

Five-year Follow-up of Rural Jamaican Children whose Mothers used Marijuana during Pregnancy

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ABSTRACT

This research provides data on the development of 59 Jamaican children, from birth to age 5 years, whose mothers used marijuana during pregnancy. Approximately one-half of the sample used marijuana during pregnancy and were matched with non-users according to age, parity, and socioeconomic status. Testing of the children was done at 1, 3, and 30 days of age with the Brazelton Neonatal Behavioral Assessment Scales and at ages 4 and 5 years with the McCarthy Scales of Children's Abilities. Data about the child's home environment and temperament were collected from direct observations as well as from standardized questionnaires. The results show no significant differences in developmental testing outcomes between children of marijuana-using and non-using mothers except at 30 days of age when the babies of users had more favourable scores on two clusters of the Brazelton Scales: autonomic stability and reflexes. The developmental scores at ages 4 and 5 years were significantly correlated to certain aspects of the home environment and to regularity of basic school (preschool) attendance.

INTRODUCTION

Marijuana is among the most commonly used of the illegal substances worldwide. The active ingredient, 9THC, is known to cross the placenta (Vardaris et al, 1976) and has been traced in the mammary glands and breast milk of smoking mothers. Studies which have followed the babies of cannabis-using mothers have reported findings indicative of CNS abnormalities, such as heightened tremors and startles, and a high-pitched cry (Fried, 1980; Lester and Dreher, 1989), meconium staining (Greenland et al, 1982), and low birth weight (Hingson et al, 1982; Linn et al, 1983). Symptoms similar to mild narcotic withdrawal have also been reported at 9 and 30 days of age (Fried et al, 1987). The possibility, however, of long-range functional impairment in humans has been neither confirmed nor ruled out.

STUDY PARTICIPANTS

The women in the study were identified through fieldwork in designated communities of St. Thomas parish, Jamaica, with the assistance of nurses in the Ministry of Health antepartum clinics. Two groups, marijuana-users and non-users, were matched according to age, parity, and socioeconomic status. The birth dates of the babies ranged from October, 1983 to May, 1985.

Initially, 60 women (30 users and 30 non-users), ranging in age from 16 to 38 years, were enlisted in the study. A major confounding variable in trying to identify the specific effects of cannabis in North American studies has been socioeconomic status. For this reason, the entire sample was drawn from what could be described as the rural lower income class. The study is not confounded by the presence of other risk factors which may affect developmental outcomes such as polydrug use, alcohol consumption, tobacco smoking, and low birth weight. It is combinations of risk factors that are frequently associated adversely with the child's later intellectual performance (Sameroff and Chandler, 1975; Sameroff et al, 1987).

Within this sample, there was one still birth (non-user) and two spontaneous abortions (users) and one woman lost to the study, resulting in 56 neonates. One mother in each group was eclamptic and satisfactorily recovered. There was one preterm birth (non-user). Most were delivered in the hospital (one by elective Caesarean Section) and the rest were delivered at home. Two women originally placed in the non-user group were observed to be users by the fieldworkers during their observations and were therefore reclassified. The result was 26 neonates of non-using mothers and 30 neonates of using mothers were included in the study.

METHODOLOGY

Using standardized testing procedures, this study followed the development of children from the prenatal period to the age of 5 years. During the neonatal period, the infants were evaluated at one, three, and thirty days of age, using the Brazelton Neonatal Behavioral Assessment Scales (BNBAS). At ages 4 and 5 years, the children were tested with the McCarthy Scales of Children's Abilities (MSCA), and the child's primary caregiver was interviewed to complete the Behavioral Style Questionnaire (BSQ) which assesses the child's temperament. The physical home environment at age 4 years was measured by a Quality of Housing Index (QHI) created for this study. At age 5 years, however, a more comprehensive assessment of the household was conducted, using the Caldwell Home Observation for Measurement of the Environment (HOME) modified for cultural appropriateness. These measures were obtained by trained ethnographers who maintained routine contact with the children and their families throughout the five-year period, and conducted naturalistic observations of the households and communities.

Standardized Tests

Brazelton Neonatal Behavioral Assessment Scales rates the responses of infants on 28 behaviours, 20 reflexes, and provides 9 global ratings of the infant. These scores then cluster into the following categories: habituation, orientation, motor development, state range, state regulation, autonomic regulation, and reflexes. All assessments were conducted by the same tester, who was certified in the Brazelton method and blind to the child's group assignment.

The McCarthy Scales of Children's Abilities (MSCA) measures the child's development on five scales: verbal, perceptual-performance, quantitative, memory, and motor. In addition, a General Cognitive Index is provided which combines the scores of the first three scales. The Index has a mean and standard deviation equivalent to an IQ score. It has been standardized in the United States and has well-established reliability and validity for that population. Some items on the test were, however, modified to make them more appropriate for Jamaican children.

The BSQ assesses the temperament characteristics of the child as perceived by the child's primary caregiver. In most cases, it was the mother, but in a few cases it was the father, grandmother or another individual who had the primary role in the care of the child. The BSQ consists of 72 items which describe certain categories of behaviour: (1) activity level, (2) rhythmicity, (3) approach/withdrawal, (4) adaptability, (5) intensity of reaction, (6) quality of mood, (7) threshold of response, (8) distractibility, and (9) attention span and persistence. It also has established reliability and validity for North American populations, and has been analyzed with other cultural groups including Chinese (Chen-Chin et al, 1981), East African (deVries and Sameroff, 1984), and Israeli (Klein, 1984). Minor modifications were made in

this instrument in order to provide examples of behaviours which are more likely to be observed in rural Jamaica.

The Quality of Housing Index was developed for this study in response to the finding in the neonatal data which indicated that, even within this rural, working class stratum, some households were better equipped, socioeconomically, to provide for the needs of the child than others. On a rating of 0-4, with 4 being the highest, the scale is based upon the physical quality of housing (structure and contents) as an indicator of the family's resources (Table 1).

Table 1: Quality of housing index

0 =	Someone without permanent housing, no beds or other material support
1 =	"Single room" wood structure, minimal furnishings (i.e., a bed), minimal sources of regular income or food
2 =	"Single room" dwelling, wood or cement, with sparse furnishings and some sources of income
3 =	Multi-room dwelling of cement, multiple and regular sources of income
4 =	Like #3 including the trappings of "middle class life" (i.e., television, refrigerator, car, etc.)

The HOME provides information about seven categories of developmental support found within the home: (1) provision of stimulation through equipment, toys, and experiences, (2) stimulation of mature behaviour, (3) provision of a stimulating physical and language environment, (4) avoidance of restriction and punishment, (5) pride, affection, and thoughtfulness, (6) masculine stimulation, and (7) independence from parental control. Modified for Jamaica, the instrument consists of 74 items which are scored with a binary yes or no.

Testing Procedures

The administration of the developmental tests of the children and interviews with the mothers took place within one month of the child's fourth and fifth birthdays. These were done at a location other than the child's home in order to keep the tester and interviewers blind to the mother's marijuana use.

Data Analysis Techniques

At ages four and five years, the sample was further divided into four groups in order to analyze for dose-related effects. This was based on the average amount of marijuana consumed per week: light users (the equivalent of up to ten marijuana cigars or "spliffs"), moderate (11-20), heavy (21-70), and non-users.

The data analysis used Statistical Package for the Social Sciences (SPSS). When comparing the user and non-user groupings for the BNBAS, a t-test was used to compare the group means. Multiple analysis of covariance (MANCOVA) and multiple analysis of variance (MANOVA) were used to

compare groups at ages four and five years. Pearson correlation coefficients were also used to test for relationships between the variables.

NEONATAL RESULTS

All babies were healthy and normal on physical examination. The average length of gestation and birth weight were not significantly different between the groups (Table 2).

Table 2: Neonatal Outcomes

	Birth Wt.	Length of Gestation	Maternal age	Parity
Non-user				
Mean	3.13 kg	39.2 weeks	22.6 yr.	2.2
S.D.	0.45	2.6	7.13	2.0
User				
Mean	3.06 kg	40.0 weeks	22.9 yr.	1.9
S.D.	0.42	2.3	5.7	1.8

The results of analysis by t-test reveal no significant difference between babies of marijuana-users and non-users on any of the BNBAS clusters at Days 1 or 3 (Hayes et al, 1988). (Table 3).

On Day 30, differences were found on autonomic regulation and reflexes, favouring the babies of users.*

Table 3: Means of Brazelton Neonatal Assessment Scale Clusters

Cluster	Day 1 Mean (SD)	Day 3 Mean (SD)	Day 30 Mean (SD)
Habituation			
Non-user	6.66 (1.3)	6.82 (.8)	6.53 (1.5)
User	6.50 (1.0)	6.84 (.8)	7.20 (.9)
Orientation			
Non-user	5.10 (1.0)	5.45 (1.3)	6.46 (1.3)
User	4.68 (1.6)	5.87 (.9)	6.63 (1.4)
Motor			
Non-user	4.90 (.6)	5.42 (.4)	6.36 (.7)
User	4.85 (.9)	5.39 (.6)	6.45 (.7)
Range of State			
Non-user	3.99 (.5)	4.07 (.5)	4.04 (.6)
User	3.08 (.6)	4.15 (.4)	3.89 (.7)
Regulation of State			
Non-user	5.22 (.8)	5.74 (.7)	5.48 (1.4)
User	5.17 (.8)	5.44 (1.2)	5.62 (1.1)
Autonomic Stability			
Non-user	3.06 (1.0)	2.74 (1.1)	3.03 (1.6)*
User	3.56 (1.2)	3.02 (1.2)	2.04 (1.2)*
Reflexes			
Non-user	13.38 (2.2)	13.82 (3.3)	13.40 (3.0)*
User	12.17 (3.1)	15.15 (2.2)	15.55 (1.9)*

*Mean scores significantly different at the 0.05 level.

RESULTS AT THE AGE OF FOUR YEARS

At age four years' follow-up, 52 of the children and their families remained in the study. Two of the non-using and one of the using mothers had moved away from Jamaica.

Another was dropped from the study when a reassessment revealed that her socioeconomic status made her significantly different from the rest of the sample.

MSCA results were analyzed for 44 of the children. Eight were unable to complete the test at age four (three of those were children of non-users and five were children of users); comments from the tester indicated that most of these children were shy and somewhat withdrawn during the testing session. One of these children was dropped from the data analysis when some conflicting information was made available regarding the mother's marijuana history.

Multiple analysis of covariance showed the Quality of Housing Index to be closely and positively related to two of the MSCA scores: General Cognitive Index and Memory. When the QHI was controlled, there were no significant differences between the groups on any of the MSCA or BSQ scores.

RESULTS AT THE AGE OF 5 YEARS

The data analyzed at age 5 years included MSCA scores, BSQ scores, regularity of Basic School attendance, and the Caldwell Home Observation for Measurement of the Environment (HOME) scale. In preparation for the five-year evaluation, eight children were recruited for the study to match those lost from the original study group. Their selection was based upon the mother's socioeconomic status, age, parity, and marijuana use at the time of the child's birth. One child of a user had moved away from Jamaica since the age four testing. Of the total 59 at age five years, 54 were included in the data analysis; four of the children were unable to successfully complete the MSCA and the data from the remaining one were again excluded due to missing information. Of the four who were unable to complete the testing, two were from the non-using group, one was classified as a moderate user, and one was classified as a heavy smoker. These four children were referred for further evaluation by 3D Projects Ltd., a programme in Jamaica which provides diagnostic and intervention services for the mentally retarded. One of those children (non-user) was diagnosed as mildly retarded, and the other three were believed to be low performers due to social or environmental disadvantage.

As with the age four years' evaluations, results of the MANOVA analysis revealed no differences among the four marijuana-use groups on any of the development (MSCA) or temperament (BSQ) scores. On the other hand, analysis of the HOME revealed that the subscale called "stimulation through toys, games, and reading material" was significantly related to several MSCA scores: (1) verbal, (2) perceptual, (3) memory, and (4) the general cognitive index and to the temperament characteristic of threshold (Table 4).

The analysis from the HOME subscale "stimulation of mature behaviour" showed a highly significant relationship to every MSCA score and to the temperament category of "mood". The correlation coefficients ranged from 0.63 to 0.69 (Table 4).

Table 4: Correlations between the HOME and MSCA scores

	Verbal	Percept	Quant	Memory	Motor	GCI
HOME 1	0.39*	0.35*	0.29	0.40*	0.26	0.38*
HOME 2	0.65**	0.63**	0.65**	0.67**	0.64**	0.69**
HOME 3	0.22	0.14	0.20	0.19	0.18	0.20
HOME 4	- 0.04	0.06	0.08	- 0.04	0.02	0.02
HOME 5	0.18	0.15	0.13	0.14	0.21	0.17
HOME 6	0.07	- 0.06	0.01	0.07	- 0.15	0.01
HOME 7	0.21	0.21	0.10	0.10	0.21	0.20

* Significant at the 0.01 level

** Significant at the 0.001 level

Regularity of Basic School Attendance

Of the 59 children in the study, 32 were regular attenders, 17 were irregular attenders, and 10 did not attend at all. These determinations were based upon teachers' reports since more precise measurement was not available due to destruction of the school records in Hurricane Gilbert. Not surprisingly, analysis showed the regularity of school attendance to be significantly related to the MSCA verbal, perceptual, memory, motor, and general cognitive scores.

A comparison of the MSCA mean scaled scores of the study group with the standardized scaled means reveals no significant differences and is consistent with the performance of Jamaican children on other standardized developmental tests (Walker and Grantham-McGregor, 1990). It should, however, be noted that the test was modified slightly for cultural appropriateness so that comparisons with other groups outside Jamaica where the MSCA was not modified should not be made (Table 5).

Table 5: Comparison between the scaled means on the MSCA five years of age

	Jamaican mean	(SD)	Standard mean	(SD)
Verbal	45	(10)	50	(10)
Perceptual	54	(13)	50	(10)
Quantitative	52	(8)	50	(10)
Memory	47	(9)	50	(10)
Motor	57	(13)	50	(10)
General Cognitive	100	(18)	100	(16)

DISCUSSION

The lack of negative findings related to prenatal marijuana exposure in this study at birth, one month, four and five years of age must be interpreted with the realization that the HOME scores and regularity of basic school attendance were very powerful variables in the statistical analysis. Whether marijuana effects were absent, so subtle as to be overpowered or compensated by the variables related to the child's environment and school attendance, or whether the outcome measures did not tap abilities which might be affected by marijuana use has not been determined. What

can be concluded is that the child who attends basic school regularly, is provided with a variety of stimulating experiences at home, and who is encouraged to show mature behaviour in the ways asked on the HOME has a profoundly better chance of performing at a higher level on the skills measured by the MSCA, whether or not the mother used marijuana during pregnancy.

Acknowledgement

This research project was funded by grants from the March of Dimes and The National Institute on Drug Abuse, U.S.H.H.S.

REFERENCES

Chen-Chin, H., Soong, W., Stigler, J.W., Hong, C. and Tiang, C. (1981) The temperamental characteristics of Chinese babies. *Child Develop.* 52: 1337-1340.

deVries, M.W. and Sameroff, A.J. (1984) Culture and temperament: Influences on infant temperament in three East African societies. *Amer. J. Orthopsychiat.* 54: 83-96.

Fried, P.A. (1980) Marijuana use by pregnant women: Neuro-behavioural effects in neonates, *Drug and Alcohol Dependence.* 6: 415-424.

Fried, P.A., Watkinson, B., Dillon, R.F. and Dulber, C.S. (1987) Neonatal neurological status in a low-risk population after prenatal exposure to cigarettes, marijuana, and alcohol. *Develop. Behav. Paediatr.* 8: 318-326.

Greenland, S., Staisch, K.J., Brown, N. and Gross, S.J. (1982) The effects of marijuana use during pregnancy 1: A preliminary epidemiologic study. *Amer. J. Obstet. Gynecol.* 143: 408-413.

Hayes, J.S., Dreher, M.C. and Nugent, J.K. (1988) Newborn outcomes with maternal marijuana use in Jamaican women. *Paediatr. Nursing.* 14: 107-110.

Hingson, R., Alpart, J.J., Day, N. et al (1982) Effects of maternal drinking and marijuana use on fetal growth and development. *Pediatrics.* 70: 539-546.

Klein, P. (1984) Behavior of Israeli mothers toward infants in relation to infants' perceived temperament. *Child Develop.* 55: 1212-1218.

Lester, B. and Dreher, M.C. (1989) Effects of marijuana use during pregnancy. *Child Develop.* 60: 765-771.

Linn, S., Schoenbaum, S.C., Monson, R.R., Rosner, R. Stubblefield, P.C. and Ryan, K.J. (1983) The association of marijuana use with outcome of pregnancy. *Amer. J. Public Health.* 73: 1161-1164.

Sameroff, A.J. and Chandler, M. (1975) Reproductive risk and the continuum of caretaking casualty, In: F.D. Horowitz, et al, eds. *Review of Child Development Research.* University of Chicago Press, Chicago, Vol. 4, 187-244.

Sameroff, A.J., Seifer, R., Barocas, R., Zax, M. and Greenspan, S. (1987) Intelligence quotient scores of 4-year-old children, social-environmental risk factors, *Pediatrics.* 79: 343-350.

Vardaris, R.M., Weisz, D.T., Fazel, A. and Rawitch, A.B. (1976) Chronic administration of delta-9-tetrahydrocannabinol to pregnant rats: Studies of public behavior and placenta transfer, *Pharmacol. Biochem. Behav.* 4: 249-254.

Walker, S.P. and Grantham-McGregor, S.M. (1990) Growth and development of West Indian children, Part 2: Development. *West Ind. Med. J.* 39: 12-19.

Zuckerman, B., Frank, D.A., Hingson, R. et al (1989) Effects of maternal marijuana and cocaine use on fetal growth. *New Engl. J. Med.* 320: 762-768.