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AN (EMPIRICALLY TESTED) ANALYSIS OF VICTIMIZATION RISKS

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1. Introduction

In recent publications various attempts have been made to design models for the delineation of victim risks (Hindelang e.a. 1978; Cohen and Felson, 1978). In this paper we will try to design a similar model, which can be used as an instrument for crime prevention policy. The aim of this model will be to identify high risk groups among the Dutch population and to assist in cost benefits analysis of crime prevention policies for these groups.

In section 2 we present a theoretical framework (framework of ideas), which leads to a risk model from which crime prevention policy and costs benefits analysis envolve.

On the basis of the victim risk model various hypotheses can be developed. These hypotheses are presented in section 3. Section 4 deals with the testing of these hypotheses by means of a non-linear principal-components technique (Homals[x)]) and a log-linear model approach (Ecta[xx)]).

x) Ryckevorsel, van, Jan and Jan de Leeuw, An outline to Homals-1, RB 002 - 1978, Department of data theory/Faculty of social sciences, University of Leyden, The Netherlands.

xx) Goodman, L.A., developed the programme Ecta (Everyman's Contingency Table Analysis) Nieman (1976) gave a description of it in Dutch.

2. A victim risk model

Personal criminal victimization depends according to Hindelang on the concept of lifestyle. The assumption of the lifestyle concept is the fact that interaction between victims and offenders do not happen at random. The interaction, however, depends on the absence or presence of contacts between victims and delinquents in an uncontrolled neighbourhood.

Interaction in this context means emphasizing the individual as a potential victim. Individual behavior as a result of a certain lifestyle exposes citizens to high risk situations with the probabilistic result of victimization.

The neighbourhood is the territorium at which interactions and individual behavior takes place. The main characteristic of the neighbourhood as a territorium in relation to criminal victimization is a lack of formal- and informal social control mechanisms.

Due to urban evolution neighbourhoods changed from places where residents know each other into completely impersonal and anonymous environment. Scaling up of the transport- and use systems with the result that use and transport systems are not anymore in balance is -according to Gardiner, 1978[x)] - the main reason for the impersonal and anonymous environment. Examples are the rise of bedroom communities and working areas, semi-private streets that changed into public crosstown connectors and schools and neighbourhood shops changing into regional schools and regional shopping centra.

On the other hand one could say with the following expression:" It is is not size that counts so much as the way things are arranged" (E.M. Forster, 1910, Howards End). We have to grow to a new state of balance in urban evolution.

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x) Design for safe neighbourhoods, Gardiner, R.A., september 1978. National institute of law enforcement and criminal justice Law Enforcement Assistence Administration, United States, Department of Justice.

According to our reasoning someone's risk of victimization is not only determined by a certain lifestyle but also by the neighbourhood where the action takes place. Besides we must remember that offenders are one of the actors in the interaction between victims and potential offenders. For this reason we distinguish besides the earlier mentioned determinants the so called attractiveness factor which makes a person or object an interesting target for the potential offender. Concluding we might say that the victim risk model we are presenting in this article consists of three main factors. These factors are attractiveness of the target (the amount of valuable property or sexual attraction), proximity to potential offenders (outgoing behavior, shopping and using public transport) and the exposure to risk of victimization (guarding and protecting by means of formal and informal social control). In the following outline we will briefly present a start of a victim risk analysis.

Outline

Risk factors	Aspects	Operationalization
attractiveness factor	possession of valuable objects	income level, buying behavior, standard of comfort of a house, cash money instead of cheques
	sex appeal	young women (style of dress)
	a rival as a symbol	adolescents (challenging behavior)
proximity factor	living in the surroundings of potential offenders	living in a criminal district of a big city
	visiting places that potential offenders frequent	outgoing behavior, shopping behavior and using public transport
exposure factor	technical prevention	accessibility of dwelling and cars, quality of fasteners
	guarding/protecting	leaving the house to look after itself; living in isolation
		venturing into situations where nobody can help you
		willingness of locals/neighbours to come to the rescue

By means of a victim risk analysis you can find the typical risk group. In addition, a risk analysis as illustrated gives indications of in what direction prevention has to be sought. Therefore a differentiation can be made between preventive rules on the level of the individual (micro-level), on the level of the district wellfare institutions or public utility service (meso-level) and on the level of the local public authorities (macro-level).
Examples of measures on <u>micro-level</u> are moving to smaller communities or safer districts, changing buying patterns (no antiques, expensive jewelry, electronica or paintings), shifting the furniture of the house (no luxeries in the living room), locking up (car) doors and windows, locking up cellar boxes, fitting new fasteners, changing leisure time-spending (not going out by oneself, not going to dangerous districts etc.).
Examples of measures on <u>meso-level</u> are better provisions for illumination, stimulating active social traffic in districts, starting dwelling experiments and organizing neigbour help.
On <u>macro-level</u> can be thought of legal measures such as the establishment of minimum requirements that community (children safety), industry (burglar-proof cars) and houses have to meet. Also preventive and registrating police patrol can be seen as the imput for communal preventive measures. These and other things should be included when a risk analysis is carried out, for example by doing experiments in order to get a better control on opportunity structures.
Possible methods to decrease the victim risks of the identified high risk groups (see next section) can be discussed within the frame of our triple factor models. Many methods are likely to be extremely costly for society since they require a fundamental change of life-styles that are popular among the population of a highly urbanized and industrialized society. Collective measures aiming at neutralizing the exposure factor seem to be preferable to (individual) measures aimed at neutralizing the attractiveness or proximity factor.

3. Hypothesis

On the basis of the triple factor model discussed in section 2 a number of hypotheses can be developed regarding the victimization risks of different groups of the Dutch population. Some of these hypotheses will be discussed here.

a) From an analysis of court files by C. van der Werff (Research and Documentation Centre, the Hague) it is apparent that the majority of petty crimes are committed in the areas where criminals live and it also stands out that the big cities of the Netherlands show significant higher rates of criminal inhabitants. Therefore inhabitants of these cities will run higher victimization risks. These hypothesis is also based on the presumed operationalization of the proximity factor.

b) An approach to understanding lifestyle (proximity factor) is to study the relation between 'how one spends his time (working, shopping and leisure activities)' and the actual interaction between criminals and victims. This is in fact what Cohen and Felson proposed in their paper 'Social change and Crime Rate Trends: a routine activity approach' August 1978. They argued that the intention of their paper is an examination of how the spatio-temporal organization helps people to translate their criminal inclination into action, instead of examining why individuals or groups are criminally inclined.
In the Dutch national victim survey up till now we did not question the respondents explicitly on their way of time spending and the actual relation between victims and offenders. That is why we have to rely on other data sources about time-spending. For this reason we used the social and cultural reports of 1974, 1976 and 1978 of the Social and Cultural Plan Office which provided the following information.
A decrease of the working hours in a working week in the years 1870 to 1970 from 70 to 43.7 working hours (decrease of 38%) and an increase of the off-days from 7 to 22 days-off (increase of 214%).
Besides, higher class people work 48 hours[x)] and have more days off then

x) These conclusions were the result of a time spending project of the Social and Cultural Plan Office in a certain week in October in 1975.

respondents from lower classes, who have a working week of 41 hours. The travelling time between dwellings and work is about 3.33 hours a week, while people from the higher classes travel less than others. People in urban areas with a high density travel more than those who are living in areas with a low density.
Leisure time takes 47 hours a week of which 33 hours is spend in the domestic sphere, while 14 hours is spend on going out. It is apparent that the spending of spare time outside the domestic sphere is linked to young age (young people spend about 60 hours a week on leisure activities of which 47 hours outdoors), to not having children, having a high education, having a high income and living in high-rise appartments.
From these data the hypothesis can be derived that as a result of the proximity and exposure factors the variable of age and social class will be related to victimization risks (low age high risk; high social class high victimization risk). These groups will have more interactions with potential victims and leave their houses or cars unguarded more often. Both hypotheses can be based on the persumed operations of the attractiveness factor as well. Young people are attractive targets for (sexual) assaults. High income groups are attractive targets for economic crime.

c) In Holland up to the present the assumption that women have lower victim risks because of their family-oriented lifestyle, is still adhered to. The increase in spare time and a greater participation of women in working society might lead to smoothing out differences in lifestyle between men and women, thus creating a strong impact on crime-opportunity structures. Both factors might directly or indirectly step up victimization in consequence of burglary[x)].

x) Richard Block found a big difference in the amount of burglaries between Holland and the U.S.A. His explanation of this difference is the greater participation of women in labor in the U.S.A.

4. Testing of the hypotheses

The hypotheses developed in section 3 were tested by means of multivariate technics for categorical data.
By means of a explorative non-linear principal components analysis we tried to find any evidence for these hypotheses.
The result of these analyses confirm our hypotheses and gave us any insight in the victim risks of the various population groups. These results are presented in section 4.1.
With the help of a log-lineair model (Everyman's Contingency Table Analyses) the victim risks of the various dutch population groups can be quantified in a simple way.
For example, the victim risk of young males living in one of the big cities from the upper class family appear to be one to .65 (60%), in comparison to a one to .28 (4%) risk of the >65 age group of females living in small villages from the lower class.
These results are presented in section 4.2.

4.1. Results of the Homals-1 analyses

DUTCH NATIONAL VICTIM SURVEY 1977

Source: Dr. J.J.M. van Dijk and Drs. C.H.D. Steinmetz, Crime: Volume and trends vi^tim surveys 1974 - 1979. Research and Documentation Centre, Ministry of Justice 1978.

The data-set used consists of 9025 responses on three polychotome and two binary questions, which are more or less constructed variables.

List of questions

a. Are you male (1) or female (2)?

b. In which size of municipality are you living?

1. size of 400,000 and more inhabitants (Amsterdam, The Hague and Rotterdam)
2. size of 50,000 - < 400,000 inhabitants
3. size of 28,000 - < 50,000 inhabitants
4. size of 5,000 - < 20,000 inhabitants

c. How old are you?
age-groups

1. < 25
2. 25 - < 40
3. 40 - < 65

d. To what social class do you or your parents belong?

1. higher social class
2. middle social class
3. lower social class

e. Victimization
Have you been a victim of one of the following offences: bicycle theft, moped theft, theft out of a car, pick-pocketing, theft from car, a hit-and-run vehicle accident, vandalism, burglary, indecent assault at home and in the street and threatening/violent behavior at home and in the street?

1. non-victim
2. victim

As you noticed we excluded from this list the small Dutch villages and elderly people. These people were seldom a victim of the earlier mentioned crimes.
The distribution of all possible response patterns:

TABLE 1

	social class	age-groups	Number	codes abcde	marginal frequency
VICTIMS	higher social class	<25	1	11112	19
			2	21112	21
			3	12112	19
			4	22112	28
			5	13112	13
			6	23112	13
			7	14112	3
			8	24112	10
		25-<40	9	11212	33
			10	21212	18
			11	12212	29
			12	22212	23
			13	13212	15
			14	23212	12
			15	14212	14
			16	24212	18
		40-<65	17	11312	17
			18	21312	71
			19	12312	16
			20	22312	17
			21	13312	15
			22	23312	13
			23	14312	9
			24	24312	10
	middle social class	<25	25	11122	87
			26	21122	55
			27	12122	97
			28	22122	79
			29	23122	47
			30	14122	34
			31	24122	49
		25-<40	32	11222	52
			33	21222	37
			34	12222	80
			35	22222	60
			36	13222	60
			37	23222	51
			38	14222	61
			39	24222	34
		40-<65	40	11322	61
			41	21322	55
			42	12322	63
			43	22322	67
			44	13322	43
			45	23322	33
			46	14322	27
			47	24322	36
	lower social class	<25	48	21132	15
			49	12132	16
			50	22132	8
			51	13132	18
			52	23132	12
			53	14132	5
			54	24132	4
		25-<40	55	11232	7
			56	21232	4
			57	12232	16
			58	22232	6
			59	13232	7
			60	23232	6
			61	14232	4
			62	24232	5
		40-<65	63	11332	9
			64	21332	5
			65	12332	23
			66	22332	7
			67	13332	2
			68	23332	7
			69	14332	5
			70	24332	2

	social class	age-groups	Number	codes abcde	marginal frequency
NON VICTIMS	higher social class	<25	71	11111	5
			72	21111	19
			73	12111	34
			74	22111	28
			75	13111	26
			76	23111	15
			77	14111	29
			78	24111	23
		25-<40	79	11211	25
			80	21211	18
			81	12211	63
			82	22211	68
			83	13211	60
			84	23211	83
			85	14211	64
			86	24211	94
		40-<65	87	11311	19
			88	21311	40
			89	12311	58
			90	22311	71
			91	13311	50
			92	23311	80
			93	14311	36
			94	24311	52
	middle social class	<25	95	11121	76
			96	21121	74
			97	12121	181
			98	22121	174
			99	13121	129
			100	23121	148
			101	14121	150
			102	24121	175
		25-<40	103	11221	90
			104	21221	94
			105	12221	265
			106	22221	242
			107	13221	251
			108	23221	240
			109	14221	318
			110	24221	275
		40-<65	111	11321	149
			112	21321	202
			113	12321	331
			114	22321	351
			115	13321	266
			116	23321	255
			117	14321	313
			118	24321	332
	lower social class	<25	119	11131	13
			120	21131	31
			121	12131	29
			122	22131	16
			123	13131	27
			124	23131	21
			125	14131	44
			126	24131	23
		25-<40	127	11231	13
			128	21231	9
			129	12231	32
			130	22231	32
			131	13231	33
			132	23231	19
			133	14231	42
			134	24231	51
		40-<65	135	11331	37
			136	21331	37
			137	12331	63
			138	22331	72
			139	13331	70
			140	23331	49
			141	14331	113
			142	24331	69

The 142 response patterns are devided into two main groups: victims (N=1918) and non-victims (N=7107). Being victim or non-victim is the dependant variable.
Each of these main groups, as you can see, is devided into social class brackets, while each of them is again devided into age, municipality and sex brackets. Social class, age, municipality and sex are the independant variables.

Description of the analysis technic

We did a Homals-1*) analysis on the 9025 x 6 data matrix to find some homogeneous sets of response patterns and simultaneously some homogeneous sets of response categories. The authors of the program speak of response patterns instead of observations because observations with the same patterns have the same quantification.
In fact the program is trying to quantify the categories of the variables by presenting each category as a point in a p-dimensional space. This means in terms of homogeneity that we want points corresponding with categories of different variables that contain the same observation to be close together and points corresponding with categories of different variables that contain different observations to be far apart (Homals-1 short nontechnical description. Jan de Leeuw 1977).
After quantifying the categories in the p-dimensional space we like to quantify sometimes the observations. This is done by the analysis of all points corresponding with the categories to which the observation belongs.

*) The program and theory has been described in an outline to Homals-1 August 1978 by Jan van Ryckevorsel and Jan de Leeuw. Department of data theorie/faculty of the social sciences University of Leyden - The Netherlands.
Homals-1 (homogeneous alternating least squares) is a nonlinear principal components analysis on categorical data on which no a priori measurement restrictions are made. The Homals-1 model tries to quantify the response categories in such a way that response patterns (observations),which are the same or more or less similar, form a so-called homogeneous set of response patterns. This means that the distances between response patterns in every homogeneous set are minimized to get the homogeneous sets as far as possible apart from each other. This is the same as minimizing the sum of all the within observation distances, while keeping the sum of all squared distances to a constant.

Problems and interpretation of the Homals-1 category plot

In trying to find some evidence for the forementioned theory of personal criminal victimization, which is partly based on the exposure model Hindelang and others presented in 1978, we analysed several variables including personal victimization of twelve minor crimes. After a prolonged process of analysing we concluded that the earlier mentioned so-called independant variables explained the amount of personal criminal victimization the best.

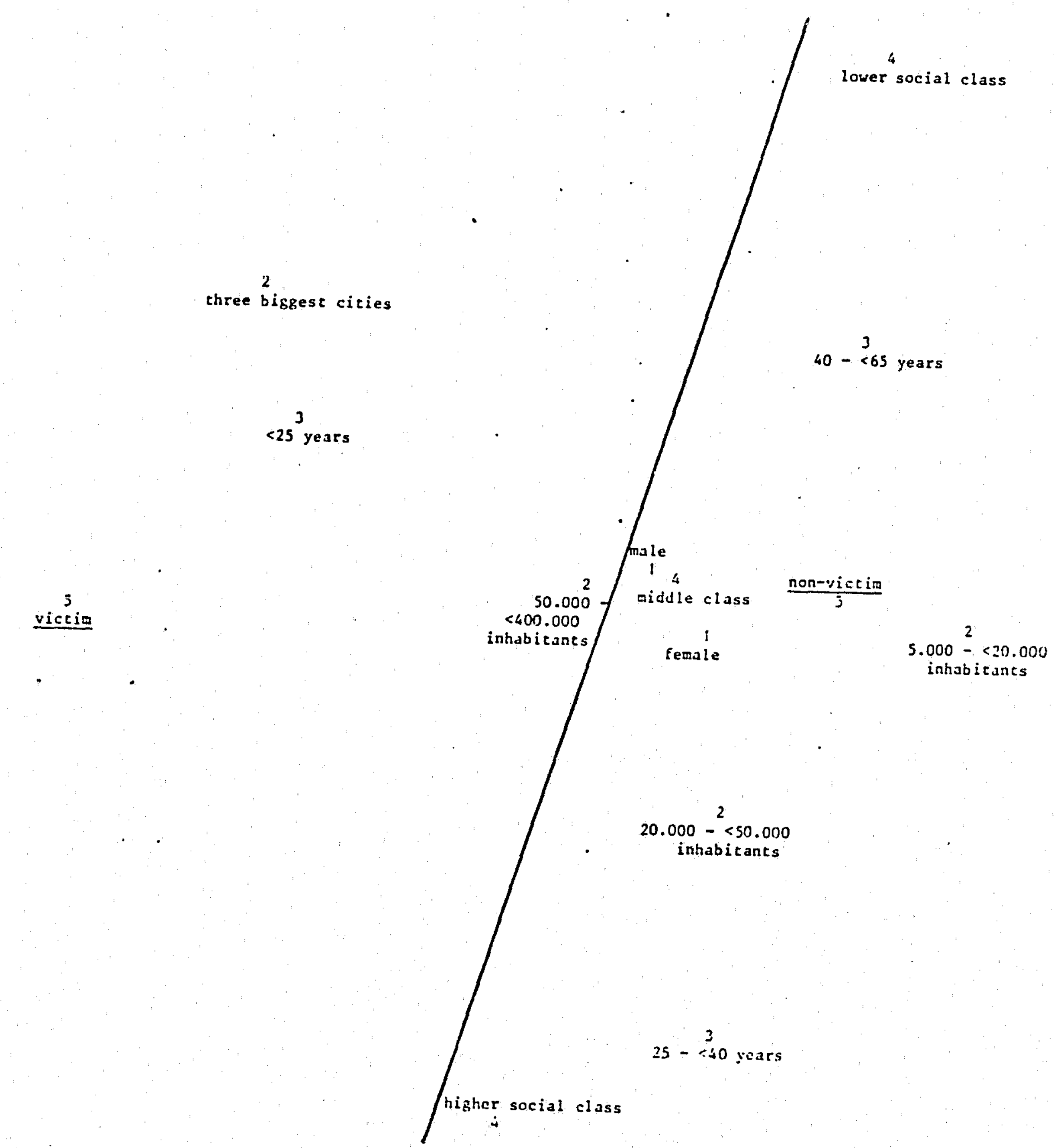
In figure 1 you will find a nice two-dimensional picture of category quantification which is the result of a Homals-1 analysis.

In this figure you will see a straight line from the upper right part to the under left part. This line is roughly separating the victims (left part) from the non-victims (right part).

The interpretation of this figure can be done in terms of similarity or dissimilarity. Similarity means that quantifications of categories which are very near each other form a homogeneous subset of observations (respondents/response patterns). Quantification of categories far apart from each other do not form a homogeneous subset and are very dissimilar. Besides we must keep in mind that quantifications of categories are the centroids of response pattern (observations) quantifications, which can be interpreted as weighted means.

figure 1. Quantification of the categories (higher social class, 24 years etc.) of the variables sex, size of municipality, age, social class and victimization, as a result of a Homals-1 analysis

Weighed selected



Results

It appears that the categories 'age below 25', 'size of municipality $\geqslant$ 400,000 inhabitants' and 'higher social class' are closely bound up with victimization. The characteristics 'middle social class' and 'size of municipality 5,000 - < 20,000 inhabitants' cohere with the category 'non-victim'. As you will notice being male or female does not discriminate at all in the Homals-1 plot. This is caused by the fact that we left the elderly people from 65 and older and the inhabitants from the small country villages with five thousand or less inhabitants out of the analysis. These two groups were mainly women who have a probability of being a victim from 0%.
The findings that have been presented up to now do not give us the precise insight in the structure of the response patterns of victims and non-victims. This is one of the main reasons that we made a plot of the response patterns (observations), which are presented in table 1.
These so-called 'labeling' plots (response patterns labeled by the categories of one variable) result from the same Homals-1 technic.
In order to understand this you should consider that category quantifications are the centroids of the response patterns and visa versa.
The several labeling plots have been presented in figure two up to five inclusive. In figure six we presented the summary visualising victim characteristic plot.

figure 2.

Homals-1 victim analysis

Response-patterns (1 up to 142 inclusive, see table 1) labelled by the categories of the variable sex.

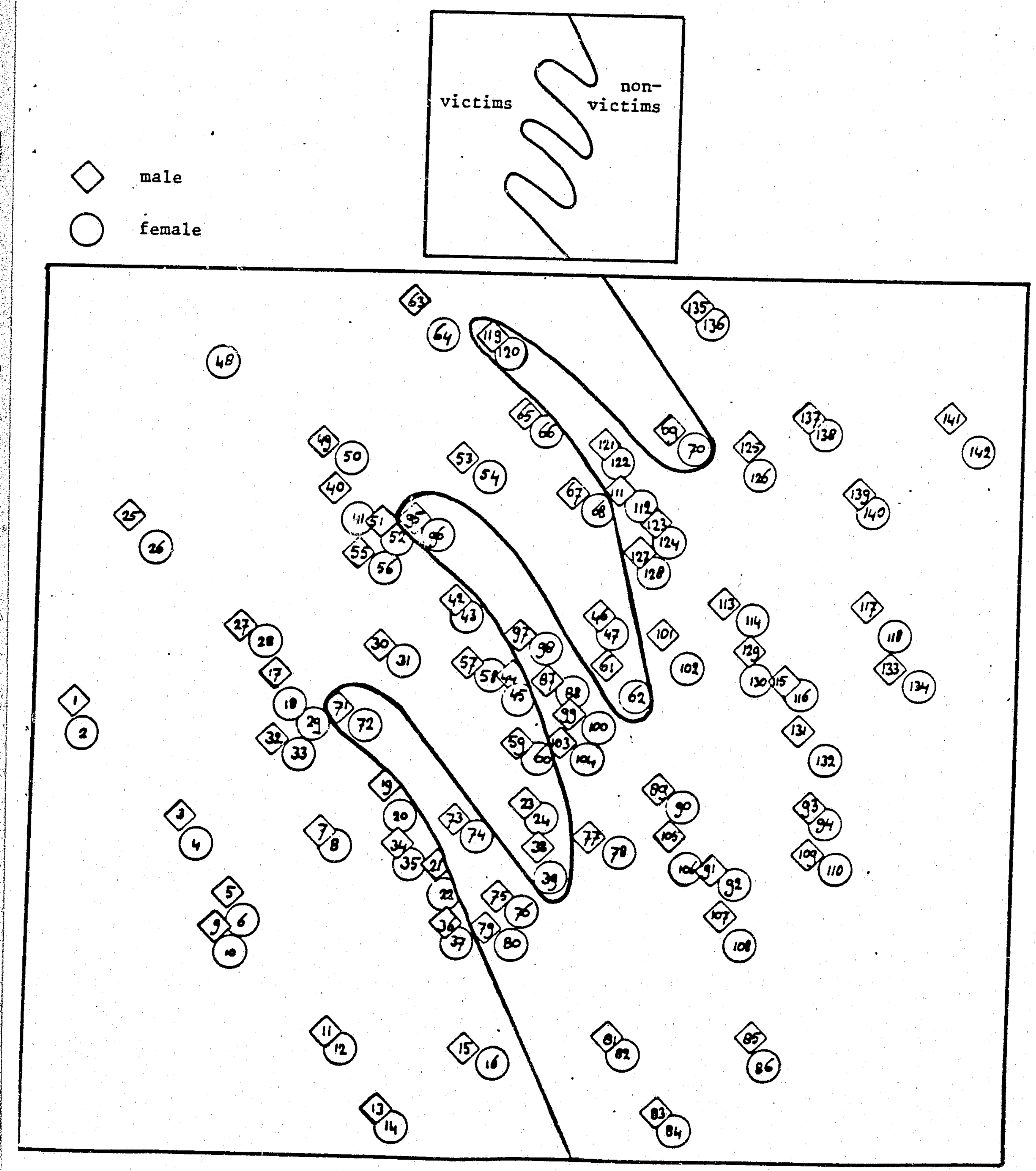


figure 3.

Homals-1 victim analysis

Response-patterns (1 up to 142 inclusive, see table 1) labelled by the categories of the variable age.

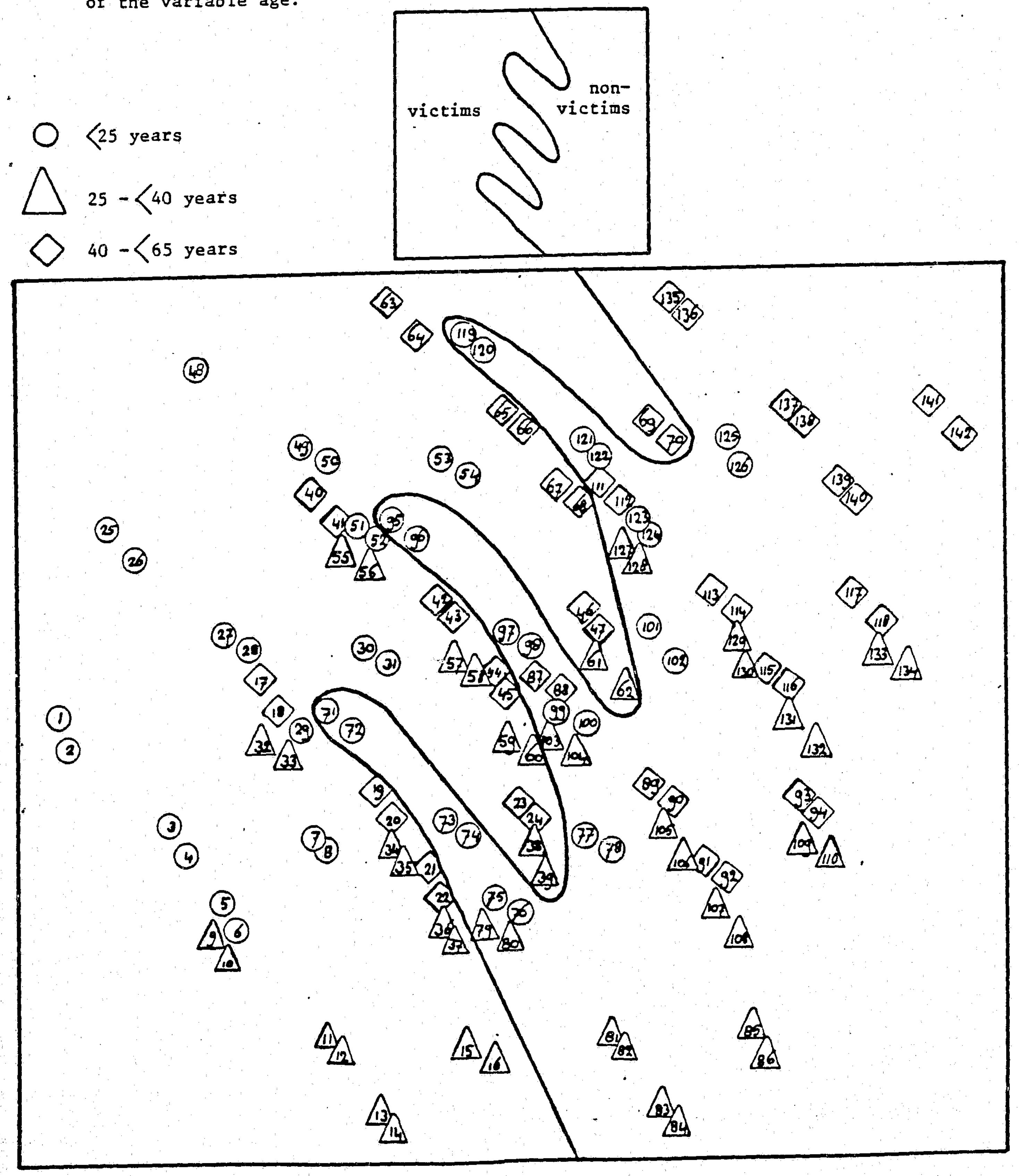


figure 4.

Homals-1 victim analysis

Response-patterns (1 up to 142 inclusive, see table 1) labelled by the categories of the variable social class.

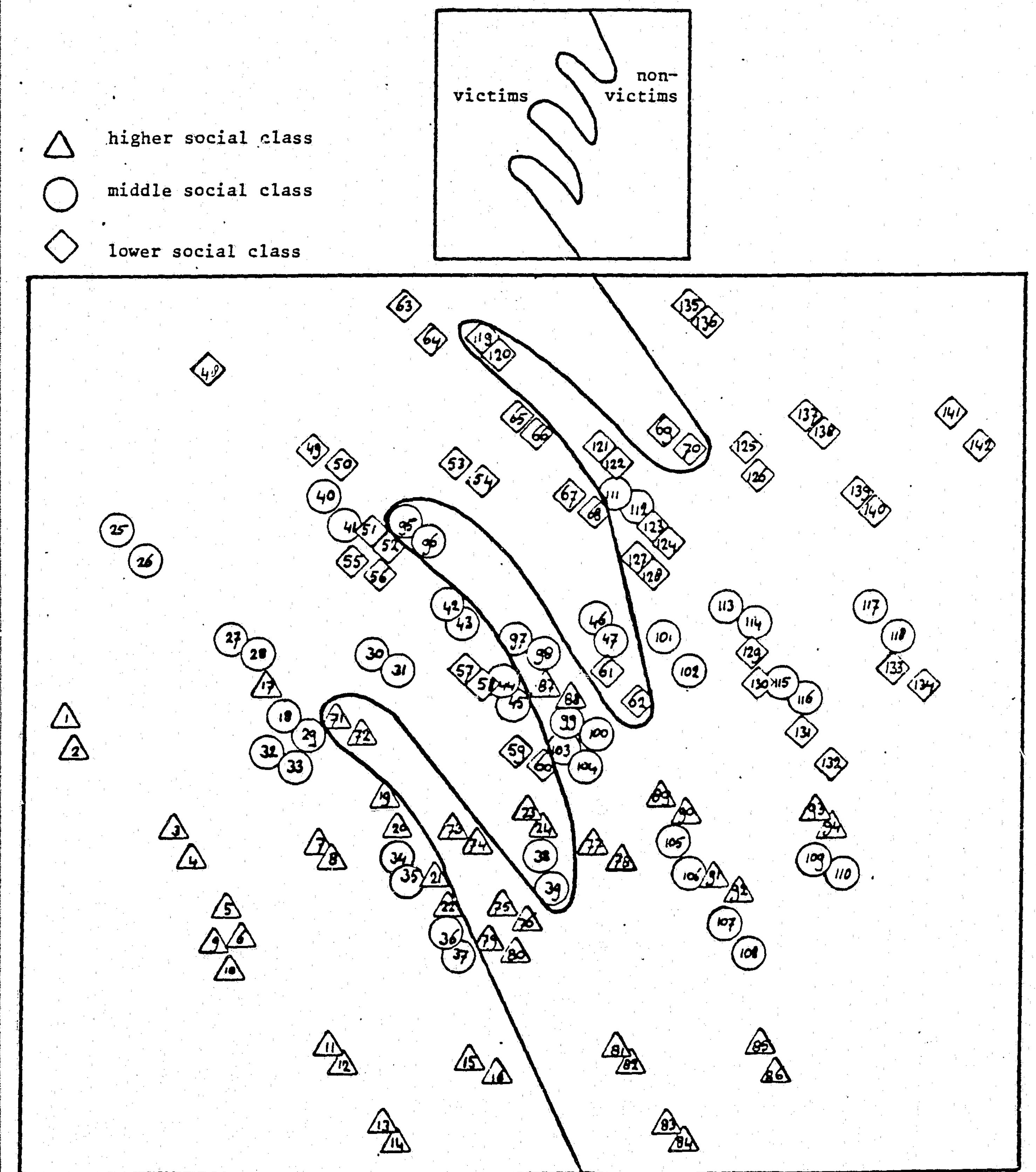


figure 5.

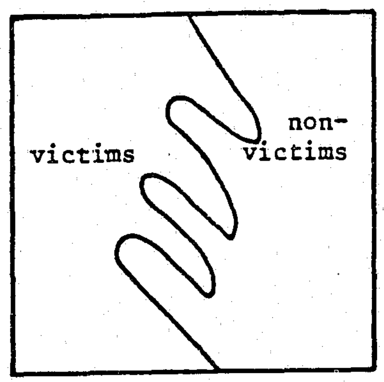
Homals-1 victim analysis (1 up to 142 inclusive, see table 1) labelled by the categories of the variable 'size of municipality'.

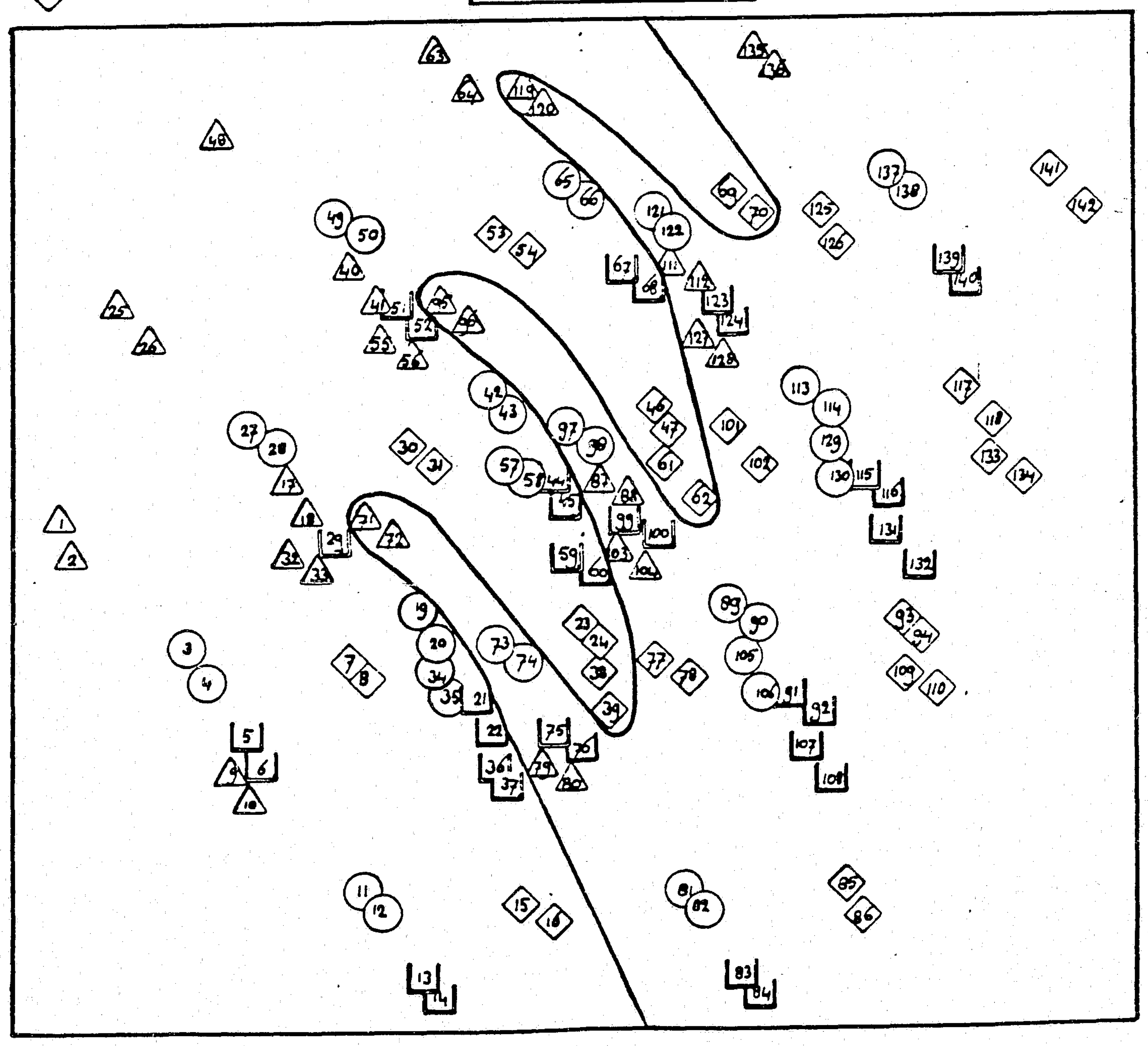
△ three biggest cities

○ 50 - <400.000 inhabitants

⊔ 20 - <50.000 inhabitants

◇ 5 - <20.000 inhabitants





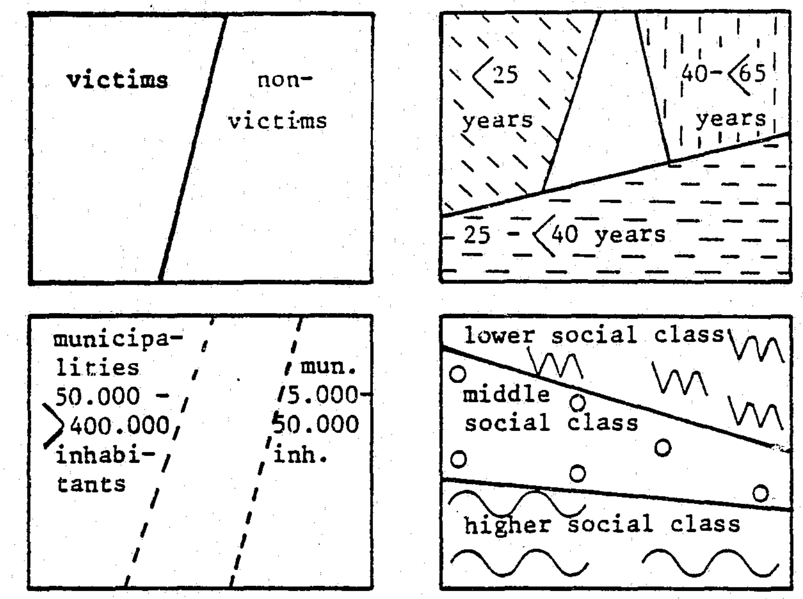
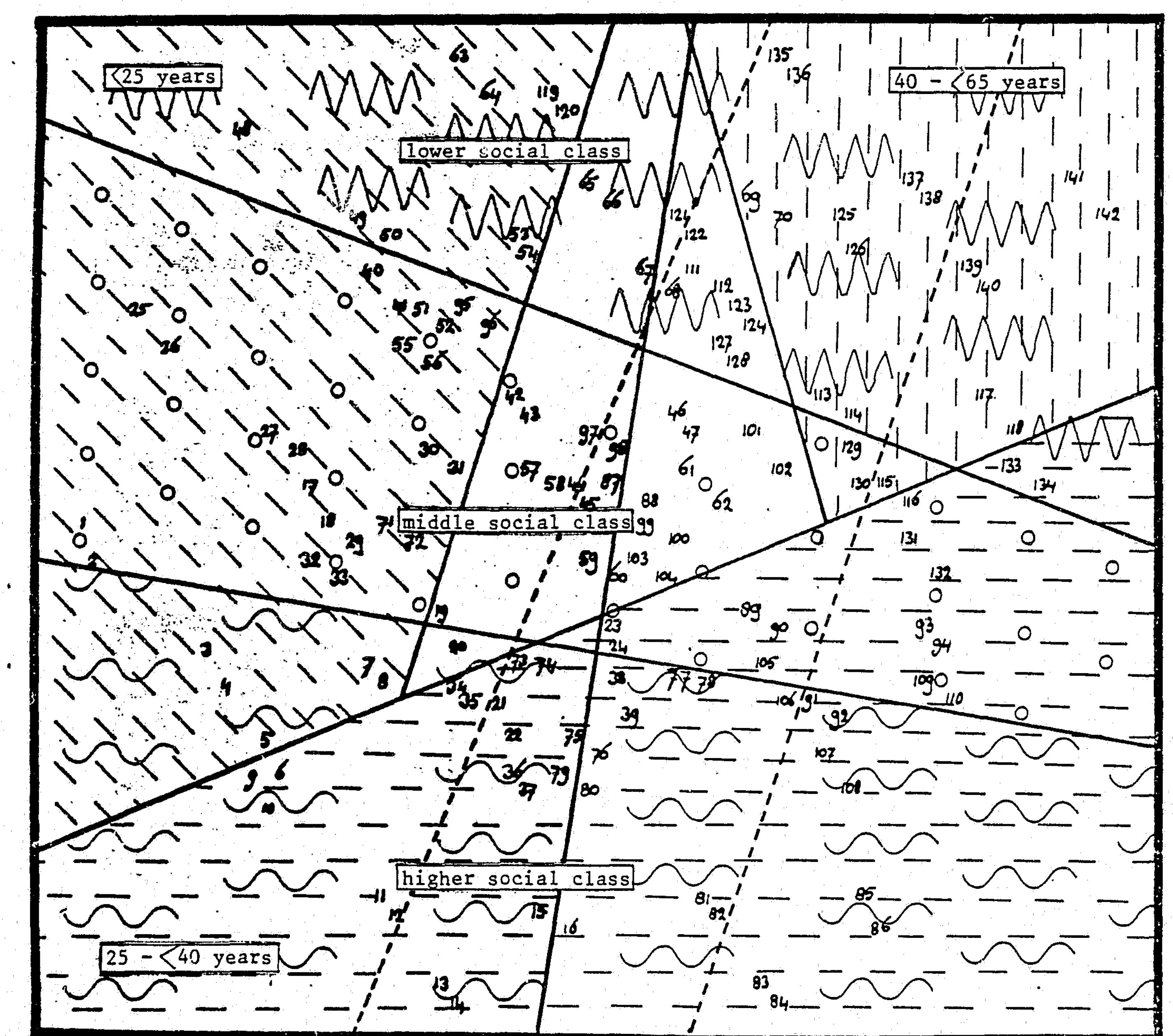


figure 6.

Homals-1 victim analysis.

Summary visualising of the victim-characteristics (Response-patterns 1 up to 142 inclusive, see table 1)



4.2. Quantifying victim risks by a log-linear model

4.2.1. Problem proposition

To what extent/degree is it possible to predict on the basis of the respondent's residence (A), age (B), social class (C) and sex (D) whether the person interviewd has been a victim of one or more types of offence or not (table 4). In predicting this subsequently we will apply oursel-ves of the log-linear model.

4.2.2. The log-linear model

In analysing categorical data one may restrict oneself to the singular chi square tests for independence, if necessary supplemented by the method of partioning the chi square statistics (Lancaster: 1969), where at the same time interactive effects might be tested/investigated. For a number of years there has been the possibility of the multi-variate analysis of the problem proposition mentioned earlier with the help of the so-called log-linear model. Theoretical backgrounds and empirical applications are to be found in the articles of L.A. Goodman (1971), Bishop, Fienberg and Holland (1975), Grizzle, Starmer and Koch (1969) and Steinmetz and Mooijaart (1975). L.A. Goodman has developed the programme ECTA (Everyman's Contingency Table Analysis) for this kind of models. A description of which in the Dutch language was given by Nieman (1976).
In describing the model we start from the observed frequencies f_{ijklm}, where i, j, k, l, m, stand for the categories of residence, age, social class, sex and victimization respectively.
In an a-select sample of the size n the chance that any observation will land in the call (ijklm) equals p_{ijklm}. The observed frequencies f_{ijklm} might be taken as the realizations of the expected numbers $f_{ijklm} = n.P_{ijklm}$.
Log-linear models are to be divided into structural (explorative) and functional models.

Structural models or, indeed, explorative models are characterized by a symmetrical relation between the variables. With functional models it is, however, the intention to predict, starting from a number of independent variables a dependent variable, in our case a victim of the twelve offences or not.

Functional models are described in terms of logits or "log-odds". A "log-odd" is the ratio between the number of respondents being no-victim and the number of respondent being a victim for any combination of categories from the variables: residence, age, social class and sex. For that purpose the ratio no-victim/victim is viewed for fixed values of cells (ijkl). The logarithm of this ratio, the logit variable $\bar{E}$ (Nieman) is to be defined as follows:

$$\text{logit } \bar{E} = \ln (f_{ijkl1}/f_{ijkl2}) \qquad (1)$$

It is the intention to determine what log-linear model approaches best the cells (ijklm). Judging from the choice of the model the observed ratios $\ln (f_{ijkl1}/f_{ijkl2})$ are compared with the ratios $\ln (F_{ijkl1}/F_{ijkl2})$ to be expected, estimated on the ground of the model.

With the help of testing statistics then it can be ascertained whether the hypothesis that a specific explanatory model fits in the observed ratios of the independent variable has to be rejected or not.

After this broad definition of the log-linear model the concrete model can be formulated mathematically. In doing so the terminology used by Nieman (1976) will be adopted.

The frequencies to be expected in the case of a complete, structural model of a five-dimensional IxJxKxLxM frequency table F_{ijklm} are defined as follows:

$$F_{ijklm} = n\, P_{ijklm} = \tau\, \tau_i^A \tau_j^B \tau_k^C \tau_l^D \tau_m^E \tau_{ij}^{AB} \tau_{ik}^{AC} \ldots\ldots\ \tau_{ijk}^{ABC} \ldots\ \tau_{ijkl}^{ABCD} \ldots\ \tau_{ijklm}^{ABCDE} \qquad (2)$$

The tau quantities in the right part of the equation are model parameters. By taking the logarithm (natural) of F_{ijklm} and identifying $\lambda \stackrel{\wedge}{=} \log \tau$ we pass from the multiplicative model to the log-linear additive model:

$$\log F_{ijklm} = \lambda + \lambda_i^A + \lambda_j^B + \lambda_k^C + \lambda_l^D + \lambda_m^E + \lambda_{ij}^{AB} + \lambda_{ik}^{AC} \ldots\ldots + \lambda_{ijk}^{ABC} \ldots\ldots + \lambda_{ijkl}^{ABCD} \ldots + \lambda_{ijklm}^{ABCDE} \qquad (3)$$

In using the functional model, which in this case is the starting point, the logartihm of the ratio to be expected, $\bar{E}_1/\bar{E}_2$, at a given (ijkl), is defined as follows:

$$\phi_{ijkl.}^{\bar{E}} = \ln \Omega_{ijkl.}^{\bar{E}} = \ln (F_{ijkl1}/F_{ijkl2}) = \ln F_{ijkl1} - \ln F_{ijkl2} \qquad (4)$$

Starting from the model assumptions that:

$$\sum_m \lambda_m^{\bar{E}} = 0, \ldots\ldots\ldots,\ \sum_m \lambda_{im}^{A\bar{E}} = \sum_i \lambda_{im}^{A\bar{E}} = 0,\ \ldots\ldots\ldots$$

$$\sum_i \lambda_{ijm}^{AB\bar{E}} = \sum_j \lambda_{ijm}^{AB\bar{E}} = \sum_m \lambda_{ijm}^{AB\bar{E}} = 0, \ldots\ldots\ldots\ldots\ldots, \qquad (5)$$

$$\sum_i \lambda_{ijkm}^{ABC\bar{E}} = \sum_j \lambda_{ijkm}^{ABC\bar{E}} = \sum_k \lambda_{ijkm}^{ABC\bar{E}} = \sum_m \lambda_{ijkm}^{ABC\bar{E}} = 0,\ \ldots\ldots,$$

$$\sum_i \lambda_{ijklm}^{ABCD\bar{E}} = \sum_j \lambda_{ijklm}^{ABCD\bar{E}} = \sum_k \lambda_{ijklm}^{ABCD\bar{E}} = \sum_l \lambda_{ijklm}^{ABCD\bar{E}} = \sum_m \lambda_{ijklm}^{ABCD\bar{E}} = 0$$

(the sum of the chances is 1 and the logarithm of 1 is 0)

with the help of (4) the equation (3) can be described in the following way:

$$\phi_{ijkl.}^{\bar{E}} = 2\lambda_1^{\bar{E}} + 2\lambda_{i1}^{A\bar{E}} + 2\lambda_{j1}^{B\bar{E}} + 2\lambda_{k1}^{C\bar{E}} + 2\lambda_{l1}^{D\bar{E}} + 2\lambda_{ij1}^{AB\bar{E}} + 2\lambda_{ik1}^{AC\bar{E}} + 2\lambda_{il1}^{AD\bar{E}} + 2\lambda_{jk1}^{BC\bar{E}} +$$

$$+ 2\lambda_{jl1}^{BD\bar{E}} + 2\lambda_{kl1}^{CD\bar{E}} + 2\lambda_{ijk1}^{ABC\bar{E}} + 2\lambda_{ijl1}^{ABD\bar{E}} + 2\lambda_{ikl1}^{ACD\bar{E}} + 2\lambda_{jkl1}^{BCD\bar{E}} + 2\lambda_{ijkl1}^{ABCD\bar{E}} \qquad (6)$$

as $\bar{E}_1 = -\bar{E}_2$ because $\bar{E}$ (victim/no-victim) is a dichotomy.

Because in future $\bar{E}$ will be handled as an dependent variable and moreover $\stackrel{\wedge}{=} 2\lambda$ in this case, the complete log-linear model will look like:

$$\phi_{ijkl.}^{\bar{E}} = \beta + \beta_i^A + \beta_j^B + \beta_k^C + \beta_l^D + \beta_{ij}^{AB} + \beta_{ik}^{AC} + \beta_{il}^{AD} + \beta_{jk}^{BC} + \beta_{jl}^{BD} + \beta_{kl}^{CD} +$$

$$+ \beta_{ijk}^{ABC} + \beta_{ijl}^{ABD} + \beta_{ikl}^{ACD} + \beta_{jkl}^{BCD} + \beta_{ijkl}^{ABCD} \qquad (7)$$

The linear multiplicative model corresponding with equation 7 is, with the help of $\gamma \stackrel{\wedge}{=} e^{\beta}$ to be written as follows:

$$\Omega_{ijkl.}^{\bar{E}} = F_{ijkl1} / F_{ijkl2} = \gamma\ \gamma_i^A\ \gamma_j^B\ \gamma_k^C\ \gamma_l^D\ \gamma_{ij}^{AB}\ \gamma_{ik}^{AC}\ \gamma_{il}^{AD}\ \gamma_{jk}^{BC}\ \gamma_{jl}^{BD}\ \gamma_{kl}^{CD}\ \gamma_{ijk}^{ABC}$$

$$\gamma_{ijl}^{ABD}\ \gamma_{ikl}^{ACD}\ \gamma_{jkl}^{BCD}\ \gamma_{ijkl}^{ABCD} \qquad (7a)$$

The natural logarithm of the ratio no-victim/victim in any cell (ijklm) is explained with this complete model with the help of sixteen parameters. In variance analytical terms the meaning of these parameters is comparable with the overall mean, the four main effects, the six second order effects, the four third order effects and the fourth order effect.

Such a model is also called a saturated model and it is rather poor from the point of view of data reduction. Then it is also the intention, by putting one or more parameters to be equal to 0, to look for a so-called restricted model that will be closely joined to the observed frequencies.

In putting the parameters to be equal to 0, making models will be executed in a hierarchical way, because most of the log-linear models are hierarchical and besides Ecta will only admit this kind of models.

An example of this is putting the parameters λ^{ABC} equal to 0, which will have the result that the parameter λ^{ABCD} automatically is put equal to 0 and that all the lower order terms are included in the model. Putting parameters equal to 0 means to express the expectation that the relevant marginals in the sense of observed and expected values after the process of estimation will deviate from each other as slightly as possible. For parameters (lower order factors) which are not put equal to 0 it is valid that the estimated marginals are equal to the observed marginals. At the same time this indicates that the so-called restricted model possesses a number of degrees of freedom in reading to an adaptation. It is evident that in the case of the saturated model marginals need not to be estimated and the number of degrees of freedom equals 0. The program Ecta generates two testing statisties, namely the Pearson's chi square statistic and the likelyhood ratio G^2 (Bishop et al, 1975) which is defined thus:

$$G^2 = -2 \ln \quad {}_{ijklm} \; f_{ijklm} \ln ({}^{F}ijklm/f_{ijklm}) \quad = \qquad (8)$$

$$2 \ln \quad {}_{ijklm} \; f_{ijklm} \ln (f_{ijklm}/F_{ijklm})$$

This statistic is (which is preferred by L.A. Goodman) with an increasing size of the sample N asymptotic chi square distributed with a number of degrees of freedom dependent of the model chosen.

4.2.3. Results

The startingpoint is the use of the functional, restricted, hierarchical log-linear model with the aim to keep the number of parameters, necessary to predict the log-ratios (f_{ijklm1}/f_{ijklm2}) of the cells, as small as possible.

In table 1 we find the possible models that constitute the basis for the decision which explanatory variables and their interactions will contribute best to the prognostication of becoming a victim or not.

Before beginning on the discussion of the models a couple of remarks has to be made.

Firstly, every elementary cell (ijklm) is increased by 0.5. This raise is meant to replace the so-called structural noughts by a positive number (Goodman, 1976), in order to make possible estimations of parameters with it.

Secondly, it appears from table 1 that with all the models the configuration ABCD is conceived as being given, since on the basis of the sample an explanation for the victimization is being thought of. On the basis of the results of the sample it is possible to generalize towards the population of the Dutch. This is only possible, however, if the drawn sample is representative of the Dutch population.

From table 2 it appears that acting on the levels of significance p, belonging to the likelyhood statistic G^2, the models 3, 4, and 5 are eligible for a further analysis. It is remarkable that the omission of the variable sex from the analysis causes a poor adaptation (model 6 with a level of significance of 0.73). In spite of the fact that model 6 does not yield a significant result, it seems that the variable sex is no strong predictor of no-victim/victim which is understandable as a summons about a number of offences has taken place.

TABLE 1 Fitting of the different hierarchical log-linear models in the data of table 1b.				
Model	Fitting configuration	G^2	df	p
1	(ABCD) (ABCE) (ACDE) (BCDE)	15.7	24	.5
2	(ABCD) (ABE) (ACE) (ADE) (BCE) (BDE) (CDE)	70.8	74	.5
3	(ABCD) (ABE) (ACE) (ADE) (BCE)	77.6	79	.5
4	(ABCD) (ABE) (ACE) (BCE) (BDE)	76.4	80	.5
5	(ABCD) (ABE) (ACE) (BCE) (CDE)	82.2	81	.443
6	(ABCD) (ABE) (ACE) (BCE)	103.4	84	.073

TABLE 2. Conditional tests for the fitting of some hierarchical log-linear model.		
G^2 (b/a)	$df_b - df_a$	P
$G^2(3/2) = 77.6 - 70.8 = 6.8$	5	>.20
$G^2(4/2) = 76.4 - 70.8 = 5.6$	6	>.30
$G^2(5/2) = 82.2 - 70.8 = 11.4$	7	>.10
$G^2(6/2) = 103.4 - 70.8 = 32.6$	10	.00
$G^2(3/4) = 77.6 - 76.4 = 1.2$	1	>.20
$G^2(5/3) = 82.2 - 77.6 = 4.6$	2	>.10
$G^2(5/4) = 82.2 - 76.4 = 5.8$	2	>.05

With the help of conditional tests the models 3, 4, and 5 can be analysed.

If it is a question of two log-linear models a and b, of which only model b contains part of the terms of model a, with the help of the difference $G^2(a) - G^2(b)$ it can be determined to what extent model a fits better than model b. In such a way it can be ascertained whether the addition of an interaction will yield a statistical significant improvement of the fitting of the frequencies observed in the frequencies to be expected.

A significant level of 5% or more means that the additional parameter yields a real contribution to the explanation of the data observed.

The stochastic quantity $G^2(b/a) = G^2(b) - G^2(a)$, (9)

is a symptotic chi square distributed with $df_a - df_b$ degrees of freedom

The results of the conditional tests are to be found in table 2. From this we can deduct that none of the conditional tests (except $G^2(6/2)$ en $G^2(5/4)$ is significant, which induces us to make a choice of the models 3, 4, and 5. Then the choice falls on model 3 on the principle of the size of the significance levels and the Z-values belonging to them.

4.2.4. Conclusions

The log-ratio no-victim/victim is predicted on the principle of combined data: size of municipality, age, social class, and sex.
This prognostication is based on the distributions found in the sample.
The log-linear model offers the following explanation for the phenomenon victimization, which, however, has to be dealt with some caution.

$$\bar{E}_{ijkl.} = \beta + \beta^{A}_{i} + \beta^{B}_{j} + \beta^{C}_{k} + \beta^{D}_{l} + \beta^{AB}_{ij} + \beta^{AC}_{ik} + \beta^{BC}_{jk} + \beta^{BD}_{jl} \qquad (10)$$

From table 3 it appears (with some exceptions) that the chance of victimization is connected with the degree of urbanization, the social class, the age-group, and the sex to which the respondent belongs. The remaining significant interactions are such a minor group out off all the possible significant interactions that they will not be taken into account with an overall interpretation. On the basis of the ratios no-victim/victim per category of the district independent variables it can be claimed that the most important meaning for the risk of victimization in a decreasing size will be indicated by age, municipality, social class, and sex.

In summary the result comes down to the fact that young male respondents from the highes social class and living in municipals of 100,000 or more inhabitants (chance of being a victim: 60%) run the risk to become a victim fifteen times as much as compared with aged ladies, living in the country (chance of being a victim: 4%). From table 3 it further appears that a particular risk group consists of respondents living in the three big cities and being of an age between 27 and 40. The estimated parameters corresponding with model 3 can be interpreted as follows (see table 3):

> The average chance to become a victim is equal to 1/5.15, which comes down to the fact that one in six Dutch persons was a victim in 1977.

The use of the gamma-values, on the other hand, has to be carried out with the greatest care.

TABLE 3. Estimated parameters for model 3

Parameters		λ understandardized	z-values (significant at z 1.96	$2\lambda = \beta$	$\gamma = e^{\beta}$ (see formula 7a)
λ^{E}_{1}		0.82	30.3	1.64	5.15
$\lambda^{A\bar{E}}_{11}$		- 0.34	- 8.0	- 0.68	0.51
$\lambda^{A\bar{E}}_{21}$		- 0.11	- 2.8	- 0.22	0.80
$\lambda^{A\bar{E}}_{31}$	(size of muci-pality)	- 0.05	- 1.1	- 0.10	0.90
$\lambda^{A\bar{E}}_{41}$		+ 0.22	4.5	+ 0.44	1.60
$\lambda^{A\bar{E}}_{51}$		+ 0.28	3.2	+ 0,56	1.75
$\lambda^{B\bar{E}}_{11}$		- 0.44	- 8.5	- 0.88	0.41
$\lambda^{B\bar{E}}_{21}$	(age)	- 0.11	- 8.0	- 0.22	0.80
$\lambda^{B\bar{E}}_{31}$		0.16	3.8	0.32	1.38
$\lambda^{B\bar{E}}_{41}$		0.40	7.1	0.80	2.22
$\lambda^{C\bar{E}}_{11}$		- 0.18	- 4.3	- 0.36	0.70
$\lambda^{C\bar{E}}_{21}$	(soc.cl.)	+ 0.10	3.2	0.20	1.22
$\lambda^{C\bar{E}}_{31}$		0.08	1.9	0.16	1.17
$\lambda^{D\bar{E}}_{11}$	(sex)	- 0.07	2.5	- 0.14	0.87 (1.15)
$\lambda^{AB\bar{E}}_{121}$		- 0.14	- 2.2	- 0.28	0.76
$\lambda^{AC\bar{E}}_{131}$		0.13	1.9	0.26	1.29
$\lambda^{BC\bar{E}}_{421}$		0.13	2.0	0.26	1.29

TABLE 1a. Presentation of variables.

Code	Variable	Category	
A_i	size of munipality	i = 1	the 3 big cities A'dam, R'dam, Den Haag
		i = 2	towns with 50.000 - < 400.000 inhab.
		i = 3	towns with 20.000 - < 50.000 inhab.
		i = 4	countrytowns with 5.000 - < 20.000 inhab.
		i = 5	villages < 5.000 inhab.
B_j	age	j = 1	< 25 years
		j = 2	25 - < 40 years
		j = 3	40 - < 65 years
		j = 4	> 65 years
C_k	social class	k = 1	higher social cl.
		k = 2	middle social cl.
		k = 3	low social cl.
D_l	sex	l = 1	male
		l = 2	female
E_m	victimization	m = 1	no-victim
		m = 2	victim

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