THE CORRELATES OF SEVERE CHILD ABUSE

D. M. FERGUSSON

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A more general discussion of the findings presented in this report is given in General Report No. 1 - "Factors Associated with Serious Ill-Treatment of Children".

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ERRATA

In some sections of this report the descriptions given of Variable 4 (child's home) are somewhat misleading. Statements relating to children "living with at least one substitute parent" should read "not living with both natural parents". Therefore the following references should be amended as indicated:

page 10, para 3, second sentence should read: "Young children not living with both natural parents had twice ....".

page 13, Table 2, group 1 should read: "Child under five years; not living with both natural parents".

page 15, variable 4, X=1 should read: "Child not living with both natural parents".

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INTRODUCTION

An earlier study (Fergusson, Fleming and O'Neill, 1972) provided a descriptive account of the incidence and nature of cases of child abuse coming to the attention of the Child Welfare Division of the Department of Education during 1967. The findings of this study identified a number of possible correlates of child abuse, including: the stability of the child's attachment to the abusing home; problems within the family unit; social and personal deviance of the child's parent figures; and stresses facing the child's mother figure. In general, the survey results agreed with those reported in earlier studies (Young, 1964; Elmer, 1965, 1967; Skinner and Castle, 1969; Gil, 1968, 1969, 1970).

For the purposes of the initial analysis, children referred to the Child Welfare Division for suspected or alleged incidents of abuse were classified into two groups:

(1) Abused children - those children for whom the allegation of abuse was supported by the available evidence.
(2) Non-abused children - those children for whom the allegation of abuse was not supported by the evidence.

The criteria used for making this classification followed Gil's (1968) definition of child abuse:

> "Non-accidental physical attack or injury, including minimal as well as fatal injury, inflicted on children by persons caring for them" (p. 20).

Within the scope of this definition, the injuries sustained by the abused children showed considerable variation: 3% died as a consequence of the assault, 2% suffered serious and permanent injury, 12% suffered serious injuries, and the remaining 83% sustained minor or non-serious injuries.

In view of the variability in the extent of injuries, it seems reasonable to ask the question: what factors distinguish those children who suffer serious injury from those who suffer non-serious injury? Or, to put the matter another way: do seriously injured children form a particular sub-group, or set of sub-groups, of the group of abused children? The

present paper is devoted to an analysis of this topic. The purposes of this analysis are two-fold:

(1) To identify the circumstantial factors which are associated with incidents of serious abuse as opposed to incidents of non-serious abuse.

(2) To provide social workers and others with some indication of the type of features to look for when dealing with families displaying incipient child abusive behaviour.

ANALYSIS PRINCIPLES

The research approach used in the analysis is based on a data model which has been described by Sonquist and Morgan (1964) as the "sample survey model". In this research paradigm, the aim is to account for the variability of some specified criterion variable Y in terms of a series of independent or predictor variables X_1, X_2 ... X_n. The conventional approach to this problem is through multiple linear regression. This procedure assumes that the estimated score of the jth subject on the variable Y is given by a weighted sum of predictor variables:

$$Y'_j = B_0 + B_1X_{1j} + B_2X_{2j} + \ldots + B_nX_{nj} \qquad (1.1)$$

where the constants B_0, B_1 ... B_n are selected to minimise the sums of the squared deviations of the estimated scores Y'_j around the observed scores Y_j.

The objections to multiple linear regression, however, are well known: frequently there is little reason to believe a priori that the criterion and the predictors are linearly related, and further, the model does not take account of interaction effects (unless special assumptions about the nature of interactions are made).

Discontent with the linear model has led to the development of a number of alternative analysis strategies. One approach to the problem has been through the use of sequential partitioning procedures which divide the sample space up into a number of mutually exclusive and exhaustive sub-groups, defined on selected predictor variables (Sonquist and Morgan, 1964; Macnaughton-Smith, 1963, 1965). Sub-groups are selected to minimise the within groups variability of the criterion variable.

The development of these methods has been comparatively recent, and as a consequence they are probably less familiar than more conventional methods. To aid the reader in the interpretation of the results presented in this report, a brief introduction to the Sonquist and Morgan (1964) automatic detection of interaction effects (AID) procedure is given below. (It can be shown that the Macnaughton-Smith Predictive Attribute Analysis method is, in fact, a special case of AID (Fergusson and Jensen, 1973)).

The AID model assumes that the criterion variable Y is measured on an

interval scale, with the minimum requirement that Y can be expressed in dichotomous form. The predictor variables X_1, X_2 ... X_n may be on nominal, ordinal, interval or ratio scales.

For a sample of N observations, the sum of squared deviations of Y around its mean is:

$$TSS_t = \sum_{j=1}^{N} Y_j^2 - \frac{(\sum_{j=1}^{N} Y_j)^2}{N} \qquad (1.2)$$

AID partitions the sample of N observations into a series of sub-groups, defined on the variables X_1, X_2 ... X_n, such that the total within sub-groups sums of squares of Y is minimised. This partitioning procedure is achieved through a series of binary splits on the initial sample. Each partition is based on the following principles: for any sub-group i with sum of squares TSS_i and sample size N_i, the reduction in the sum of squares that is achieved by partitioning the group i into two further sub-groups, based on a binary partition of variable X_k at some cutting point p, is:

$$BSS_{ikp} = TSS_i - (TSS_1 + TSS_2) \qquad (1.3)$$

where TSS_1 and TSS_2 are the total within groups sums of squares for the two sub-groups formed by the partition. A little algebraic manipulation reduces equation 1.3 to:

$$BSS_{ikp} = (N_1\bar{Y}_1^2 + N_2\bar{Y}_2^2) - N_i\bar{Y}_i^2 \qquad (1.4)$$

where N_1, N_2 are the sizes of the two sub-groups, $\bar{Y}_1$, $\bar{Y}_2$ are the corresponding mean values and $\bar{Y}_i$ is the mean of the group i.

The index BSS_{ikp} is the absolute reduction in the sums of squares that is achieved by a particular partition. Thus, if all possible partitions on the predictor variables are examined, the partition which maximises BSS_{ikp} produces the set of conditions which minimises the within sub-groups variability of Y. If this procedure is applied iteratively, the sample is reduced to a series of sub-groups formed by successive binary partitions on selected predictor variables. At each stage of the analysis the partition selected is chosen to minimise the within groups variability of Y.

Thus, as the partitioning proceeds, the within groups variability of Y becomes increasingly small, so that if the procedure could be carried on

indefinitely with a sufficient number of effective predictor variables, each of the terminal sub-groups of the analysis would be associated with a single value of the criterion variable Y.

In practice it is neither possible nor desirable to carry out the partitioning to this extent, and the AID analysis is terminated by a series of "stopping rules" which specify the conditions under which any partition is permissible. These stopping rules are arbitrary and have no particular statistical justification. However, their intent is to prevent the partition of groups having a negligible amount of variability; to ensure that groups containing a small number of observations are not partitioned; and to ensure that each partition reduces the variability of Y by an appreciable amount. The stopping rules proposed by Sonquist and Morgan (1964) are as follows:

A partition on any sub-group i is permissible if and only if:

(1) $TSS_i \geq R(TSS_t)$ (Where R is some arbitrarily stipulated real number in the range $.01 \leq R \leq .10$)

(2) $N_i \geq M$ (Where M is some arbitrarily stipulated integer in the range $20 \leq M \leq 40$)

(3) $BSS_{ikp} \geq Q(TSS_t)$ (Where Q is some arbitrarily stipulated real number in the range $.001 \leq Q \leq R$)

The output of AID is most efficiently represented as a dendrogram, or tree, of binary partitions, with each path through the tree representing a particular set of conditions which reduce the variability of Y. It is possible to estimate the predictive efficacy of the method by considering the k terminal groups of the AID tree as a k way partition on the sample of N observations. Sonquist and Morgan (1964) have proposed the index R^{*2} which they define as:

$$R^{*2} = \frac{BSS_t}{TSS_t} \qquad (1.5)$$

where BSS_t is the total between groups sums of squares for the k terminal groups and TSS_t is the total sum of squares for the unpartitioned sample. It will be noted that R^{*2} has an analgous interpretation to that of the squared multiple correlation coefficient: the proportion of variation in the criterion variable that is accounted for by the prediction method. In

fact, both R^{*2} and the squared multiple correlation are special cases of a more general correlation index η^2 which is simply a measure of proportionate variance reduction. As a sample statistic R^{*2} has a simple interpretation, but as a measure of the population correlation ratio it can be shown to be biassed (Fergusson and Jensen, 1973). The unbiassed estimator of the population correlation ratio is the statistic ε where:

$$\varepsilon^2 = \frac{(N-1)R^{*2} - (k-1)}{N-k} \qquad (1.6)$$

However, since in practice k is usually small and N moderately large, the extent of bias in R^{*2} is generally negligible.

It is important to recognise that estimates of predictive power based on any particular AID analysis tend to be overly optimistic. This is because at each stage of the analysis, AID seeks the partition which optimises predictive power. As a consequence of this, AID is prone to capitalise upon chance variations in the data and, as a result, provides biassed estimates of predictive power. The solution to this problem is well known. For each AID analysis there should be presented a corresponding set of validation data on which the results of the analysis are tested. Conventionally, this is achieved by splitting a sample of observations into two halves. On the first half the prediction rule is derived, and on the second half the prediction rule is applied and unbiassed estimates of predictive power are obtained.

METHOD

The Sample

The sample of observations used in the study comprised all cases of established child abuse coming to the attention of the Child Welfare Division during 1967. There were 255 such cases. It should be noted that there is no reason to believe that this sample was necessarily representative of the population of cases occurring in New Zealand at that time. In particular, it was suspected that the sample could have been biassed toward the inclusion of children coming from inadequate or unstable home backgrounds. (Fergusson, Fleming and O'Neill, 1972). Strictly speaking, these considerations restrict the applicability of the inferences made in this report to the population of cases coming to the attention of the Division. However, it may be seen as reasonable to use the findings as a basis for inferences about other samples and populations.

The Criterion Variable

Table 1 shows the severity of injury sustained by the 255 abused children.

Table 1 SEVERITY OF INJURY

Injury Severity	Number of Cases	Percentage of Sample
Died	7	2.7%
Serious and permanent injury	5	2.0%
Serious injury without permanent effect	30	11.8%
Non-serious injury	182	71.4%
No injury	31	12.2%
Total	255	100.0%

Inspection of Table 1 reveals that 42 (16%) of the 255 abused children died or suffered serious injury. A detailed description of the 42 severely injured children is given in Appendix 4 of Fergusson, Fleming and O'Neill (1972).

Using the data in Table 1, a dichotomous criterion variable Y was defined with the property that:

(1) Y=1 denoted that the child had died, suffered serious and permanent injury or had suffered serious injury without permanent effect.
(2) Y=0 denoted that the child had not died or suffered serious injury.

Predictor Variables

The predictor variables used in this study comprised 28 variables selected from the 180 item questionnaire on child abuse used in the previous study. These variables were selected from the survey data on the grounds that in the light of the available information about child abuse, they seemed to be the most likely indicators of serious incidents of abuse.

All predictor variables were cast in dichotomous form using the convention that symptoms assumed to be associated with severe abuse were scored 1 and symptoms assumed not to be associated with severe abuse were scored 0. Appendix 1 to this report shows the variables and the scoring conventions. It could be objected that prior dichotomisation of the data was wasteful in that it discarded some of the available information. However, there were two reasons for the choice of dichotomous variables. First, the interpretation of AID is simplified if variables are specified in some predetermined dichotomous form. Second, a recent study by Simon (1971) suggested that, for data of the type used in the analysis, the loss of predictive power caused by dichotomisation is relatively small. Further, dichotomous variables appear to be robust and less prone to produce shrinkage effects.

Analysis

The analysis was run on the Elliott 503 computer at the Applied Mathematics Division, Department of Scientific and Industrial Research, using an ALGOL version of the Sonquist and Morgan (1964) AID programme. Stopping rule values were set at the lower limits of the specified parameter ranges in order to allow an extensive exploration of the data structure.

One rather unfortunate feature of the analysis method was that, owing to the relatively small number of observations and the skewed nature of the

criterion variable, it was not possible to carry out a validation analysis. Consequently the results reported in this paper apply only to the construction data, and the estimates of predictive power, etc., that are reported must be treated as biassed. Nonetheless, despite the absence of validation data it is hoped that the analysis will provide some indication of the major variables associated with incidents of severe child abuse.

RESULTS

Figure 1 shows the AID tree for the analysis. Each cell in this tree presents three summary statistics: n, the group size; p, the proportion of seriously injured children in the group; and TSS, the total within group sum of squares. The value of R^{*2} for the analysis was .25, (ε^2=.24) - a figure that corresponds to a coefficient of multiple correlation of .50. This suggests that the analysis was able to provide a moderately good account of the variability in injury severity. However, it must be remembered that this level of prediction will shrink on validation of the results. A commentary on the tree structure and its interpretation is given below.

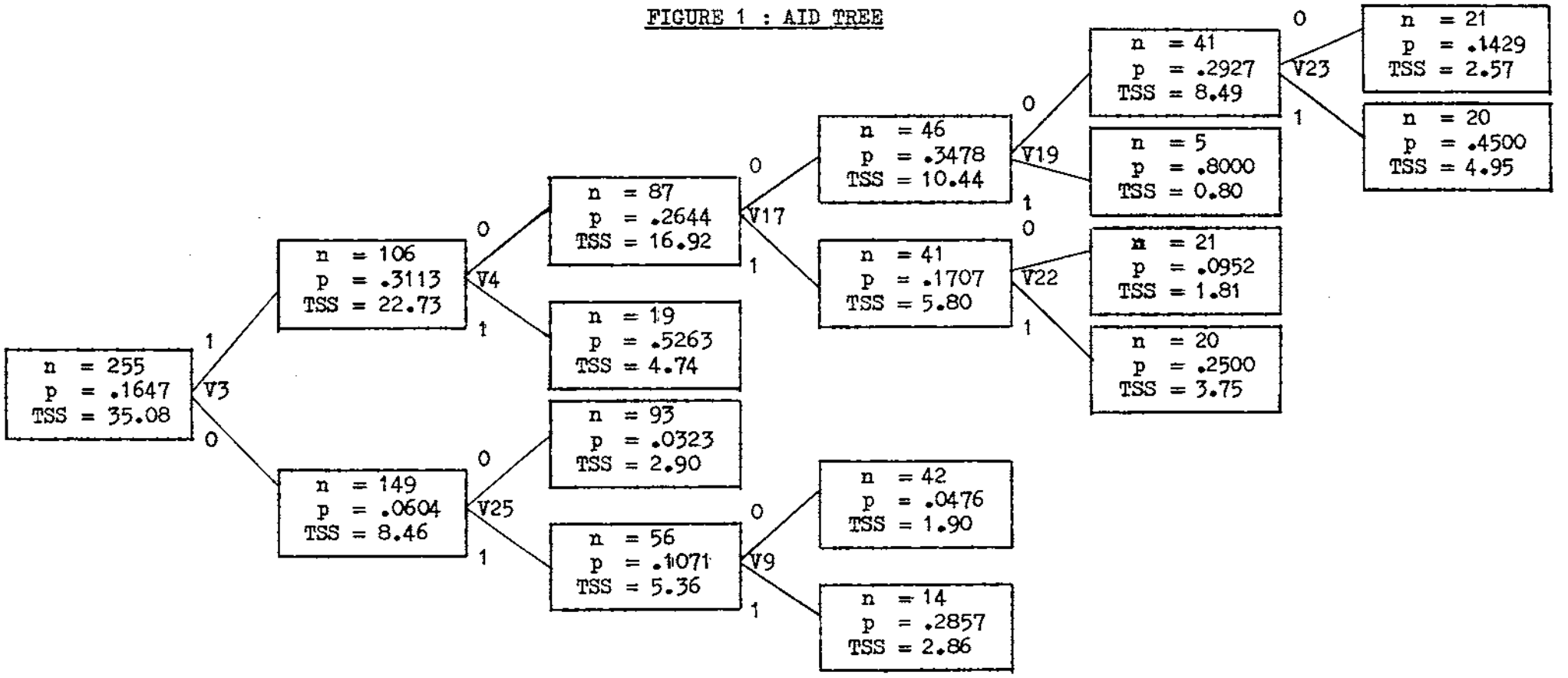
As one might expect, the variable which best discriminated between the seriously and non-seriously abused groups was the age of the child: children under the age of five had a five times greater risk of being seriously assaulted than children of five or over. The reasons for this result seem fairly obvious; young children are probably more prone to serious injury and, in addition, are less able to protect themselves from attack.

Within the under five age group, the variable most associated with serious assault was whether or not the child was living with both natural parents. Young children living with at least one substitute parent had twice as great a risk of being severely abused as young children living with both natural parents, and a nine times greater risk of being seriously abused than children of five or over.

Further inspection of the tree reveals that, with one exception, all predictor variables behaved in the expected way: that is groups associated with predictor values of 1 tended to show an increase in the likelihood of serious abuse, whereas groups associated with values of 0 tended to show a decrease in the likelihood of serious abuse.

The exception to this tendency is interesting. It can be seen from Figure 1 that Variable 17 (Parents' notice to the Child Welfare Division as children) gives the prediction that parents who had not been known to the Division as children had a greater propensity to severely abuse their children than parents who had come to attention. This result is anomalous in view of the finding that severe incidents of abuse tend to be associated

FIGURE 1 : AID TREE



KEY TO VARIABLES

V3 = Age of Child
V4 = Child's Home
V9 = Neglect
V17 = Parents' Childhood Notice
V19 = Serious Offending
V22 = Parents' Childhood Neglect or Ill-Treatment
V23 = Mother's Problems with Children
V25 = Mother's Health Problems

SUMMARY STATISTICS

$TSS_t = 35.08$

$\sum_{i=1}^{k} TSS_i = 26.28$

$R^{*2} = 0.25$

$R^* = 0.50$

$\varepsilon^2 = 0.24$

$\varepsilon = 0.49$

with early childhood difficulties, rejection or ill-treatment (Steele and Pollock, 1968: Nurse, 1964). The simplest interpretation of the result is that it reflects the effects of a bias in reporting procedures. The results presented by Fergusson, Fleming and O'Neill (1972) showed that Parents' notice as children was correlated with a whole series of measures of behavioural difficulty and inadequacy, including criminal offending as an adult, mental illness, notice to the Child Welfare Division as an adult, etc. All of these factors would be expected to make the family more conspicuous as a potential source of child abuse. One of the consequences of such conspicuousness could be to bring a higher frequency of minor cases of abuse to attention in families displaying manifest inadequacies. If this were the case one would expect to see an effect of exactly the form described above.

Further, it is interesting to observe that, once the sample has been partitioned on the parents' childhood notice, both of the subsequent partitions involve variables correlated with childhood notice: the parents' serious criminal offending, and neglect or ill-treatment during their childhood.

It is almost as if the data contain two competing tendencies: first, a tendency for inadequate families more often to be reported for incidents of minor abuse, and second, a tendency for inadequate families to commit more incidents of severe abuse. When the effects of the reporting bias are taken account of, the tendency for severe abuse to concentrate in inadequate families becomes apparent. It must be stressed that this is only one of the possible interpretations that could be placed on the result and that there are possibly other equally plausible explanations. Further, it should not be forgotten that, the results could be spurious and may merely reflect the capricious effects of chance variation within the data.

To summarise the main findings of the study, Table 2 shows the major sets of conditions associated with abused children who suffered serious injury. It must be stressed that this specification should be considered as giving only a tentative description of the factors associated with cases of serious abuse, as the AID results are not validated and the range of variables used in the analysis is restricted to those measured in the 1967 survey. Further, it is important to realise that the factors discussed relate to the differences between severely and non-severely abused children; they do not relate to the differences between severely abused children and the general child population. The results do, however, have some degree of

Table 2 GROUPS HAVING A HIGH RISK OF SERIOUS ABUSE

Group Description	Risk of Serious Abuse	Ratio of Group Risk to Base Risk*
Child under five years; living with at least one substitute parent	.53	3.21
Child under five years; living with both natural parents; one or both parents have come to the attention of Child Welfare as children; one or both parents were ill-treated as children	.25	1.52
Child under five years; living with both natural parents; neither parent came to Child Welfare attention as a child; one or both parents has a history of serious criminal offending	.80**	4.85
Child under five years; living with both natural parents; neither parent came to Child Welfare attention as a child; neither parent has been involved in serious criminal offending; mother experiences stresses associated with child rearing	.45	2.73
Child five years or over; mother experiences stresses associated with health; child subject to inadequate or neglectful physical care	.29	1.73

* This ratio is the ratio of the group risk to the base risk of serious abuse (.165).

** The risk estimate for this group is based on five cases only.

practical application. Often, social workers and others are required to deal with families showing signs of incipient child abusive behaviour. Under these circumstances it seems essential to exercise particular oversight and supervision of those families displaying the symptoms that appear to be associated with the severe abuse of children.

APPENDIX 1 DESCRIPTION OF PREDICTOR VARIABLES

A total of 28 predictor variables were used in the study. The listing below shows these variables and the conventions used to reduce them to dichotomous form. Unless explicitly stated, the terms "parents", "mother" and "father" refer to the parent figures living in the home at the time of the incident of child abuse; these are not necessarily the natural parents of the child. More detailed information on the source items used to construct these dichotomies can be found in Appendix 5 of Fergusson, Fleming and O'Neill (1972).

Variable Number	Variable Name	X = 1	X = 0
1	Child's race	Non-European child	European child, or race not known
2	Child's legitimacy	Child known to be illegitimate	Child legitimate, or legitimacy not known
3	Child's age	Child under five years of age	Child five years of age or over, or age not known
4	Child's home	Child living with at least one substitute parent	Child living with both natural parents, or not known
5	Child's past home (1)	Child has not lived with both parent figures all of life	Child has lived with both parent figures throughout life, or not known

Variable Number	Variable Name	X = 1	X = 0
6	Child's past home (2)	Child has not lived continuously with either parent figure throughout life	Child has lived continuously with one or both parents, or not known
7	Changes in home	Child had 2 or more changes in home prior to incident	Child had less than 2 changes in home, or not known
8	Disabilities and illness	Child suffers from physical disability or chronic illness	Child does not suffer illness or disability, or not known
9	Neglect	Child subject to physical neglect	Child not subject to physical neglect, or not known
10	Number of children in home	Four or more children in the home	Less than four children in the home, or not known
11	Home standards	Standards of housekeeping poor or inadequate	Housekeeping standards average or above average, or not known
12	Early mother/child separation	Child separated from natural mother during first three years of life	No separation from natural mother during first three years of life, or not known, or not living with natural mother
13	Cohabitation stability	Parents' living situation unstable	Parents' living situation stable, or not known

Variable Number	Variable Name	X = 1	X = 0
14	Child's conception	Child conceived or born prior to natural parents' marriage	Child conceived within marriage, or not living with natural parent, or not known
15	Mother's pregnancy	Mother suspected or known to be pregnant at the time of the incident	Mother not pregnant, or no mother in the home, or not known
16	Marital discord	Indications of marital discord in the family	No indications of marital discord, or not known
17	Parents' Childhood notice to Child Welfare	One or both parents known to Child Welfare as children	Neither parent known to Child Welfare as children
18	Criminal offending	One or both parents convicted of a criminal offence	Neither parent convicted of a criminal offence
19	Serious offending	One or both parents convicted of a criminal offence resulting in a custodial sentence or probation	Neither parent convicted of a serious offence
20	Mental illness	One or both parents admitted to mental hospital; diagnosed as mentally ill; or displayed strong indications of mental illness	Neither parent displayed any marked indication of mental illness, or not known

Variable Number	Variable Name	X = 1	X = 0
21	Drinking	One or both parents drinks heavily or frequently	Neither parent drinks heavily or frequently; or not known
22	Childhood ill-treatment or neglect	One or both parents had been neglected or ill-treated during childhood	Neither parent had been neglected or ill-treated during childhood, or not known
23	Mother's situation (children)	Mother known to be experiencing problems with child-rearing	No known problems associated with child-rearing
24	Mother's situation (husband)	Mother known to be experiencing problems in relationship with husband	No known problems in mother's relationship with husband
25	Mother's situation (health)	Mother experiencing health problems; menopause, pregnancy, etc.	No known problems with mother's health
26	Mother's situation (finance)	Mother known to be experiencing problems associated with finance	No known problems associated with finance
27	Father's violence (1)	Father has been prosecuted for acts of violence	Father has not been prosecuted for acts of violence
28	Father's violence (2)	Father known to assault wife	Father not known to assault wife

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TECHNICAL RESEARCH REPORTS

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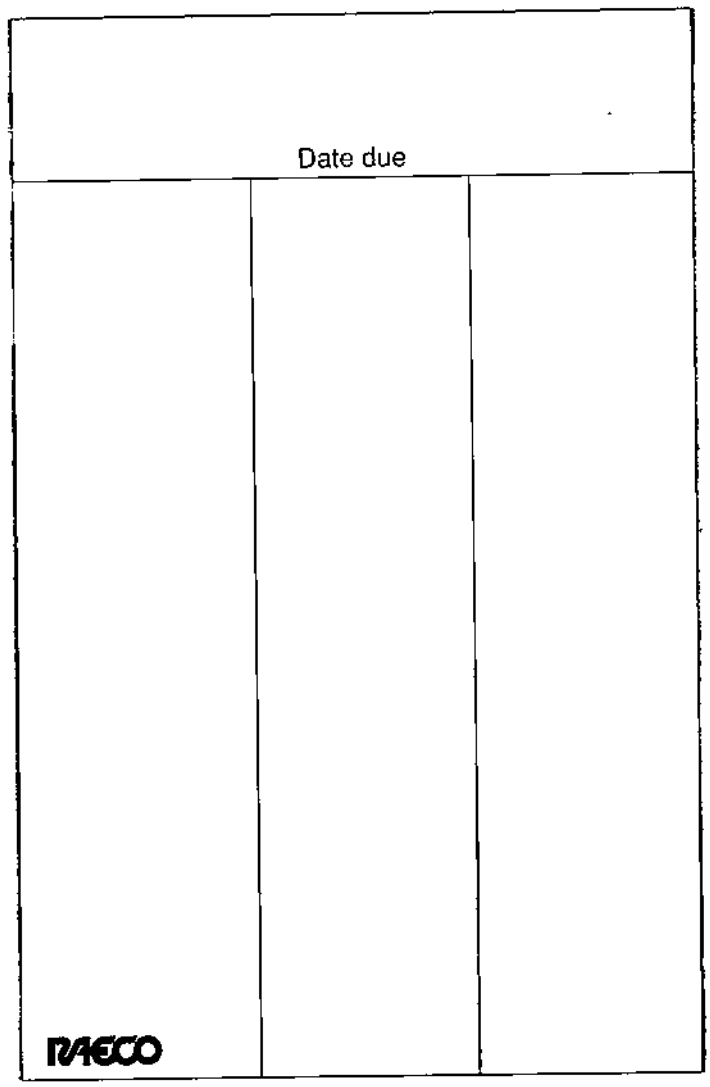
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