SM, Himes J, Chang S. Behaviour and development of stunted and nonstunted Jamaican children. *J Child Psychol Psychiatry* 1999;40:819-27.
- 5 Galler JR, Ramsey F. A follow-up study of the influence of early malnutrition on development: behavior at home and at school. *J Am Acad Child Adolesc Psychiatry* 1989;28:254-61.
- 6 Richardson SA, Birch HG, Grabie E, Yoder K. The behavior of children in school who were severely malnourished in the first two years of life. *J Health Soc Behav* 1972;13:276-84.
- 7 Richardson SA, Birch HG, Ragbeer C. The behaviour of children at home who were severely malnourished in the first 2 years of life. *J Biosoc Sci* 1975;7:255-67.
- 8 Olds D, Henderson CR Jr, Cole R, Eckenrode J, Kitzman H, Luckey D, et al. Long-term effects of nurse home visitation on children's criminal and antisocial behavior: 15-year follow-up of a randomized controlled trial. *JAMA* 1998;280:1238-44.
- 9 Yoshikawa H. Long-term effects of early childhood programs on social outcomes and delinquency. *Future Child* 1995;5:51-75.
- 10 Walker SP, Grantham-McGregor SM, Powell CA, Chang SM. Effects of growth restriction in early childhood on growth, IQ, and cognition at age 11 to 12 years and the benefits of nutritional supplementation and psychosocial stimulation. *J Pediatr* 2000;137:36-41.
- 11 Chang SM, Walker SP, Grantham-McGregor S, Powell CA. Early childhood stunting and later behaviour and school achievement. *J Child Psychol Psychiatry* 2002;43:775-83.
- 12 Fernald LC, Grantham-McGregor SM. Stress response in school-age children who have been growth retarded since early childhood. *Am J Clin Nutr* 1998;68:691-8.
- 13 Hamil P, Drizd T, Johnson C, Reed R, Roche A. *Growth curves for children, birth-18 years. 165 (DHEW 78-1650), vital and health statistics series 11*. Hyattsville, MD: National Center for Health Statistics, 1977.
- 14 Walker SP, Powell CA, Grantham-McGregor SM, Himes JH, Chang SM. Nutritional supplementation, psychosocial stimulation, and growth of stunted children: the Jamaican study. *Am J Clin Nutr* 1991;54:642-8.
- 15 Warr P, Jackson P. Self-esteem and unemployment among young workers. *Le Travail Humain* 1983;46:355-66.
- 16 Reynolds CR, Richmond BO. What I think and feel: a revised measure of children's manifest anxiety. *J Abnorm Child Psychol* 1978;6:271-80.
- 17 Costello EJ, Angold A. Scales to assess child and adolescent depression: checklists, screens, and nets. *J Am Acad Child Adolesc Psychiatry* 1988;27:726-37.

What is already known on this topic

Linear growth retardation (stunting) in childhood is associated with cognitive deficits and poor educational achievement in late adolescence

Stunting is also associated with behavioural problems at 9-11 years of age

Psychosocial stimulation in early childhood has long term benefits for stunted children's cognitive outcomes

What this study adds

A programme of home based psychosocial stimulation has sustained benefits for stunted children's emotional outcomes and attention

- 18 Olweus D. Persistence and prevalence in the study of antisocial behaviour: definitions and measurement. In: Klein MW, ed. *Cross-national research in self reported crime and delinquency*. Dordrecht, Netherlands: Kluwer, 1989.
- 19 Conners CK, Sitarenios G, Parker JD, Epstein JN. The revised Conners' parent rating scale (CPRS-R): factor structure, reliability, and criterion validity. *J Abnorm Child Psychol* 1998;26:257-68.
- 20 Farran DC. Another decade of intervention for children who are low income or disabled: What do we do now? In: Shonkoff JP, Meisels SJ, eds. *Handbook of early childhood intervention*. New York: Cambridge University Press, 2000:501-39.
- 21 Walker SP, Chang SM, Powell CA, Grantham-McGregor SM. Effects of early childhood psychosocial stimulation and nutritional supplementation on cognition and education in growth-stunted Jamaican children: prospective cohort study. *Lancet* 2005;366:1804-7.
- 22 Baker-Henningham H, Powell C, Walker S, Grantham-McGregor S. The effect of early stimulation on maternal depression: a cluster randomised controlled trial. *Arch Dis Child* 2005;90:1230-4.
(Accepted 7 June 2006)

doi 10.1136/bmj.38897.555208.2F

Epidemiology Research Unit, Tropical Medicine Research Institute, University of the West Indies, Mona, Kingston 7, Jamaica

Susan P Walker *professor*

Susan M Chang *lecturer*

Christine A Powell *senior lecturer*

Institute of Psychiatry, London SE5 8AF

Emily Simonoff *professor*

Institute of Child Health, London WC1N 1EH

Sally M Grantham-McGregor *professor*

Correspondence to: S Walker susan.walker@uwimona.edu.jm