An evaluation of domestic food hygiene and food preparation practices

Thesis

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AN EVALUATION OF DOMESTIC FOOD HYGIENE AND FOOD PREPARATION PRACTICES

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Sponsoring Establishment: Cardiff Institute of Higher Education

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ABSTRACT

The aim of this investigation was to evaluate the hygiene of domestic food preparation practices. The traditional survey approach used to study this behaviour has problems of interpretation and verification. In this study direct observation, supplemented with food temperature measurements was used to gather information for the purpose of developing an understanding of the causes of domestic food poisoning.

The food handling practices of 108 people preparing foods commonly implicated in outbreaks of food poisoning were analysed. A HACCP approach was employed and a standard measure of hygienic food handling behaviour, the Food Safety Risk Score, (FSR) was devised. The FSR score indicated the extent of the use of appropriate control measures during food preparation. The higher the score the greater the risk of unsafe food being produced. Scores expressed as a percentage, ranged from 0 to 65% with over half of the subjects scoring below 20%. More than half (60%) of the people cooked in advance of consumption but most (85%) cooked the food thoroughly. Few used any method to speed the cooling of cooked food. Temperature abuse during food transport and storage was exhibited by more than 40% of people. Cooked food was held at ambient temperature for prolonged periods by 19% of the people and was re-heated inadequately by 11%. The standard of personal hygiene of some participants was low.

An assessment of the cleanliness of the domestic kitchen and the condition of equipment and surfaces used in food preparation, based on ATP measurements and a kitchen check-list showed that there was a wide variation in the standards found in homes. The great potential for indirect and direct cross contamination in the domestic kitchen was highlighted.

The problems involved in persuading people to practise well-known food hygiene principles are considered and recommendations for improving domestic food hygiene are made.

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ABBREVIATIONS

APC	- Aerobic Plate Count
ATP	- Adenosine Triphosphate
a_w	- Water activity
BSA	- British Sandwich Association
CCDAM	- Committee on Communicable Diseases affecting Man
CCP	- Critical Control Points
CDSC	- Communicable Disease Surveillance Centre
CFU	- Colony Forming Unit
DoE	- Department of Education
DoH	- Department of Health
EPT	- End Point Temperature
FDA	- Food and Drugs Administration
FDF	- Food and Drink Federation
FOR	- Food Operation Risk
FSR	- Food Safety Risk
HACCP	- Hazard Analysis Critical Control Point
ICMSF	- International Commission on Microbiological Specifications for Foods
IEHO	- Institution of Environmental Health Officers
MAFF	- Ministry of Agriculture, Fisheries and Food
NACMCF	- National Advisory Committee on Microbiological Criteria for Foods
OPCS	- The Office of Population Censuses and Surveys
PHLS	- The Public Health Laboratory Service
SD	- Standard Deviation
SEG	- Socio-economic group
WHO	- World Health Organisation

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CHAPTER 1. LITERATURE REVIEW

'In a nutshell, the consumer has
to be held responsible for a large
share of the foodborne illness
that occurs in this country'

Professor James M. Jay
Department of Biological Sciences
Wayne State University, Detroit
1992

1. Literature Review

1.1 Food poisoning

The term bacterial food poisoning is used with some ambiguity. It is also somewhat misleading, as most incidents given the name are not due to 'poisoning ' as such but rather the consumption of pathogen-contaminated food. In this thesis bacterial food poisoning refers to an acute disturbance of the gastrointestinal tract resulting in abdominal pain, with or without diarrhoea and vomiting, due to eating food contaminated by specific pathogenic bacteria or their toxins (Sprenger, 1991). With this definition intoxifications by *Bacillus species (sp), Clostridium sp.* and *Staphylococcus aureus* and infections by *Salmonella, Listeria monocytogenes* and *Yersinia enterocolitica*, would be regarded as types of food poisoning. The Public Health Laboratory Service (PHLS) Communicable Disease Surveillance Centre (CDSC) restricts the use of the term food poisoning (PHLS, CDSC, 1993) to illness associated with toxins produced in food, or in the intestine, by *Bacillus sp., Clostridium sp.* and *Staphylococcus aureus* (PHLS, CDSC, 1993). They use the term 'foodborne illness' to include infections or intoxifications associated with bacteria other than those listed above. Salmonellosis and campylobacteriosis are, therefore, both regarded as foodborne illnesses as are illnesses caused by haemagglutinin, scrombotoxin, ciguatera and red whelk toxins.

Many authors (e.g. Sprenger, 1991; Harrigan and Park, 1991) however, make the distinction between foodborne infections and infection-type food poisoning. Foodborne infections are characterised by longer incubation periods, lower infective doses and the role of the food, which serves purely as a vehicle and would therefore include illness such as campylobacteriosis and bacillary dysentery but would exclude illness caused by *Salmonella typhimurium* or *S. enteritidis*. Epidemiological and research data have demonstrated that usually several causal factors must occur sequentially to result in food poisoning. Hence, (1) pathogens must reach the food; (2) they must survive there until the food is ingested; (3) often they must multiply to reach infectious levels or produce toxins; and (4) the person who ingests the foods must be susceptible to the levels ingested.

Pathogens will multiply in food if:

1. the food contains sufficient quantity and variety of nutrients and growth factors and a suitable water activity (a_w)
2. the pH of the food is within the range that favours growth
3. the redox potential of the food and the surrounding atmosphere are favourable
5. the temperature at which the food is held, is within the growth range for adequate time
6. the pathogens can successfully compete with the mixed microbial flora on and in the food.

Critical review of epidemiological data on food poisoning implicates factors that contribute to contamination of foods and/or encourage the growth and survival of micro-organisms or the persistence of their toxins. Two or more of these factors must usually occur sequentially before there are outbreaks.

1.2 The Incidence of Food poisoning

Surveillance reports on food poisoning in England and Wales have been published by the PHLS since 1950. The CDSC provides a weekly Communicable Disease Report and annual detailed statistics and trends. Many cases of illness, however, never come to the notice of environmental health departments and microbiologists. Only when the symptoms are severe, or an outbreak occurs among a well defined group such as a hospital, are incidents likely to be reported and investigations undertaken.

Although statistics on the incidence of food poisoning are incomplete, they do indicate general trends, the distribution of the different types of bacteria responsible, the situations in which outbreaks most often occur, and the range of foods most frequently incriminated.

The food poisoning statistics have shown an upward trend since the mid-1980s. In 1982 there were 14,253 cases of food poisoning notified to the Office of Population Censuses and Surveys (OPCS), and by 1991 this had increased to an annual figure of 52,543 cases. The officially notified food poisoning cases released by OPCS show 62,607 cases in 1992 (PHLS CDSC, 1993).

The problem of interpreting official data is especially acute in relation to food poisoning. The food poisoning figures are considered to be extremely inaccurate and represent only a fraction of the total number of cases. Whether it is reasonable to multiply them by 10, 30 or 100 to produce the true incidence is a question of intense debate. Lacey (1993), using a multiplier of 10, estimates an annual figure of around 2 million food poisoning cases.

The CDSC statistics show an increase in the number of family outbreaks, (involving 2 or more persons in the same household) of salmonellosis, from 812 in 1989 to 2374 in 1991. This represents 86% of all outbreaks. It should be noted that changes in the analysis of individual cases have improved the identification of family outbreaks. The CDSC report family outbreaks of food poisoning are more commonly associated with *Bacillus sp.* than with *S. aureus* or *C. perfringens*.

In most investigations of family outbreaks the suspect food is not identified. If the ill members of the family have not recently consumed food outside the house then the place will be recorded as a private house. However contaminated food from local shops, which may not have been mishandled by the purchasers, may have been the cause of these outbreaks.

The CDSC suggest that the high proportion of family outbreaks may reflect methods of handling potentially contaminated raw foods in the domestic home. They believe that this was confirmed to some extent by a survey of domestic food handling practices (MAFF, 1988).

Epidemiological data from Europe and N. America reveal family homes to be high on the list of places where food poisoning is acquired (ICMSF, 1988). In America between 1973-1976, 27% of outbreaks of food poisoning occurred in homes (Bryan, 1978). In 1984 the reported frequency of the home as the place where food poisoning was acquired ranged from 94% in Austria to 1% in Belgium. Sixty percent of the food poisoning in England and Wales was acquired in the home (ICMSF, 1988). Because of differences in the reporting systems in different countries the data are, however, incomplete and may not be directly comparable. The statistics do, however, stress the need to identify the causes of foodborne hazards in the home and to direct educational efforts accordingly.

1.3 Food vehicles

> 'Such has been the importance of food to the human race both as a source of pleasure and as a fuel that almost everything we eat or drink has at some time or other been denounced as illegal, immoral, irreligious or nasty, even the humblest of vegetables'.
>
> Abstain from Beans Pythagoras, 6th century BC.
>
> from the Frank Muir Book, 1976

Raw foods as received in the kitchen sometimes harbour pathogens. Raw meat and poultry are often contaminated with *C. perfringens, S. aureus* and *Salmonella*. In one survey, *Salmonella* was isolated from 79 of 100 frozen chickens purchased in retail outlets (Roberts, 1972). Lacey (1992) considers the presence of *Campylobacter* in raw poultry as inevitable. Eggs may harbour *Salmonella*, shellfish and fish are sometimes contaminated with *Vibrio parahaemolyticus* and raw vegetables and spices are often contaminated with *C. perfringens* and *B. cereus*. Rice and other cereals frequently harbour *B. cereus*.

The likelihood that a food could become a vehicle of foodborne disease is related to certain of its attributes: physicochemical (eg. pH, water activity, oxidation-reduction potential), biological (eg nutrient content) and ecological (usual microfloral population and their source).

Bryan, 1988 reviewed 1,586 outbreaks in the US occurring between the years 1977-1984, to determine the relative importance of foods as food poisoning vehicles.

The items most frequently implicated in outbreaks were roast beef, ham, turkey, chicken, and raw clams. Chinese foods, usually fried rice and Mexican-style foods, usually ground meat or pinto beans were also commonly implicated. Potato and chicken salads were identified more frequently than other salads. Roast beef and turkey were the most common vehicles of *C. perfringens* and *Salmonella*. Ham was the most common vehicle of staphylococcal enterotoxin.

In the UK the CDSC produce periodic reviews of the types of foods involved in outbreaks. Microbiological or epidemiological evidence is not available for many outbreaks. The foods implicated in food poisoning due to *C. perfringens, S. aureus* and *B. cereus* are traced in approximately 90% of reported outbreaks. However, in the case of *Salmonella* the food responsible is identified only in about 20% of outbreaks (Sprenger, 1991). This is probably because the food remnants have been discarded before the onset of the symptoms, 18-36 hours after the meal, a period longer than for other bacterial agents.

Between 1979 and 1981, where epidemiological evidence was available, cooked meat and poultry were incriminated in more than 80% of the outbreaks due to all agents. This figure has declined recently, whereas the number of outbreaks attributable to eggs and egg product has risen from 1% in 1983 to 23% in 1989. The number of outbreaks in which egg was suspected increased from 14 in 1989 to 20 in 1991. This major change in the epidemiology of *Salmonella* concerns the increase of *S. enteritidis PT 4*. Between 1989 and 1991 there were 38 outbreaks caused by *S. enteriditis PT 4,* and seven due to other *S. enteriditis* phage types, in which dishes containing egg were reported as the suspected vehicle of infection. It is suggested that transovarian transmission may be responsible for the contamination in eggs and that traditional methods of cooking eggs are inadequate to destroy the contaminants (Lacey, 1993).

The foodborne disease surveillance data of the US and the UK do not reveal the location of the foods implicated as vehicles. The data are culled from all incidents arising in restaurants, hospitals, canteens and homes. It is not possible to estimate whether most domestic food poisoning involves poultry or eggs or some other vehicle.

1.4 Factors contributing to outbreaks of food poisoning

Accompanying the development of epidemiology and improved surveillance of food poisoning, specific factors that contribute to the occurrence of outbreaks of these diseases have become apparent.

Roberts (1987) reviewed the most common factors thought to have contributed to 1479 outbreaks of food poisoning in England and Wales between 1970 and 1982 (Table 1.1). There is no evidence to suggest that the factors contributing to food poisoning incidents have changed significantly over the last decade (Roberts, 1993). It should be noted that the data reviewed represented only 20% of all notified incidents and, because of incomplete data, only 15% of the incidents occurred in domestic homes.

Bryan (1988) has reviewed the factors that are thought to have contributed to outbreaks in North American homes from 1973-1982 (345 outbreaks). Important factors that contributed to outbreaks in the home are shown in Table 1.2.

Table 1.1 Factors contributing to outbreaks of food poisoning (Adapted from Roberts, 1987)

Contributing factor		Total	(%)
1	preparation of food in advance of needs	844	57
2	storage at ambient temperature	566	38
3	inadequate cooling	468	32
4	inadequate re-heating	391	26
5	use of contaminated processed food	246	17
6	under-cooking	223	15
7	contaminated canned food	104	7
8	inadequate thawing	95	6
9	cross contamination	94	6
10	consumption of raw food	93	6

Table 1.2 Factors contributing to outbreaks of food poisoning in the home (Adapted from Bryan, 1988)

Contributing factor		(%)
1	contaminated raw foods	42.0
2	inadequate cooking	31.0
3	unsafe source	29.0
4	improper cooling	22.0
5	lapse of 12 or more hours between preparing and eating	13.0
6	colonised persons handling food	9.9
7	inadequate re-heating	3.5
8	improper hot holding	3.2
9	cross contamination	3.2
10	use of leftovers	3.2
11	improper cleaning of equipment	0.3

The main change in ranking between this and earlier reviews (Bryan 1981) was that ingesting raw contaminated foods or incorporating these foods into dishes and obtaining foods from unsafe sources increased considerably. This was primarily due to numerous outbreaks of viral gastroenteritis (similar to that caused by *Norwalk* agent) attributed to ingestion of raw clams and oysters, mostly in 1982.

Whilst there are differences between the relative importance of different factors that have contributed to food poisoning in the home in the US and the UK, the ranking and frequency of contributory factors in outbreaks from all US locations over the period 1977 to 1982 is similar to the UK (Bryan, 1988).

Risks of food poisoning are high wherever these practices (Table 1.1, 1.2) are followed. Preparation of food in advance of consumption, storage of perishable foods for several hours at ambient temperature and improper hot holding or cooling of foods are significant factors that affect microbial growth. Significant factors that affect the survival of micro-organisms or their toxins are inadequate time or temperature during cooking or re-heating of previously cooked foods. Cross-contamination and infected food handlers are factors which contribute significantly to contamination of foods. It is likely that the importance of cross-contamination is underestimated since it involves a series of sequential events occurring over time and is therefore not easily audited.

Control/preventative measures must be targeted at preventing or minimising contamination of foods, killing pathogens or destroying toxins and inhibiting growth and multiplication. There is a Pareto principle in quality control that states that:

A few ('the vital few') contributors to a problem account for most of the total size of the problem and the remaining many contributors to the problem (the 'trivial many') account for only a small proportion of the total. The factors that contribute to outbreaks of food poisoning fit this principle. In this regard a few factors such as preparation too far in advance, inadequate cooling, inadequate re-heating occur more frequently than others and hence are vital. Those factors that frequently contribute to outbreaks define priorities for preventative food control and indicate where control should be focused. This can be accomplished through the application of the Hazard Analysis Critical Control Point (HACCP) system to food operations.

1.5 The domestic kitchen

In attempting to improve the control of food poisoning in the home, the Richmond Report (1991) emphasised the importance of understanding the contribution of direct or indirect cross-contamination together with inadequate food storage.
Information on food handling behaviour likely to lead to cross-contamination has been obtained from questionnaires and interviews (Beddows, 1983; HMSO, 1988; Spriegel, 1991; FDF IEHO, 1993a). Attention has been drawn to the risk of direct contamination of foods as the result of poor food storage (Ackerley, 1990), the indirect cross-contamination risk of using general purpose kitchen cloths and the same chopping board for raw and cooked meats (Ackerley, 1992).
In 1978 a study by De Wit *et al.* (1978) showed that if frozen chickens were artificially contaminated with an indicator organism *E. coli K12,* then after thawing and preparation by 60 housewives, the organism could be recovered from a large number of surfaces, including sinks, taps, chopping boards

and cloths. The indicator organism was still recovered after rinsing, cleaning or washing-up.

Borneff (1989) investigated the effectiveness of sanitisers in a domestic setting, in which housewives had prepared a meal using minced beef contaminated with *Micrococcus luteus ATCC 9341*. He found that household cleaners with bactericidal properties were useful in reducing the organisms which were widely distributed over many surfaces.

There is little information available on the maintenance and cleanliness of the domestic kitchen which, unlike the commercial equivalent, is not open to inspection by environmental health officials. A report commissioned by the Consumer Association (1989) on 20 home kitchens conducted by Environmental Health Officers has revealed a number of microbiological hazards.

An assessment of physical conditions in commercial and public sector food premises was conducted by the Audit Commission (1990). This established that the worse the conditions, the higher the health risk. In additional analyses of the statistics the Richmond Report (1991) showed that about a quarter of food premises were unsatisfactory in terms of design, construction and cleanliness. Poor handwashing facilities, and conditions conducive to cross-contamination were amongst the most important health risks found in hotels and guesthouses. There has been no equivalent assessment of domestic food premises.

The Richmond report recommended that domestic kitchens should be designed to allow for segregation of raw and cooked foods during processing, should be easy to clean and be well ventilated. They advised that architects, manufacturers and fitters of domestic kitchens pay more concern to the microbiological safety of the kitchens they design or install.

1.6 The domestic food handler

Questionnaire surveys (Beddows, 1983; MAFF, 1988; Ackerley, 1990; Spriegel, 1991; FDF IEHO, 1993a) of the public have been undertaken to measure the extent of their understanding of food hygiene principles and knowledge of food poisoning. Wide spread confusion and lack of knowledge about cross-contamination, temperature control and the aetiology of food poisoning was found by Ackerley (1990) in her study of public perceptions of food hygiene and food poisoning.

Spriegel (1991), however, found that consumers exhibited a high degree of awareness of safe food storage.

The MAFF survey (1988) found little general understanding of the mechanism of food poisoning among the public, although most recognised the dangers associated with the storage and preparation of food. Beddows's (1983) survey of 100 housewives, however, indicated that many were unaware of or did not follow practices to prevent outbreaks of food poisoning. The surveys indicate that there is no consensus of opinion on the main causes of food poisoning.

The FDF IEHO survey found that most consumers were fairly or very confident when buying food, that they had enough information about storage, preparation and cooking in order to keep it safe and they claimed that they usually follow hygiene rules carefully and keep everything clean. Yet less than 23% knew the correct temperature for their refrigerator or freezer. And when deciding if stored or left-over food was fit to eat, people were most likely to smell it or look for signs of deterioration.

Questionnaire surveys of the public have some value in indicating what people know about food safety practices and their knowledge of bacterial contamination of food but there is little information on whether the public actually behave in the way they claim to. Jones and Weimer (1977) attempted to look at the relationship between food safety behaviour and knowledge. They assessed the food safety risk of households on the basis of a sample of their reported food handling behaviour and also determined their food safety awareness. They found the largest group (50%) were ignorant of food safety principles and indicated that they would use unsafe handling methods.

1.7 The traditional approach to food control

The retrospective examination of final food samples for pertinent target organisms as a method of food control has a number of drawbacks (Mossel, 1989).

The currently used sampling and examination procedures are hardly ever adequate to identify pathogens in products. Pathogens usually exhibit a marked heterogeneous distribution in food. Reference values or standards are often arbitrary. Technical expertise is required to interpret test results, which are often slow and costly. Quality control is seen to be the responsibility of the Quality Control department, which is often distant from the point of production. This backward control is reactive. Foster(1972) has likened it to

> 'leaning back and waiting for disease to occur'

A strategy of intervention is required to bring about proactive food control. Analytical methods along with the inspection of the production chain could then be used to validate the efficacy of intervention, not the reverse.
For pragmatic reasons, traditional methods of food control have no place in the domestic situation. A system of food control based on the prevention of food safety problems is required. The key to an effective food safety system in the home is to focus attention on those hazards which must be tightly controlled and to determine how control may be exercised and monitored.

1.8 The HACCP approach to food control

The accepted definition of the HACCP concept is:
'a systematic approach to the identification and assessment of the microbiological hazards and risks associated with the manufacture, distribution and use of a particular foodstuff and the definition of means for their control' (ICMSF, 1988). It is widely accepted as the most effective means of controlling foodborne disease (WHO, 1988, 1990; NACMCF, 1990). However HACCP is not a solution to all food safety problems. It will not in itself prevent all microbiological problems occurring - 'absolute safety is absolutely unattainable'(Hall, 1981).
HACCP originated in the field of engineering and is derived from 'Failure Mode and Effect Analysis'. It was developed first by the Pillsbury company in association with NASA to control microbiological hazards in the manufacture of food for the United States Manned Space Programme in the early 1970's. The concept has been widely employed in the food

manufacturing and food service industries (Bauman, 1974, 1990; Peterson and Gunnerson, 1974; Bryan, 1990; Snyder, 1986).

The aim of the system is to identify potential hazards in the production process and to eliminate them where possible. Where eliminating those hazards is not practicable, the aim is to control them within acceptable parameters.

HACCP is not just new terminology; it is a system of sequential actions to ensure the highest degree of food safety. Neither the hazards addressed nor the preventative measures prescribed are new. What is innovative, however, is the way in which various procedures are put together in a rational order, so the severity and risks of hazards can be assessed, the priorities for control can be set, the critical control points monitored and processes adjusted accordingly. The system requires that safe procedures be carried out routinely and that immediate corrective action be taken whenever hazards do arise.

The HACCP concept is logical because it is based on epidemiological data on food poisoning. It focuses attention on critical operations where control is essential.

Mitchell (1992) has said that, in principle, HACCP is a philosophy, whilst in practice it is a tool and that there are many different opinions on how it should be applied.

1.9 The basic HACCP principles

In 1988, the ICMSF published *HACCP in Microbiological Safety and Quality*. This provided definitions of the components of the system and background information on what was required before it could be successfully applied. Practical HACCP guides have been produced by the Campden Food and Drink Research Association (1987, 1992), Mayes (1992), Mitchell (1992), the Committee on Communicable Diseases Affecting Man (CCDAM) (1991) and the Codex Alimentarius Committee on Food Hygiene (1993).

The Hazard Analysis Critical Control Point (HACCP) analysis (Fig. 1.1) consists of (1) determination of hazards and assessment of their severity and the risks they pose; (2) identification of critical control points; (3) establishment of control measures and criteria; (4) monitoring and recording of each critical control point; (5) implementation of corrective action whenever the criteria are not met, and (6) verification that the system is functioning as planned (ICMSF, 1988).

The semantics of this method of food control must be briefly explained. It is important to be clear and rigorous in the use of the terminology, so that during the analysis sight is not lost of the primary objective. *Collins English Dictionary* (1979) define 'hazard' as 'risk' and 'risk' as 'hazard'. These two words are often used interchangeably. However, within the HACCP system, they have their own and separate meaning and they must be defined and used precisely if the analysis is to be of any real use.

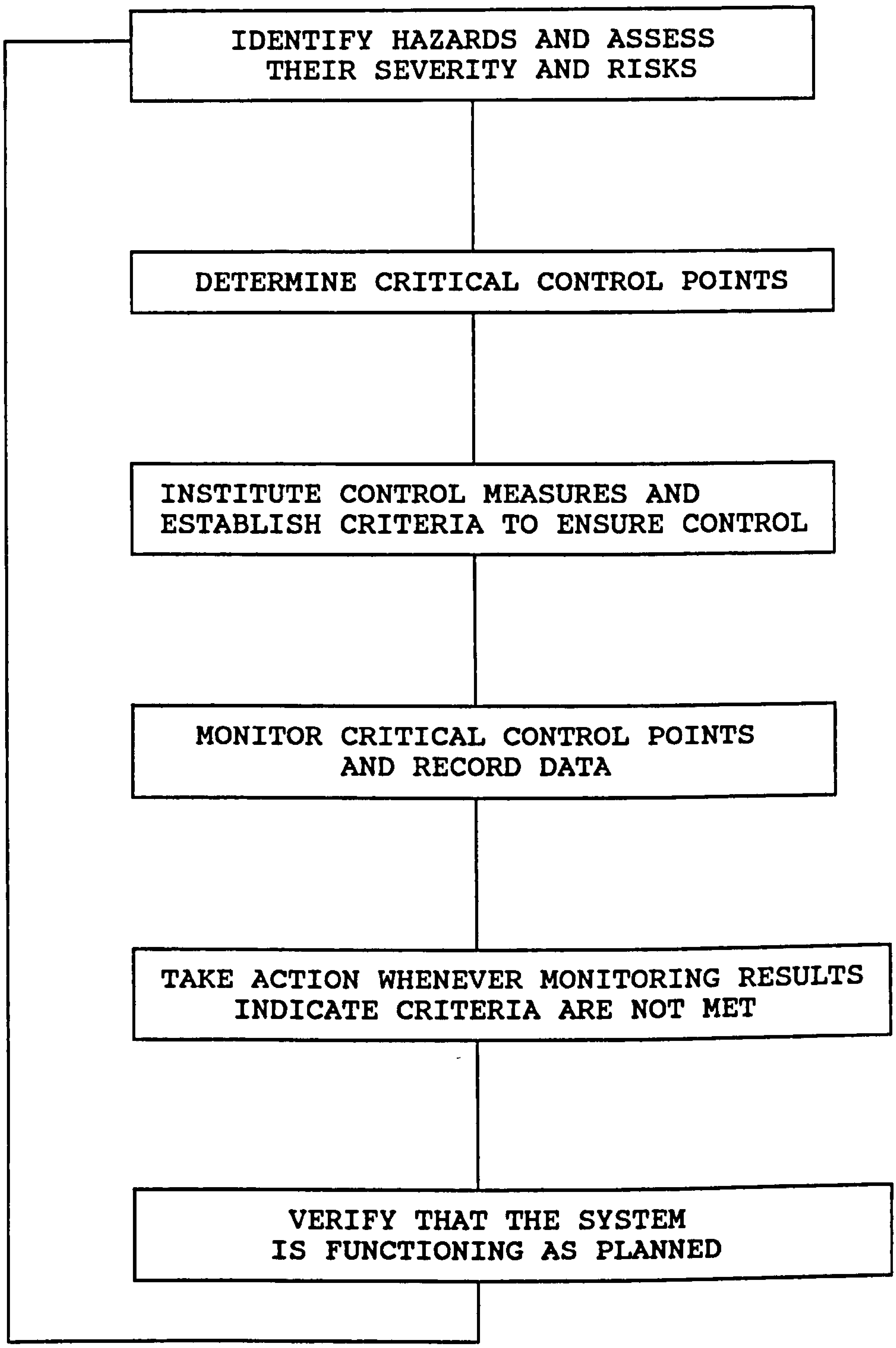


Fig. 1.1 The HACCP SYSTEM

1. Identification of hazards and assessment of their severity and risks

Hazard analysis is the first step of the HACCP system. Its purpose is to identify actual and potential hazards associated with ingredients, the processes and the product's ultimate use. The entire process under study must be audited to produce a flow diagram of the process, that can be used as the basis for the HACCP analysis. The flow diagram is a detailed sequence of operations for the product under study. Audits must be carried out by closely following actual processing operations.

Identified hazards are then assessed for their severity and risks.

A hazard is the potential to cause harm. It is unacceptable contamination of a biological, chemical or physical nature and/or survival or multiplication of micro-organisms of concern to safety (or spoilage) and/or unacceptable production or persistence in foods of toxins. An unacceptable level may be only one cell of *Salmonella* or *Shigella* or 100,000 or more *B. cereus* or *C. perfringens* per ml or gram. Hazards can be divided into life threatening, severe or chronic and moderate or mild illness. Life-threatening illnesses include those caused by *C. botulinum, Salmonella typhi, Listeria monocytogenes* (for foetuses, infants or immunosuppressed persons), *Vibrio cholerae, Vibrio vulnificus*, paralytic shellfish poisoning and amnesic shellfish poison.

Severe or chronic illnesses include those caused by *Campylobacter*, pathogenic *Escherichia coli, Salmonella, Vibrio parahaemolyticus, Yersinia enterocolitica*.

Moderate illnesses include those caused by *Staphylococcus aureus, C. perfringens, L. monocytogenes* (for previously healthy adults).

Risk is an estimate of the probability of occurrence of a hazard or the sequential occurrences of several hazards. Degrees of risk are high, moderate, low and negligible. Risky situations may vary, depending on what is happening at the time. Outbreak and other epidemiological data indicate that microbiological hazards are of the highest risk to the greatest number of people.

Hazards can be identified by reviewing reports of outbreaks of foodborne diseases to ascertain:

a) likely problem situations

b) places where mishandling commonly occurs

c) frequently identified vehicles

d) factors that contribute to the occurrence of the outbreaks.

In reference to bacterial hazards, two or more of these factors usually occur sequentially before outbreaks result. Operations relating to factors that lead to outbreaks of foodborne diseases ordinarily call for critical control points.

Bryan (1981) has reviewed the salient features of the hazard analysis, which include:

a) Appraisal of incoming foods to determine whether they are contaminated with the hazards under consideration and whether the foods will support microbial growth.

b) Appraisal of storage and handling methods to determine whether they facilitate contamination or promote microbial growth.

c) Measurement of the time-temperature exposure of foods during cooking to determine whether or not pathogens could survive.

d) Appraisal of post-cooking handling methods to determine whether they facilitate contamination or promote microbial growth.

e) Measurement of time-temperature exposures of foods during hot-holding, post-cooking storage or re-heating to determine whether pathogens could survive or multiply.

f) Appraisal of cleaning procedures to determine whether or not pathogens are removed from equipment and utensils.

g) Appraisal of food safety awareness and practices of food handlers.

2. Determination of Critical Control Points

The Critical Control Point (CCP) is a step which if controlled will eliminate or reduce a hazard to an acceptable level.

The term critical control point draws attention to the fact that not all hazards are equally critical to the safety of the end product. Determining which hazards must be controlled, and how that control is to be exercised and monitored, is the key to the effective safety system. But deciding which hazards are to be controlled depends on a number of factors. The severity of the hazard and its likely frequency are important concerns. Consideration of where the hazard occurs in the sequence of operations is also relevant.

It is recommended that a CCP decision tree be used to determine whether a process step is a CCP for the identified hazard. The control of hazards at a CCP ranges from absolute to partial. A CCP that can eliminate hazards may be designated a CCP1, whereas steps where hazards are minimised, reduced or delayed are designated CCP2s.

A Critical Control Point must be distinguished from an ordinary control point. This is an operation at which preventative measures are taken because of good manufacturing or catering practices.

The intent of the HACCP system is to focus control at the CCPs and so their determination is at the heart of HACCP.

3. Institution of Control Measures and establishment of criteria (limits and tolerances) to ensure control

Control Measures are actions that are required to eliminate or reduce hazards to an acceptable level.

Criteria are specified limits or characteristics of a physical, chemical or biological nature.

The terms 'target level' and 'tolerance' are now widely used in the same context (CFDRA, 1987).

Target Level is a predetermined value for the control measure which has been shown to eliminate or control a hazard at a CCP.

Tolerance is the absolute value for the control measure at a CCP (ie the degree of latitude); values outside this tolerence indicate a deviation (CFDRA, 1987).

4. Monitoring of critical control points and recording of data

Monitoring is a planned sequence of observations or measurements of a CCP target level and tolerance (criteria).

These are designed to produce an accurate record and provide evidence for future use in verification that the CCP is under control.

5. **Corrective action whenever monitoring results indicate criteria are not met**

Corrective actions are those that will bring the CCP back under control and should be taken immediately any deviation from the target levels is detected. Action will vary with the process being monitored and decisions will be based on the hazards, assessed severity and risks, and the expected use of the product.

6. **Verification that the system is functioning as planned**

Verification involves procedures, other than those in monitoring, which ensure that the HACCP has been carried out correctly and is effective. The formulation of food products and the production process should be reviewed periodically, to see whether changes have been made since the system was established. Appropriate revision of the HACCP system should be made in the light of any changes.

1.10 The HACCP approach in the catering industry

The catering industry was responsible for over 80% of general outbreaks of *salmonella* infection between 1989-1991 (CDSC, 1993). Catering operations range in size and complexity from cook-freeze and cook-chill units that are equivalent to food factories to small kitchens similar to domestic kitchens. Interest in the HACCP concept has been shown by the large scale 'systems' sector, which includes cook-freeze, cook-chill and sous vide. Practical guidance on the application of HACCP to catering operations has been produced by Bryan

(1979, 1981, 1982, 1990), Bobeng and David (1977) and Sheard (1986).

HACCP analyses have been conducted in Mexican-style food operations (Bryan and Bartleson, 1985), Cantonese-style restaurants (Bryan *et al.*, 1981), airline catering (Bryan *et al.*, 1978) and hospital food service operations (Bobeng and David, 1978).

Many of the steps involved in producing food in the home are similar to those used in small catering units. Domestic food handlers like their commercial counterparts will be involved in receiving ingredients in different stages of preparation, storage, cleaning, cutting, weighing, blending, cooking, holding, serving, disposing of leftovers, recycling, cooling and re-heating. Home cooks and caterers use more extensive food handling techniques than operatives in food manufacturing plants. Like caterers, home cooks deal with a wide range of products, they lack standardised methods, there is a frequent mismatch of equipment capacity and production is batch rather than continuous. Food safety control in such complex food handling systems presents a formidable challenge and means that it is more difficult and complex to apply HACCP to the catering industry and the home than to the food manufacturing industry.

Bryan (1988) has reviewed the most common hazards observed during the preparation of raw meats and poultry, of salad preparation, of cooking, hot-holding and cooling processes in catering operations. It seems reasonable to suppose that similar hazardous practices will be revealed in the domestic home. This seems to be supported by information on food handling methods in the home, supplied by respondents to questionnaires (Beckers, 1983; Jones and Weimer, 1977).

1.11 The HACCP approach in the home

Any food operation, large or small, is amenable to HACCP. The ICMSF (1988) and the World Health Organisation (1982) have suggested that the system can be applied to the whole of the food chain including the home of the food consumer.

When selecting places to implement HACCP systems, CCDAM (1991) advocates establishing priorities by reference to epidemiological data. High priority should be given to places where outbreaks of food poisoning have occurred and to those preparing the kinds of foods commonly implicated as food poisoning vehicles. Risk factors such as the volume of food prepared and the susceptibility of consumers to food poisoning should also be taken into account. Using these criteria it would be appropriate to conduct HACCP analyses in domestic homes. Paradoxically, these would be the places where HACCP would be most difficult to apply. Homes are private and no government department has direct authority to dictate how food is handled, prepared, stored or consumed. Difficulties may be experienced in gaining access to private households to undertake detailed HACCP analyses.

HACCP analyses can make considerable demands on time and resources and it may not be appropriate to apply full-scale HACCP procedures to catering and domestic food operations (Richmond, 1991). Bryan (1992) believes that, although there may be substantial variation in food preparation practices in individual homes, there is considerable uniformity within different groups of a society. He suggests that the HACCP approach can be used to obtain information about hazards associated with preparation and storage of foods in homes, to assess risks and to identify critical control points. The data arising from such analyses can then be generalised and used in health education campaigns.

Bryan *et al.* (1988) have undertaken feasibility studies in a small number of the homes of Peruvian Indians and migrants. The HACCP analyses consisted of watching all steps of preparation, recording temperatures throughout all of these steps and collecting samples of food and testing them for common food poisoning pathogens and indicator organisms. In these homes they identified cooking, holding between cooking and serving, and re-heating as critical control points (CCPs). Simple, practical monitoring techniques were advocated such as checking that food was cooked at prescribed temperatures for exact times, checking that liquids boil during cooking and re-heating and restricting the use of leftovers.

In these peasant homes in developing countries, food preparation practices were simple. The range of foods was very limited, the equipment was basic and eating patterns were traditional. It may be expected that HACCP analyses undertaken in homes in the UK would be much more complex.

Beddows (1983) applied a HACCP approach to the preparation and handling of cooked chickens in the home. Analysis of the responses of housewives to a questionnaire enabled her to identify the critical control points in the preparation and cooking of chicken that would allow contamination, survival or growth of salmonellae.

Beard (1991) identified eight critical control points after interviewing 50 consumers in North America and produced some guidance for the domestic food handler, which he claims was based on HACCP principles.

1.12 The problem

Foodborne disease has shown a dramatic increase in the last decade. The surveillance statistics show that many food poisoning cases occur in the home and surveys of the public have revealed wide spread ignorance of cross-contamination, temperature control and the aetiology of food poisoning. Educators have responded by targeting domestic food handlers with food safety leaflets. The assumption was made that if people are informed about the basic mechanisms of food poisoning this will help to eradicate poor hygiene. Whilst some incidents of foodborne disease may be due to ignorance of the facts, others may result from the failure to apply already well-known principles. Effective education must be based on knowledge and understanding of people's prevailing beliefs and practices. Food safety educators need to know if people behave as they report and why people behave as they do. They need to take account of people's motivations and explore the resistances, barriers and constraints on change. Information on the hygiene of domestic kitchens and food handling practices in the home is very limited.

An investigation of food handling in the home, using direct observation would assist our knowledge and understanding of prevailing practices and the context in which they are conducted.

1.13 Aims

The aims of this study were to:

1. assess the hygiene of the domestic kitchen
2. evaluate the hygiene of domestic food preparation practices
3. formulate recommendations for improving food hygiene in the home.

The objectives were to:

1. devise a domestic kitchen hygiene check-list
2. conduct inspections of domestic kitchens to assess levels of hygiene
3. determine standards of kitchen cleanliness using adenosine triphosphate (ATP) bioluminescence assay
4. select suitable recipes for preparation by domestic subjects and analyse these, using a HACCP approach for risks and hazards
5. determine the critical control points in these recipes and establish control measures
6. verify that the HACCP system was working by microbiological analysis of the end product
7. define a standard for the preparation of each recipe against which the performance of subjects could be measured
8. construct recipe preparation check-lists based on the HACCP analyses and devise a method of scoring the food preparation practices of the subjects
9. assess the hygiene of food preparation practices in the home by direct observation, using the check-lists and measuring temperatures of foods during preparation and storage

10. design a questionnaire to cover aspects of food handling not open to direct observation
11. conduct structured interviews with the subjects using the questionnaire
12. analyse and interpret the data derived from the observations and interviews
13. develop recommendations for improving the standard of kitchen hygiene and cleanliness and the methods of food handling in the home.

CHAPTER 2. ASSESSMENT OF KITCHEN HYGIENE

'Kitchen hygiene has to be
the final line of defence'

R. J. Gilbert, Director
Food Hygiene Laboratory
Central Public Health Laboratory
1987

2. Assessment of Kitchen Hygiene

2.1 Introduction

The design and layout of the domestic kitchen may affect the standard of food hygiene that can be achieved. Information on conditions conducive to cross-contamination and the adequacy of food storage, preparation and cooking facilities is required if a comprehensive evaluation of food preparation practices in the home is to be made.

Audit schedules have been devised for hospital catering units (Aston, 1987) and for restaurant groups (Harvester, 1990) but no kitchen inspection schedules are available for the home. The aim was to devise a check-list which could be used to detect conditions that might jeopardise the safety of food stored and prepared in domestic kitchens. In the absence of legal domestic standards, reference was made to the Food Hygiene (General) Regulations 1970, the Food Hygiene (Amendment) Regulations 1990 and 1991 and the Code of Practice No. 9: Food Hygiene Inspections (1991). A kitchen hygiene check-list for the home was developed (Appendix 1). The practicality of using the check-list as a measurement instrument, such as access to specific equipment and appliances, and the time involved for completion would be assessed with the intention of developing a schedule that could be used during the home visit when food was to be prepared.

2.2 Method

The participants were recruited for a free kitchen appliance check by home economists at a consumer advice centre in a large supermarket in South Wales. The hygiene inspection was conducted during the course of the home visit. Fifty six domestic kitchens were examined.

2.3 Results

The main findings of the study are presented in the following tables and figures.

Table 2.1 Participant profile

Sex	**Percentage**
Female	100
Age	**Percentage**
16-34	21
35-54	52
54+	27
Social Group*	**Percentage**
A/B	21
C1	21
C2	15
D	9
E	34

* According to The Market Research Society (1991)

Table 2.2 Kitchen design and layout

	Percentage
Access.	
Door to garden	45
Walls	
Tiled behind cooker, sink and work surface	80
Floor	
Carpeted	45
Ventilation	
Extract fan, cooker hood	50
Work surface	
Two or more working areas	80
Surface finish smooth	50
Sink	
One sink	80
Made from stainless steel	70

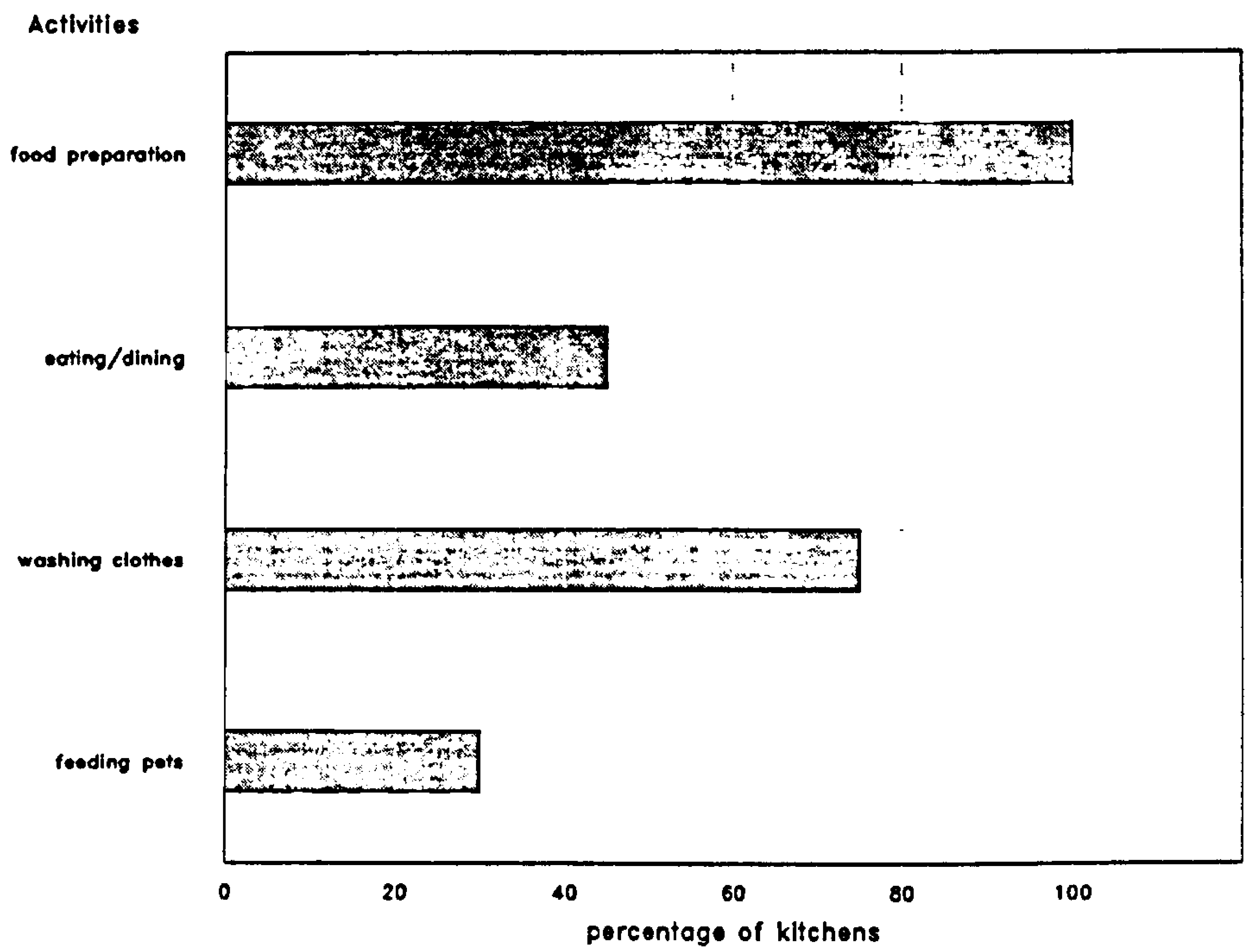


Fig.2.1 Activities in Kitchens

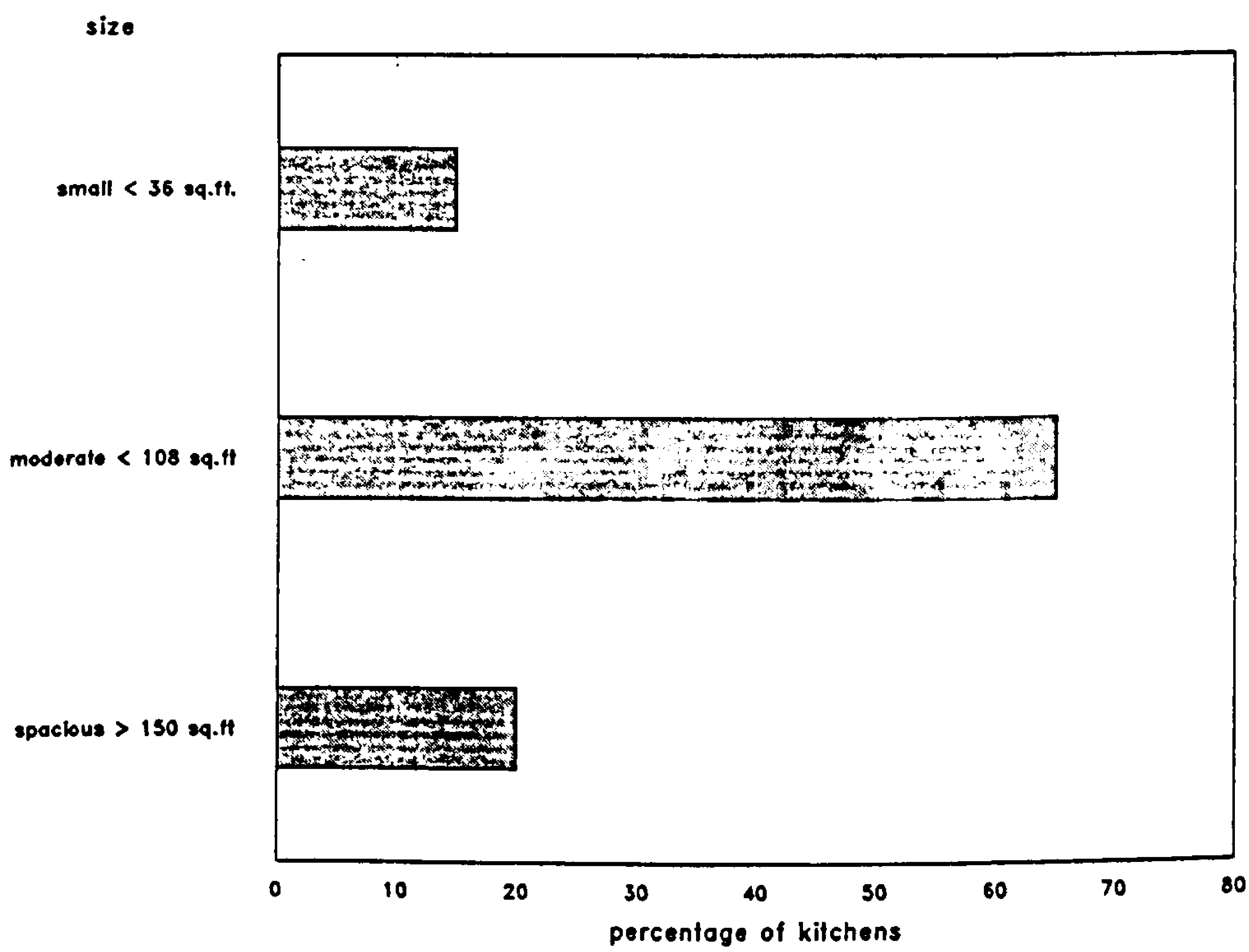


Fig.2.2 Kitchen Size

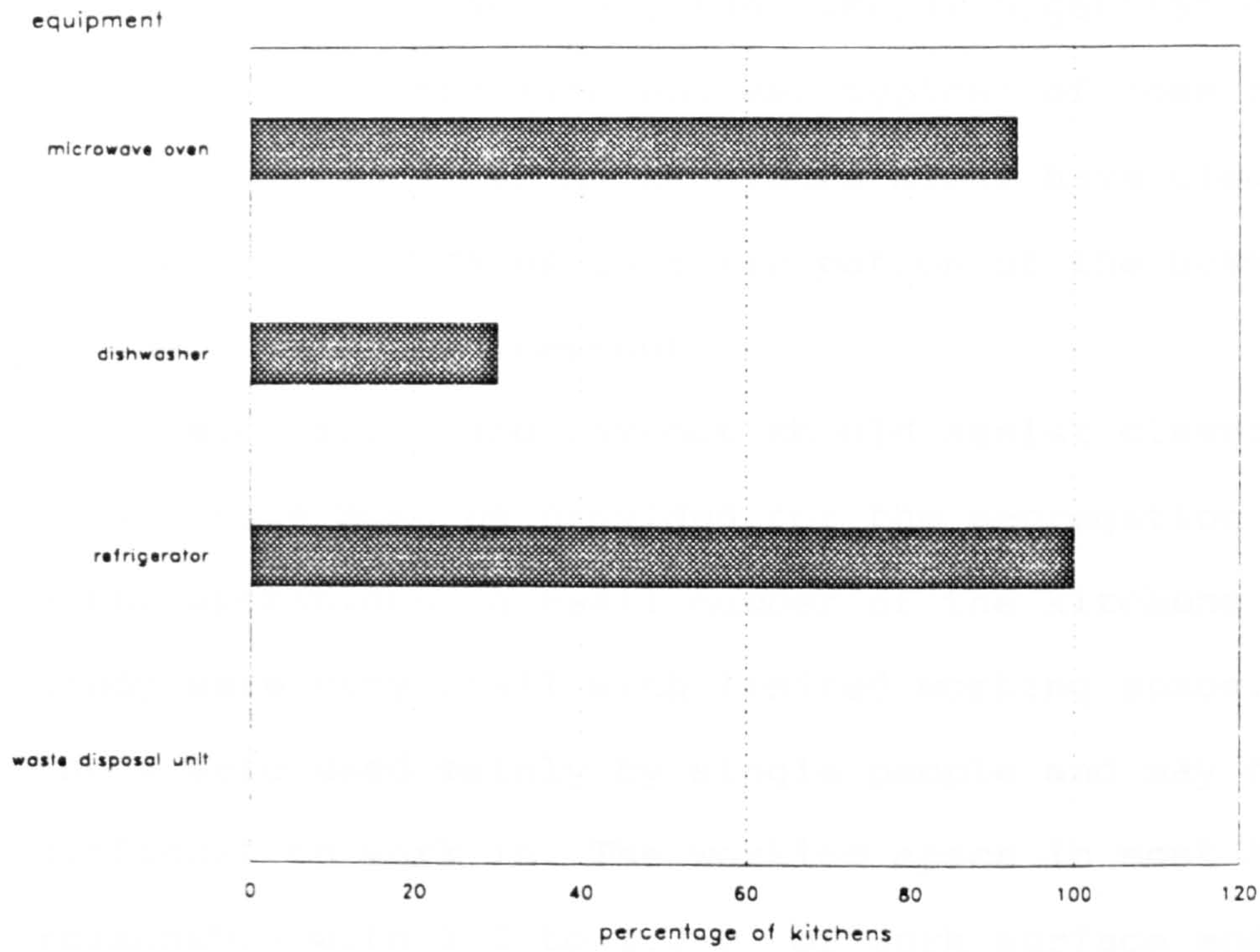


Fig. 2.3 Kitchen equipment

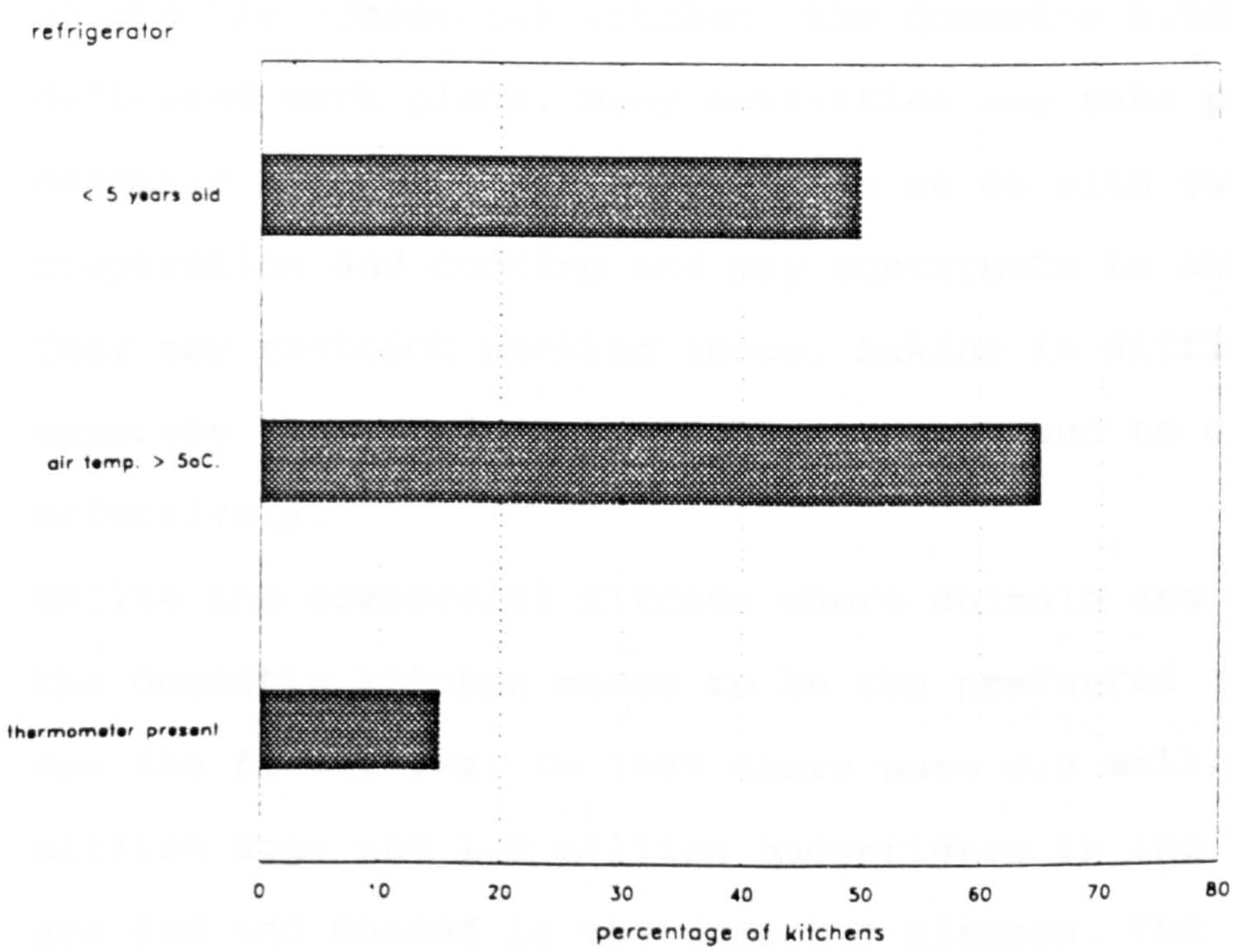


Fig. 2.4 Refrigerated storage

2.4 Discussion

Participants were aware that selected kitchen appliances would be examined during the home visit but were unaware that a visual hygiene inspection would be conducted at the same time. It was assumed that the general organisation and cleanliness of the kitchens was typical of some people's normal regime. Other householders might have cleaned and tidied their kitchens in anticipation of the home visit.

Kitchen Design and Lay-out

The basic design and lay-out should assist cleaning and work flow. Space must be provided for the segregation of clean and dirty operations. A small number of the kitchens in this study were very small with limited working space. However these were used mainly by single people and may not have been difficult to work in. The working space in most kitchens was reasonable with 1.2 to 1.8 m. of work surface and passage space between cooker, sink and preparation surfaces. However, unlike the commercial kitchen, the domestic kitchen is not a dedicated work place. Many activities may take place in the domestic kitchen which have little to do with food preparation and cooking and may contribute to contamination. They may restrict working space, making it difficult to separate clean and dirty food processes and to clean effectively.

Unlike the commercial kitchen where animals are denied access the domestic kitchen seems to be the preferred accommodation for the family pet. In 1989 there were 6.9 million cats, 7.4 million dogs and 1.9 million budgerigars in the UK. Many pets are fed and housed in the domestic kitchen. The presence of uncovered feeding bowls, the possibility of animals gaining access to the work surfaces, contamination of surfaces with hair and the handling of animal food which may not be fit for human consumption are all issues of concern.

Kitchens in many smaller homes have to function as the laundry. Dirty washing may be sorted in the food preparation environment prior to washing. The study by Burn (1971) on napkin hygiene in the home revealed that some mothers placed nappy buckets on kitchen surfaces and poured soiled soak water down the sink.

The kitchen may be more difficult to clean if it is used as a dining room. Jay (1987), a kitchen planning consultant, claims that over 90% of the kitchens she designs have a place to sit and eat. It was observed that kitchen-diners were usually decorated more elaborately than single function rooms. They tended to have curtains rather than blinds, carpet rather than vinyl flooring and wallpaper rather than tiles, all of which are more difficult to keep clean.

All the kitchens surveyed had plastic laminated work surfaces. Most of these (80%) were separated into at least two distinct areas. This would enable the home cook to process raw and cooked foods in separate areas, thereby reducing the risk of cross-contamination. Work surfaces in the food industry are made from stainless steel, a material which is more durable and easier to clean than plastic laminate especially when this has a textured finish. The condition of the work surface was very variable, with some work surfaces badly scored, suggesting that they had been used directly for chopping or cutting food. Not unexpectedly, the areas of greatest wear were located near to the sink and cooker.

Few of the kitchens in this survey had more than one sink. This may have to be used for hand, dish and clothes washing and for food preparation. The risk of contaminating adjacent surfaces like the draining board may be quite high. The position, shape and finish of many taps would seem to make cleaning difficult.

Kitchen equipment

A dishwasher was found in 30% of homes but no waste disposal machines were observed in any of the homes visited.

All of the homes possessed a separate refrigerator or fridge/freezer. The shape, size and arrangement of kitchen furniture meant that some refrigerators and/or freezers had to be located next to a heat source such as the stove or a radiator or near to the window.

Many domestic homes had only one general purpose chopping board. It was usually made from wood or plastic laminate, which cannot be put in the dishwasher. Many of the laminated boards were very worn and scored. Polypropylene and ceramic boards were found in 30% of kitchens.

Food Storage

Most (90%) of the homes were centrally heated, yet the majority lacked a food larder. Larders were only found in older properties. The lack of a larder means that, in some households, storage space in the refrigerator was very over-crowded. Scarce chilled storage space has to be used for a wide range of products which would spoil quickly if held at ambient temperature. The storage of soiled vegetables which may be a source of food poisoning organisms, appears to be a particular problem in some modern homes. There are few places in the home which are sufficiently cool and ventilated to store them in good condition. There is also a lack of adequate cooling facilities for cooked food that is awaiting refrigeration. Safe thawing of frozen food in some homes presents problems. Refrigerators may be too crowded to permit thawing of frozen food but kitchen temperatures are too high to be considered safe for defrosting food.

Refrigerators

Half of the homes had refrigerators which were less than five years old. Some appliances however were very old, with the oldest being twenty three years old and still, apparently in good working order. The refrigerators did not seem to show many obvious signs of age such as rust, cabinet damage or defective seals. A large number (66%) were found to be operating at a temperature higher than recommended for safe food storage. The mean refrigerator air temperature was 8.5^{o}C, with a minority of appliances operating between 10-12^{o}C. These temperatures are higher than those reported by Evans *et al.* (1991).

There are a number of sources of error when taking spot checks of the air temperature of refrigerators. The temperature cycles in response to the temperature control mechanism. The cycling may be as small as 0.5^{o}C but can be as much as 5^{o}C. The number, and length of door openings and the amount, temperature and position of food products have been shown to have a considerable effect on the air temperature that is recorded. It is difficult to locate the areas of maximum and minimum temperature because they can be in a different position in different refrigerators. Within an appliance, the position of maximum temperature can also change with the loading.

Rubbish storage

In none of the kitchens surveyed was rubbish stored in open bins. Bins were covered and bin-liners were used in 70% of homes. Half of the bins observed had a foot-operated lid whilst the remainder had a flap lid operated by hand, which might result in hand contamination.

2.5 Conclusion

The check-list enabled information on the design and lay-out of the domestic kitchen and the provision of facilities and equipment to be gathered and an assessment of conditions conducive to cross-contamination and the adequacy of food storage facilities to be made. However the check-list contained too many items to be completed in the time allocated to the home visit. A reduction in the number of items was justified given that completion of a kitchen hygiene check-list will be only one of a number of activities to be undertaken in the main study.

Items were retained or rejected on the strength of their likely direct relationship with contamination in the kitchen. The more tenuous the relationship, the more readily they were discarded.

Examples of items removed from check-list were: cleanliness of walls, ceiling and the standard of lighting.

Items were also rejected if they proved difficult to examine unobtrusively. Examples included: cleanliness of storage cupboards, condition of refrigerator door seals, extent of ice accumulation in the refrigerator.

Additional items were included as a result of the study. These included the provision of materials for handwashing such as soap, nailbrush and separate towel and the provision of disposable paper towel used for cleaning and drying.

In this pilot study it was not possible to determine whether people worked hygienically in their kitchens. Those with a hygienic environment might have limited appreciation of food safety principles. Conversely, a kitchen which appeared poorly maintained and sanitised might offer little risk to food safety.

CHAPTER 3. ASSESSMENT OF KITCHEN CLEANLINESS

'...it should be remembered that,
just as it is possible to avoid
food poisoning in a bad kitchen,
it is possible for it to arise
from faulty hygiene in the
most suitable premises'

DHSS
The Report of the Committee of Inquiry
into the Outbreak of Food Poisoning
at Stanley Royd Hospital
1986

3. Assessment of kitchen cleanliness

3.1 Introduction

Domestic kitchens, unlike their commercial equivalents are not open for hygiene inspections, so little information is available on standards of cleanliness. The bacterial flora of the domestic kitchen has been the focus of a number of investigations. A survey of 21 homes conducted by Finch *et al.* (1978) and a larger study by Scott *et al.* (1982) showed similar patterns of bacterial contamination. More than 80% of homes were contaminated with enterobacteria, a group which contains pathogenic species. Other pathogens isolated in these surveys included *Staphylococcus aureus, Bacillus cereus, Streptococcus sp.* and *Aeromonas hydrophila*. High levels of contamination were found mostly in sinks, washing machines, dishcloths, cleaning cloths, vegetable racks and on the floor.

Although improper cleaning of equipment/utensils comes low on the list of reported factors contributing to outbreaks of food poisoning (responsible for only 3.8% of all American outbreaks and 0.3% family outbreaks), the potential risks are high (Bryan, 1988).

It is not easy to demonstrate whether or not the levels of contamination found in the domestic environment represent an infection hazard to the average family member. However, cross-contamination of foods was one of the ten most common factors contributing to outbreaks of food poisoning noted by Hobbs and Roberts (1987) and the transfer of bacteria to different surfaces by dirty cloths is well documented (Gilbert, 1969; Davis *et al.*, 1968; Tebbutt, 1986).

Raw foods are known to be a particularly good source of micro-organisms and the soiling of both surfaces and equipment is unavoidable during the production of cooked food. It is important to prevent the accumulation of food soil to a level which might expose other foods and finished products to a risk of contamination. The development of this soil which includes food residues, foreign matter and micro-organisms can be controlled by cleaning and disinfection. Scott and Bloomfield (1990) have shown that microbial survival times on soiled surfaces range from 4 hours to 24 hours. Survival is enhanced if the contaminated surface is soiled and wet. There is evidence that multiplication of some species can take place on these contaminated surfaces and that sufficient numbers can be transferred onto food, to represent a potential hazard to food safety.

Hygiene monitoring of the food production environment has traditionally placed reliance upon the enumeration of micro-organisms present on surfaces using viable count techniques. A rapid technique, using adenosine triphosphate (ATP) bioluminescence assay can now be used to measure surface soiling. This method marketed by several companies, including Biotrace, is based on the detection of ATP, a high energy compound present in all living cells. The amount of ATP present in a sample can be related to the level of cells present. The technique is able to detect ATP derived from micro-organisms, food residues and humans.

The protocol involves swabbing a surface, releasing the ATP from the cells by means of a cationic detergent and then adding a luciferase-luciferin reagent. In the presence of ATP, light is emitted which can be detected by a luminometer. A digital display of relative light units is given.

It is possible to detect less than 0.1 picograms ($1pg=10^{-12}g$) of ATP using this technique.
A claimed advantage of using ATP detection rather than counting micro-organisms is that a measure of the surface contamination with food and other debris, in addition to the microbial contaminants, can be made. Effective sanitation techniques should remove all organic residues, thereby depriving microbial contaminants of an available food source.
A preliminary study was undertaken to assess the extent of soiling and the effectiveness of routine cleaning in domestic kitchens using the Biotrace M3 Hygiene Monitor. The ATP bioluminescence assay technique was assessed for use in the HACCP analyses with the intention of determining the contamination hazard resulting from improper cleaning.

3.2 Method

Five surfaces in the kitchen were selected for investigation. These were: the work surface adjacent to the cooker, the draining board, the hot water tap, the chopping board and the refrigerator handle. The surfaces were chosen because they are present in almost all kitchens and they represent either direct food contact surfaces or hand contact surfaces that present a potential cross-contamination hazard if not correctly sanitised.
A 10 cm^2 area was sampled from five test surfaces and the swabs were processed using the Biotrace Hygiene Monitor.

'Clean' Reference ATP Levels

In order to establish reference levels for these surfaces which have been subjected to routine cleaning, 10 subjects were asked to clean their kitchen according to their normal practice, after which swabs were taken and processed using the Biotrace Hygiene Monitor.

'Rigorous Clean' Reference ATP Levels

The researcher then re-cleaned and disinfected the surfaces with a sanitiser. They were dried with paper towel and were then re-swabbed. The ATP readings were taken to represent a high standard of cleanliness of these surfaces.

The kitchens used for establishing these reference levels provided a representative range of construction materials and were also subjected to a variety of soils. They varied in age from two to thirty years old. The work surfaces were all plastic laminate but included smooth and textured finishes. Taps and refrigerator handles varied in shape and finish. Sink drainers were made from stainless steel, enamel, and synthetic materials, such as Corion by Du Pont and Asterite by ICI. Chopping boards were ceramic or made from wood, polypropylene or melamine.

The sample

The kitchens of 47 people who had applied to have their kitchen appliances tested for safety were subjected to a hygiene assessment. They were told that a hygiene check would be conducted at the same time as the safety test but were not informed how this would be done or which areas would be assessed. Before swabs were taken, participants were asked to confirm that they would be willing to undertake food preparation in the kitchen without further cleaning.

The readings obtained from the kitchens of the sample of the public were compared to the 'clean' and 'rigorous clean' reference levels.

3.3 Results

Clean and rigorous clean reference ATP levels are given in Table 3.1 and 3.2. ATP readings for surfaces in the kitchens investigated are given in Table 3.3.

Table 3.1 **ATP levels on cleaned kitchen surfaces. 'Clean' Reference Levels**

Surface	Mean	Std. Dev.	Minimum	Maximum
Work surface	336	279	15	802
Board	813	1893	16	5813
Tap	86	89	12	327
Drainer	621	1411	2	4500
Refrigerator handle	171	112	48	441
Luminometer reading (relative light units)				

Sample size = 10

Table 3.2 **ATP levels on cleaned kitchen surfaces. 'Rigorous Clean' Reference Levels**

Surface	Mean	Std. Dev.	Minimum	Maximum
Work surface	128	161	0	486
Board	114	167	8	461
Tap	27	28	0	100
Drainer	154	299	0	975
Refrigerator handle	58	56	2	185
Luminometer reading (relative light units)				

Sample size = 10

Table 3.3 **ATP levels on kitchen surfaces**

Surface	Mean	Std. Dev.	Minimum	Maximum
Work surface	768	1596	14	9821
Board	835	1837	0	10234
Tap	1081	1876	6	11062
Drainer	3339	15388	13	103490
Refrigerator handle	1019	1209	2	4995
Luminometer reading (relative light units)				

Sample size = 47

The readings obtained from the kitchens were compared to the 'rigorous clean' reference levels and are shown in Table 3.4.

Table 3.4 Comparison of ATP levels on kitchen surfaces with 'rigorous clean'(Table 3.2) reference ATP levels

Surface	The percentage of surfaces which exceeded the maximum 'rigorous clean' reference ATP level
Work surface	37%
Drainer	24%
Board	29%
Tap	85%
Refrigerator Handle	83%
Surface	**The percentage of surfaces which exceeded the mean 'rigorous clean' ATP reference level**
Work surface	70%
Drainer	52%
Board	57%
Tap	98%
Refrigerator Handle	98%

The readings obtained from the kitchens were then compared to the 'clean' reference levels (Table 3.1) and are shown in Table 3.5.

Table 3.5 Comparison of ATP levels on kitchen surfaces with 'clean'(Table 3.1) reference ATP levels.

Surface	The percentage of surfaces which exceeded the maximum 'clean' reference ATP level
Work surface	22%
Drainer	9%
Board	2%
Tap	55%
Refrigerator handle	64%
Surface	**The percentage of surfaces which exceeded the mean 'clean' ATP reference level**
Work surface	46%
Drainer	30%
Board	19%
Tap	87%
Refrigerator handle	85%

3.4 Discussion

The results show that a high percentage of ATP readings from the kitchen surfaces exceeded the reference levels obtained when equivalent surfaces were cleaned using recommended sanitation techniques. The ATP levels of work surfaces, taps and refrigerator handles were significantly higher than the 'rigorous clean' reference levels ($P < 0.01$).

The high ATP readings obtained from many kitchen surfaces indicated fairly extensive soiling. This suggests either low standards of cleaning or the prevalence of conditions, between cleaning episodes, conducive to contamination or perhaps a combination of both. The ATP detected might have originated from viable micro-organisms, product debris or from the food handler. The presence of free ATP may be of no immediate microbiological significance but indicates that soil remains attached to the surface providing a source of nutrients for micro-organisms. The breakdown of ATP from damaged food cells probably occurs fairly rapidly.

The 'rigorous clean' reference ATP levels were obtained from swabs taken immediately after cleaning had taken place. There was, therefore, little opportunity for further contamination with ATP from food, bacteria or the food handler. The kitchens in the study had been cleaned after the last episode of food preparation and in some cases many hours had elapsed since the last clean-down. Whilst the use of chopping boards, sink drainers and work surfaces is likely to be linked to food preparation, refrigerator handles and taps may be subjected to repeated use throughout the day. Much of the reading might therefore represent hand ATP although the possibility that it represents hand microbial flora cannot be ignored. Staphylococci can be isolated from the hands of 14-

44% of persons (Hobbs and Roberts, 1987). Most of the participants stated that cleaning normally took place at the end of food preparation whereas expert opinion would encourage the de-contamination of surfaces before and after food preparation.

Scott *et al.* (1984) have found that the effect of bleach and phenolic disinfectants on kitchen surfaces was relatively short-lived, with contamination levels only slightly less 3-6 hours after disinfection, than the levels before treatment. When the test surfaces were re-cleaned with a quaternary ammonium sanitiser (QAC), lower levels of ATP were recorded on all surfaces (Table 1) with the reduction on taps, refrigerator handles and the work surface being significant ($P < 0.05$). There was a possibility that the use of a terminal disinfectant might have quenched the light emitted in the reaction. However, the manufacturers of the Biotrace system suggest that the use of QAC disinfectants is compatible with the chemicals employed.

The ATP levels for work surfaces, drainers and boards in the kitchens were similar to the 'clean' reference levels, but the levels for taps and refrigerator handles were significantly higher ($P < 0.005$). Participants and subjects who had cleaned their kitchen on request volunteered the information that taps and refrigerator handles receive less regular cleaning attention than boards and work surfaces. These surfaces were considered difficult to clean effectively. Tebbutt and Midwood (1990) using the same technique, found high levels of ATP on some of the door plates and refrigerator handles in hospital kitchens.

Using conventional viable count techniques Scott *et al.* (1982) found high levels of contamination (a count of more than 100 colonies per 25 cm^2 contact plate) on 38% of drainers, but on only 6.3% of tap handles and 2.4% of work surfaces and chopping boards. These lower results may reflect the difficulty of sampling some surfaces with contact plates. In the bacteriological survey of commercial kitchens undertaken by Mendes *et al.* (1978), 75% of drainers, 40% of work surfaces, 51% of hot water taps, 39% of refrigerator handles and 65% of chopping blocks were contaminated by coliforms.

Thompson (1989) has shown a correlation of 87% between the rapid ATP method and the total count Millipore method. However, Tebbutt and Midwood (1990) found a good correlation between ATP levels and viable counts on some surfaces but not on others. Poulis *et al.* (1993) have recently reported that ATP measurements in a food factory did not relate directly to numbers of viable micro-organisms detected by conventional methods. They observed that their experiments were conducted with a highly mixed microbial population in the potential presence of non-microbial ATP.

The small size of bacteria means that relatively large numbers must be present before detection by bioluminescence is possible. At least 10,000 bacteria are needed to register a reading on the luminometer (Tebbutt and Midwood, 1990). It would be difficult to detect bacterial spores because they contain low amounts of ATP, which is very difficult to extract.

The subjects who cleaned their kitchen surfaces to provide the 'clean' ATP reference levels used a variety of cleaning chemicals, including washing-up detergent, multi-surface liquid cleaners, cream cleaners and sanitisers, for a 'normal clean'. They were applied with cotton dishcloths, sponges or disposable cellulose cloths. The disposable cloths could have been in use from one to seven days. Surfaces were rarely dried after cleaning.

The most popular cleaning method for hard kitchen surfaces was wiping with cloths immersed in hot water and detergent. Some claimed routine wiping of kitchen surfaces at the end of a period of manual dishwashing, with soiled dishwater.

Scott *et al.* (1984) have shown that cleaning with hot water and detergent produced no observable reduction in microbial contamination of hard surfaces in kitchens. Detergent washing of cloths was not very effective if the cloths were then allowed to remain wet, as surviving microbes subsequently multiplied.

The average age of disposable dishcloths was claimed to be three days, but some subjects were very vague about cloth life, and the suspicion remains that cloths might have a longer life than given. Cotton dishcloths were more popular than cellulose cloths. There seems to be considerable variation in the frequency and method of disinfection of these items.

This investigation revealed a wide range of ATP readings from the five selected surfaces in the kitchens. Given that the surfaces differed in age, wear and construction and were cleaned with different materials by different people, it is perhaps not surprising that this wide range of ATP readings was obtained. The type of food processed in the kitchen, the frequency of cleaning, its timing in relation to episodes of food preparation and the conditions between cleaning operations are other variables which could contribute to the wide spread of ATP readings. The high ATP readings obtained from many kitchen surfaces indicated fairly extensive soiling, yet all subjects had confirmed that they considered the kitchen sufficiently clean for food preparation. The soiling may be the result of ineffective cleaning rather than a failure to clean and could be substantially reduced by using recommended cleaning methods.

ATP detection has a place in monitoring cleaning standards in food premises. The decision not to use it in the domestic HACCP analyses was taken on these grounds:

1. The samples must be processed without delay, otherwise the amount of ATP diminishes. This fact will influence when samples can be taken. It was estimated that observations for the HACCP analyses would take about one to two hours. It would be inappropriate to delay taking samples until the end of the observation period when they could be processed and yet it would not be possible to process the samples whilst conducting the observations.

2. The taking of samples at critical control points during the preparation process was found to be intrusive and disruptive.

3. Difficulty was experienced in determining optimum sampling points and times. For example, there was uncertainty about when tap handles should be sampled, either immediately after contamination or later in the process when they might be touched prior to handling cooked produce.

4. The technique is not suitable for soft surfaces such as dishcloths, which play an important role in cross-contamination.

5. Extensive work would be required to establish cleanliness standards for the variety of materials used in the construction of equipment and surfaces in domestic kitchens.

The decision was therefore made to evaluate the effectiveness of cleaning and disinfecting equipment, food or hand contact surfaces by undertaking observations of the cleaning procedures and examining the appearance of equipment, surfaces and cleaning materials. It is recognised that visual observations of cleanliness lack the accuracy of microbiological counts or ATP measurements (Tebbutt and Midwood, 1990). This technique has, however, been used by others, (Bryan 1990) when conducting HACCP analyses in catering operations.

CHAPTER 4. METHODS

'HACCP is all about doing.
In fact HACCP is much easier to
do than to read or write about'

Bob. Mitchell
Head of Microbiology Branch
Food Safety Directorate
Ministry of Agriculture, Fisheries and Food
1992

4. Methods

4.1 Introduction

Previous research on food safety in the home has been based mainly upon interviews and questionnaires. A limited number of studies employing direct observations of domestic food handling, have been conducted in third world countries, using very small samples (Bryan 1988). The over-dependence upon a survey approach may have distorted the view we have of domestic food handling behaviour. Many social researchers believe that subjects under investigation tell researchers what they think they want to hear or what they want them to know (Douglas, 1976). In other words, they may say one thing and do something else.

In order to overcome the obstacles to truth and the problems of interpretation and verification inherent in the survey approach, the technique of direct observation was used to collect data on the behaviour of subjects in their homes. The observation of food handling practices was guided by the hazard analyses that were conducted on the selected recipes prepared by the researcher. Observations were systematically recorded by means of an observation check-list. A semi-structured interview was conducted with each subject to elicit information not accessible by observation.

One of the limitations of this type of approach to data collection is that it restricts the number of cases studied, and therefore the representativeness of the findings may be subject to doubt.

4.2 Recruitment

Gaining access to private homes was an essential prerequisite for the research to be conducted. Burgess (1984) emphasises the importance of initial contacts in influencing the ways in which those who are to be researched define the research and the activities of the researcher. Access will also influence the reliability and the validity of the data that are obtained. The original intention was to recruit all subjects from visitors to a supermarket consumer advice centre. The main advantage of this recruitment strategy was that the researcher would have direct access to members of the quota sample recruited by the centre's market researchers to participate in taste panels. Access would also be provided to members of a large healthy eating group, established by the centre in the previous year. By the time the phase of active recruitment was due to start, the healthy eating group was not running and attempts to recruit members of the public in the advice centre met with limited success. The researcher was more successful when given the opportunity to address audiences in the centre who were attending cookery demonstrations or presentations on healthy eating. A change in the organisation of the centre soon resulted in the cessation of these sessions. The researcher then extended the opportunities of addressing audiences of potential recruits by giving talks on healthy eating to groups such as the Women's Institute (WI), church groups and retirement groups. Recruitment was also conducted regularly in the coffee shop of a local community centre which had a creche and health centre attached.

Purposive sampling of subjects with a routine responsibility for food preparation in the home was undertaken. An attempt was made to recruit across the age range and over a geographical range of three counties, included rural and urban locations. Recruits were informed that they would be observed during the course of the preparation of the recipe and that an observation check-list would be completed by the researcher. They were guided to believe that the researcher was interested in the evaluation of healthy eating recipes. If the subjects were aware of the intentions of the researcher it was felt that it would be impossible to obtain access and that subjects might act in a way so as to please the researcher. In order to reduce the demand effect, the use of a mis-directed experimental approach was felt to be ethically defensible.

Subjects were invited to select one of the four recipes. Arrangements were made with them to collect the ingredients and a data logger from the nearest supermarket. The researcher later conducted direct observations of the food preparation of the recipe in the home of the subject. During the course of the preparation the observation schedule and the kitchen and personal hygiene check-lists were completed and temperature measurements were made. The subject was interviewed and the questionnaire completed. The subject was provided with a gift voucher at the end of the session.

In order to gain additional information on re-heating methods based on direct observation rather than interview responses, 19 subjects who had taken part in the investigation were invited to re-heat a chilled version of the recipe and to evaluate it.

4.3 The Recipes

The decision to use recipes which could be described as 'healthy eating' was taken because recruitment was to be centred in the supermarket advice centre. This actively promotes healthy eating and provides free recipe leaflets for the public. Recruits were told that they would be observed during the preparation of a healthy eating recipe and would be asked to evaluate it on the clarity of the directions and the quality of the end product. Discussion with members of the public who visited the centre and with the market researchers who selected them, suggested that if subjects were aware of the true nature of the exercise they might be reluctant to participate or might modify their work procedures to create a favourable impression on the researcher.

The recipes were selected according to the following criteria:

1. the ingredients should include those commonly implicated in food poisoning
2. microbiological specifications of ingredients should be available
3. the recipe should include perishable ingredients which require correct storage
4. the ingredients should be widely available all year from major supermarkets
5. the ingredients should not be too expensive
6. excessive demands on the cook in terms of time, experience or equipment should not be made
7. the recipe should involve handling techniques which are potentially hazardous unless executed correctly

8. the recipe should involve some element of judgement about length of cooking period and about appropriate hygienic handling techniques

9. the recipe should be sufficiently appealing to engage the interest of participants.

The four recipes (Figs. 4.1, 4.2, 4.3, 4.4) were designed, prepared and evaluated; where necessary, modifications were made. Recipe directions were produced which would allow the user some freedom of interpretation.

Fig. 4.1 Recipe 1 (Chicken Surprise)

Chicken Surprise

Serves 2

Ingredients

1 tablespoon (1 x 15ml spoon) sunflower oil
7 oz (175 g) chicken breast, skinned and cubed
1 small onion, chopped
5 oz (125 g) mushrooms, sliced
1 clove of garlic, crushed
1.5 oz (37 g) plain flour
3/4 pint (375 ml) skimmed milk
2 teaspoons (5ml spoon) chopped parsley
4oz (100 g) lean ham, chopped
Salt and pepper

Method

1. Heat the oil, and fry the onion and garlic together for 3-4 minutes. Remove from the pan.
2. Add the chicken to the pan and fry until sealed.
3. Add the mushrooms and fry until the chicken and mushrooms are cooked.
4. Return the onion and garlic to the pan and add the flour stirring over a low heat for 1 minute.
5. Gradually add the milk, bring to the boil and simmer for 1 minute or until the sauce has thickened.
6. Add the parsley and ham and cook for one minute.
7. Season to taste.
8. Serve with wholemeal pasta and a mixed salad.

Fig. 4.2 Recipe 2 (Mexican Beef)

Mexican Beef

Serves 2

Ingredients

7 oz (175 g) spaghetti or rice
4 oz (100 g) lean minced beef
4 oz (100 g) chicken livers, chopped small
2 slices of streaky bacon, chopped small
1 tablespoon oil
1 small onion, finely chopped
1 red pepper, finely chopped
1 large clove of garlic, crushed
1 medium carrot, grated
1 heaped tablespoon tomato puree
2 tablespoons dry cider
1/2 teaspoon mild chilli powder
1 dessertspoon fresh chopped parsley
Small tin of chopped tomatoes
Salt
Grated Parmesan Cheese

Method

1. Heat the oil in a thick-based saucepan. Add the onion, chopped pepper, garlic, and bacon and cook for about 5 minutes until the vegetables start softening.
2. Turn up the heat, add the chicken livers and mince and brown them.
3. Pour in the chopped tomatoes, together with the tomato puree, cider, chilli powder and the salt.
4. Put on a lid and simmer gently for 15 minutes, add the carrot and simmer gently for a further 15 minutes.
5. Add the parsley, stir well and simmer for a further minute.
6. Meanwhile cook the spaghetti or rice.

5\. Serve straight away on a warmed plate, with the sauce poured over, and freshly grated Parmesan sprinkled on top.

Fig. 4.3 Recipe 3 (Egg, leek and prawn gratinee)

Egg, leek and prawn gratinee

Serves 2

Ingredients

4 eggs
2 leeks trimmed
1 oz (25 g) polyunsaturated margarine
8 tablespoons single cream
2 oz (50 g) cooked frozen prawns, thawed
2 oz (50 g) grated mature cheddar cheese
Salt and coarse black pepper
Fresh parsley, chopped

Method

1. Wash and cut the leeks into 1/2 inch (1cm) slices.
2. Melt the margarine, add the leeks and cook for about 15 minutes or until they are soft.
3. Transfer them to the base of flame-proof dish, 7-8 inches in diameter and spread them out evenly. Season with salt and pepper.
4. Place the prawns on the leeks.
5. Break the eggs and beat lightly. Add the cream and mix.
6. Pour the cream/egg mix over the leeks and prawns.
7. Sprinkle with grated cheese.
8. Put in a pre-heated oven on a high shelf at 180^{o}C for 20-25 minutes depending on how you like your eggs done.
9. Place the dish under a hot grill so that the surface browns.
10. Sprinkle with chopped parsley and serve immediately with salad and crusty bread.

Fig. 4.4 Recipe 4 (Tropical Chicken)

Tropical Chicken Snack

Serves 2

Ingredients

2 tablespoons (30 ml) fromage frais
1 x teaspoon (5 ml) curry powder
1 dessertspoon (10 ml) mango chutney
3 pineapple rings, in natural juice, drained well and chopped
1 oz (25 g) flaked almonds
1 chicken breast
Iceberg lettuce, shredded
2 pitta breads

Method

1. Cover the chicken with boiling water and poach gently for 20 minutes.
2. Remove the cooked chicken from the liquor, allow to cool, skin and slice.
3. Mix the fromage frais, curry powder and chutney together until well blended.
4. Toss the chopped chicken, the pineapple pieces and the nuts in the fromage frais dressing.
5. Serve on a bed of shredded lettuce in the pitta breads.

4.4 Hazard Analyses of the recipes

The selected recipes were prepared by the researcher in a domestic environment and were subjected to hazard analysis. The hazard analyses entailed examination of operations to: (1) identify potentially hazardous ingredients; (2) find sources and specific points of contamination by observing each step of the operation; (3) determine the potential for micro-organisms to survive a heat process; and (4) determine the potential for micro-organisms to multiply at room temperature and during cold storage. Based on these observations, flow diagrams were constructed which provided details about actual or potential contamination and hazards from microbial growth (Figs. 4.5, 4.10, 4.15, 4.20).

Identification of hazards

The ingredients in each of the recipes were assessed, by reference to the literature, for the likely presence of pathogens or their toxins and the severity of their outcome and risks of occurrence. An evaluation of relevant intrinsic qualities of the final products were made, since these factors will affect the growth or survival of pathogens. Each recipe was analysed, by a food chemistry technician, for protein, water, pH and a_w using standard methods (Egan *et al.*, 1981) and the results were recorded on Form 1 (Figs. 4.6, 4.11, 4.16, 4.21). Information on the process hazards involved in the production of each recipe was recorded on Form 2 (Figs. 4.7, 4.12, 4.17, 4.22).

Measure time-temperature exposures of foods

The air temperature during transport and refrigerated storage of the food was recorded by means of a Temptrak temperature data logger fitted with an integral sensor, programmed to record the temperature at one minute intervals.

The logger was strapped to one of the perishable recipe ingredients issued to participants and remained with the food until preparation commenced. The data logger has an accuracy of +/- 0.3^{o}C. The temperature of the interior of the food at the end of cooking was taken with a Comark 9009 digital thermometer with an accuracy of +/- 0.5^{o}C.

Determination of Control Points

Critical Control Points are points in the process where loss of control would result in a reasonable probability of an unacceptable health risk. There are likely to be only a few points in the process which can be considered critical. On the other hand, in domestic food preparation, there are likely to be several control points. These are points in the process where loss of control is not likely to result in an unacceptable health risk, but correction is required. A risk to health may arise if several related control points are violated in conjunction. Control points, including those which may be considered critical, were selected on the basis of the hazards identified and their estimated severity and risks in relation to unacceptable contamination, growth or survival of micro-organisms. Realistic preventative measures for each identified hazard were determined at each of the main process steps. It is difficult, however, for the consumer to monitor control criteria (target levels and tolerances) in the domestic context due to the lack of measurement instruments and the absence of food safety training, so there can be only limited assurance that any control criteria will eliminate or reduce hazards to acceptable levels. Sheppard *et al.* (1990) has suggested that it is only appropriate to stipulate control criteria where they are capable of being routinely monitored, usually by simple observation or measurement. The concept of Critical Control Points and control criteria as applied to domestic food handling practices will have to be interpreted with common sense and flexibility (Mitchell, 1992).

Form 3 was used to identify the control points and to specify the control measures (Figs. 4.8, 4.13, 4.18, 4.23).

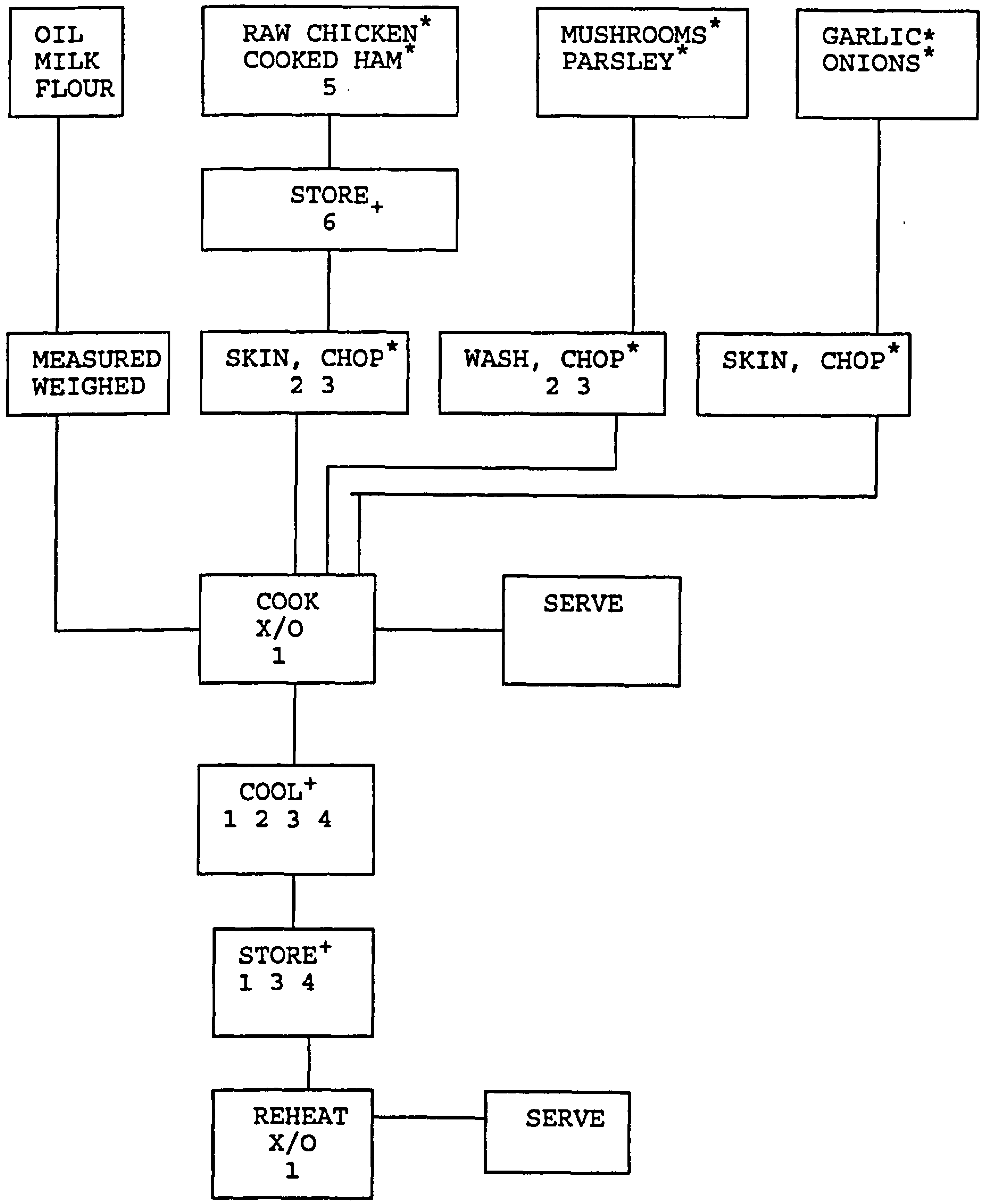
Food Preparation Observation Check-list

After conducting a number of hazard analyses on the recipes, check-lists (Form 4) were developed for use in the evaluation of specific hazards for each recipe. They listed all the process steps where uncontrolled hazards could lead to outbreaks of food poisoning and followed the general food flow as observed (Fig. 4.9, 4.14, 4.19, 4.24). A pilot study was conducted in the homes of twelve subjects during which the check-lists were used and modified where necessary.

Summary of HACCP Forms

Form 1	Food hazards
Form 2	Process hazards
Form 3	Control measures
Form 4	Food preparation observation check-list

Fig. 4.5 A Flow diagram for Recipe 1 (Chicken Surprise)



Legend

* Hazard of contamination likely

\+ Hazard of bacterial growth likely

X Vegetative bacteria destruction likely

O Spore survival likely

Control Points

1. Time-temperature control
2. Personal Hygiene
3. Equipment sanitation
4. Environmental maintenance and sanitation
5. Ingredient control
6. Ingredient storage

Fig. 4.6 Form 1 Food Hazards in Recipe 1

1. High protein, average 10%
2. High a_W, average 0.98
3. pH 6
4. Moisture content 63%

Pathogens or toxins likely to be present

Ingredients.	Severity* of illness	Risks**
Raw chicken		
Salmonella species	severe	high
Campylobacter jejuni	severe	high
Yersinia enterocolitica	severe	low
Clostridium perfringens	mild	high
Listeria monocytogenes	severe/mild	variable
Raw vegetables		
Bacillus cereus	mild	high
Clostridium perfringens	mild	high
Listeria monocytogenes	severe/mild	variable
Cooked Ham		
Staphylococcus aureus	mild	moderate
Pasteurised Milk		
Salmonella species	severe	low
Campylobacter jejuni	severe	low
Escherichia coli	severe	low
Staphylococcus aureus	mild	low
Listeria monocytogenes	severe/mild	low
Enterococcus faecalis	mild	low
Yersinia enterocolitica	severe	low

* Hazards are divided into life threatening, severe or chronic and moderate or mild illness

** Degrees of risk of contamination are high, moderate, low and negligible

Fig. 4.7 Form 2 Process Hazards in Recipe 1

Operational step	Hazards
Procuring	
• Damaged packaging	Contamination of ham
• Older than 'use by' date	Growth of pathogens
• Temperature abuse during transport	Growth of pathogens
Storage	
• Ham, chicken stored above 5°C	Growth of pathogens in time
• Chicken stored longer than 2 days	Growth of pathogens in time
Handling and Preparing raw foods	
• Leaves chicken packaging on work surface	May contaminate preparation environment
• Washes chicken	Contaminates sink, preparation environment
• Handler does not wash hands after handling raw chicken	Contamination of ham, parsley
• Parsley not washed	Contamination of product
• Ham cut on dirty board	Contamination of product
• Chicken cut in large uneven pieces	Vegetative cells may survive inadequate heat penetration
Cooking	
• Product not cooked to internal temperature of at least 74°C	Some vegetative cells and spores survive
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	Spores germinate, pathogenic growth
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes	Spores germinate, pathogenic growth
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C. or less	Pathogenic growth
• Product is stored in refrigerator longer than 3 days	Pathogenic growth
• Product is not covered	Contamination possible
Re-heating	
• Product is not re-heated to an internal temperature of 74°C.	Vegetative cells survive and *B. cereus* toxin survives re-heating
• Product is re-heated more than once with intervening holding periods at room temperature	Vegetative cells survives and *B. cereus* toxin survives re-heating, bacterial growth

Fig. 4.8 Form 3 Control Measures for Recipe 1

Hazard	Control Measures.
Procuring	
• Damaged packaging	Reject, check integrity in store
• Older than 'use by' date	Reject, check date in store
• Temperature abuse during transport	Low temp, short time, use insulated chilled cool bag, check time (less than 60 minutes in bag)
Storage	
• Ham, chicken, milk above 5°C	Store at 5°C or less
• Chicken stored longer than 2 days	Limit storage period to less than 48 hours
Handling and Preparing raw foods	
• Chicken packaging	Discard immediately
• Washes chicken	Discourage, wipe with paper towel
• Handler does not wash hands after handling raw food	Handwashing (generate lather), drying
• Parsley not washed	Wash, use clean board, before preparing chicken
• Ham cut on dirty board	Prepare before chicken, use separate board or clean board - wash, rinse, disinfect
• Chicken cut in large uneven pieces	Cut regular cubes 1 inch or less
Cooking	
• Product not cooked to internal temperature of at least 74°C	Allow sufficient time (30 minutes), adequate temperature (Moderate), use pan not less than 8 inch diameter, seal the chicken, stir frequently, check sauce boils, observe bubbles.
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	Transfer to shallow container, do not cover, use water bath or ice-pack, stir every 5 minutes, use cool place
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes.	Limit time at ambient to 90 minutes.
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	Low temperature, short time, check time and temperature
• Product is not covered contamination possible	Cover product, store top of refrigerator
• Product is stored in refrigerator longer than 3 days	Limit storage period to less than 3 days
Re-heating	
• Food is not re-heated to an internal temperature of 74°C	Allow sufficient time (6 minutes, microwave oven), sufficient temp. (650 Watt, full-power), stir twice, check liquid boils, observe bubbles. Adjust cooking time if the appliance has a different power rating. Or use a clean saucepan (diameter not less than 7 inches) on the top of the stove. Bring to the boil and then simmer for 5 minutes
• Food is re-heated more than once, with intervening holding periods at room temperature	Discourage, re-heat once only

Fig. 4.9 Form 4 Observation Check-list for Recipe 1

Circle deficiencies in operations **Further comments**

Process Steps

Procuring
1. Perishable food is subjected to temperature abuse during transport
2. Perishable food with damaged packaging is accepted
3. Perishable food which is past the 'use by' date is accepted

Storage
1. Raw perishable foods are held at temperatures above 5°C
2. Chicken is held for longer than 2 days

Handling and Preparing raw foods
1. Handler does not wash hands (generate lather) after handling raw chicken
2. Vegetables, garnishes not washed
3. Ham cut on contaminated board
4. Chicken packaging contaminates work surface
5. Washes chicken, contaminates sink area
6. Chicken cut in large uneven pieces making even and adequate heat penetration difficult

Cooking
1. Food not cooked to internal temperature of at least 74°C

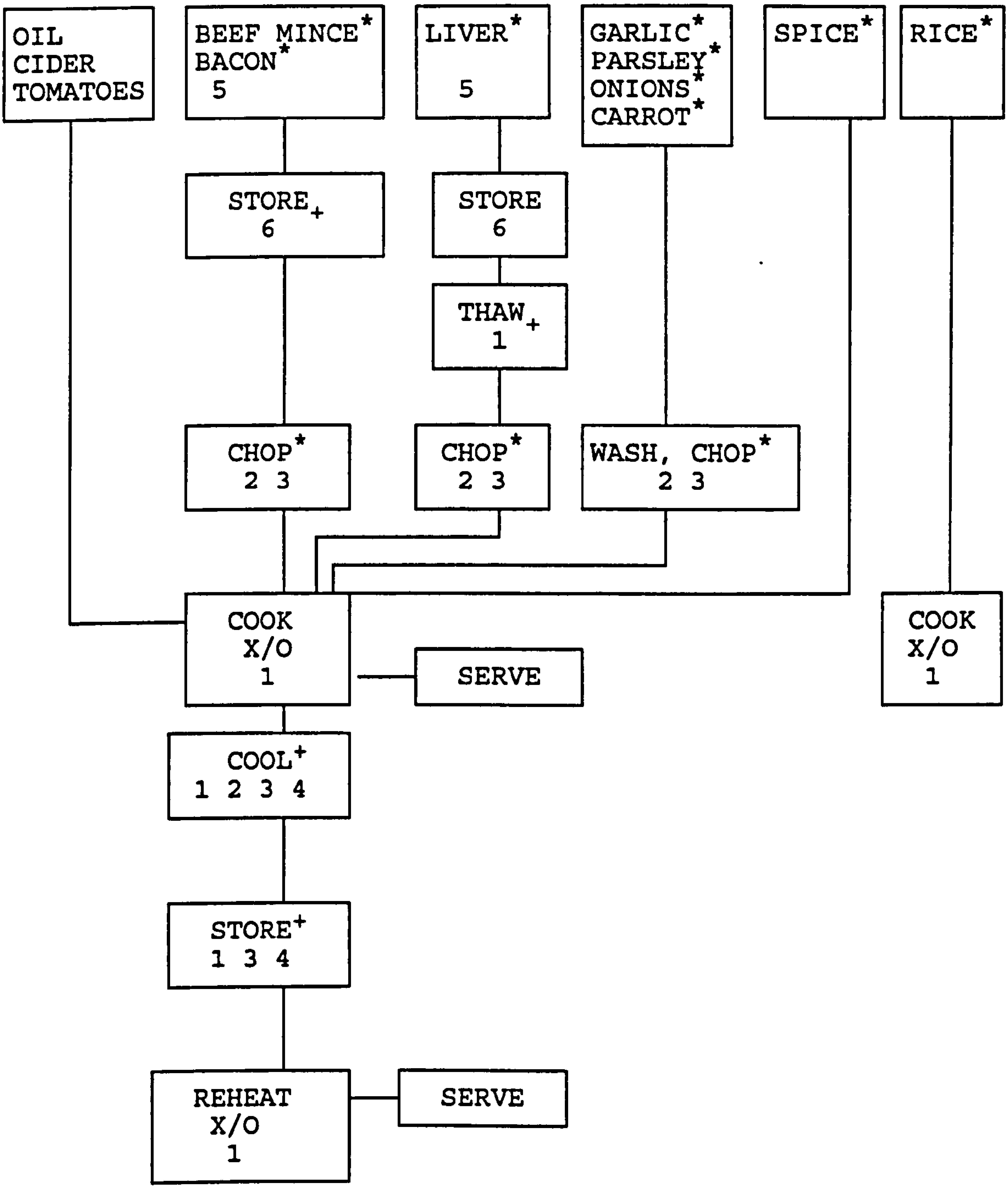
Cooling
1. Cooked food is not cooled rapidly to 21°C within 90 minutes

Room Temperature Storage
1. Cooked food is kept at room temperature for longer than 90 minutes

Refrigeration
1. Cooked food is stored in refrigerator which does not maintain a temperature of 5°C or less
2. Cooked food is stored in refrigerator for longer than 3 days

Re-heating
1. Food is not re-heated to an internal temperature of 74°C
2. Food is re-heated more than once with intervening holding periods at room temperature

Fig. 4.10 A Flow Diagram for Recipe 2 (Mexican Beef).



Legend

- * Hazard of contamination likely
- \+ Hazard of bacterial growth likely
- X Vegetative bacteria destruction likely
- O Spore survival likely

Control Points

1. Time-temperature control
2. Personal Hygiene
3. Equipment sanitation
4. Environmental maintenance and sanitation
5. Ingredient control
6. Ingredient storage

Fig. 4.11 Form 1 Food Hazards in Recipe 2

1. Protein, average 5%
2. High a_W, average 0.98
3. pH 4
4. Moisture content 73%

Pathogens or toxins likely to be present

	Severity* of illness	Risks**
Ingredients		
Raw beef, liver, bacon		
Salmonella species	severe	high
Campylobacter jejuni	severe	high
Escherichia coli	severe	high
Clostridium perfringens	mild	high
Staphylococcus aureus	mild	moderate
Raw vegetables		
Bacillus cereus	mild	high
Clostridium perfringens	mild	high
Listeria monocytogenes	severe/mild	variable
Rice, pasta		
Bacillus cereus	mild	high
Spices		
Salmonella species	severe	high
Bacillus cereus	mild	high
Clostridium perfringens	mild	high

* Hazards are divided into life threatening, severe or chronic and moderate or mild illness

** Degrees of risk of contamination are high, moderate, low and negligible

Fig. 4.12 Form 2 Process Hazards in Recipe 2

Operational step	Hazards
Procuring	
• Older than 'use by' date	Growth of pathogens
• Temperature abuse during transport	Growth of pathogens
Storage	
• Beef, bacon, liver stored above 5°C	Growth of pathogens in time
• Beef stored longer than 2 days	Growth of pathogens in time
Thawing	
• Insufficient time allowed	Incomplete thawing may result in inadequate heating
• Thawed in kitchen	May contaminate environment
• Thawed in kitchen	growth of pathogens
Handling and Preparing raw foods	
• Leaves meat packaging on work surface	May contaminate preparation environment
• Washes liver	May contaminate sink and preparation environment
• Handler does not wash hands after handling raw food	Contaminates environment
• Parsley not washed	Contamination of product
• Parsley cut on dirty board	Contamination of product
Cooking	
• Product not cooked to internal temperature of at least 74°C	Some vegetative cells and spores survive
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	Spores germinate, pathogenic growth
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes	Spores germinate, pathogenic growth
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	Pathogenic growth
• Product is stored in refrigerator longer than 3 days	Pathogenic growth
• Product is not covered	Contamination possible
Re-heating	
• Product is not re-heated to an internal temperature of 74°C	Vegetative cells survive and *B. cereus* toxin survives re-heating
• Product is re-heated more than once with intervening holding periods at room temperature	Vegetative cells survive and *B. cereus* toxin survives re-heating, bacterial growth

Fig. 4.13 Form 3 Control Measures for Recipe 2

Hazard	Control Measures
Procuring	
• Damaged packaging	Reject, check integrity in store
• Older than 'use by' date	Reject, check date in store
• Temperature abuse during transport	Low temp, short time, use insulated chilled cool bag, check time (less than 60 minutes in bag)
Storage	
• Beef, bacon, liver above 5^{o}C	Store at 5^{o}C or less
• Beef stored longer than 2 days	Limit storage period to less than 48 hours.
Thawing	
• Incomplete thawing may result in inadequate heating	Thaw in refrigerator for 8 hours
• Thawed in kitchen	Discourage, use refrigerator, lower shelf, covered on plate
Handling and Preparing raw foods	
• Meat packaging	Discard immediately
• Washes liver	Discourage, wipe with paper towel
• Handler does not wash hands after handling raw food	Handwashing (generate lather), drying
• Parsley not washed	Wash, use clean board, before preparing meat
Cooking	
• Product not cooked to internal temperature of at least 74^{o}C.	Allow sufficient time (30 minutes), adequate temp. (Moderate). Beef to be browned evenly on high heat, stirred regularly, heat to boiling, simmered for 30 minutes, use lid when directed, simmered for further minute after parsley added.
Cooling	
• Product is not cooled rapidly to 21^{o}C within 90 minutes	Transfer meat sauce to shallow container, do not cover. Use water bath or ice-pack, stir every 10 minutes, use cool place. Transfer cooked rice to shallow dish, cool rapidly
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes	Limit time at ambient to 90 minutes.
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5^{o}C or less	Store at 5^{o}C or less
• Product is not covered, contamination possible	Cover product, store top of refrigerator
• Product is stored in refrigerator longer than 3 days	Limit storage period to less than 3 days
Re-heating	
• Food is not re-heated to an internal temperature of 74^{o}C	Allow sufficient time (7 minutes, microwave oven), sufficient temp. (650 Watt, full-power), stir twice, check liquid boils, observe bubbles. Adjust cooking time if the appliance has a different power rating. Or use a clean saucepan (diameter not less than 7 inches) on the top of the stove. Bring to the boil and then simmer for 5 minutes.
• Food is re-heated more than once, with intervening holding periods at room temperature	Discourage, re-heat once only

Fig. 4.14 Form 4 Observation Check-list for Recipe 2

Circle deficiencies in operations **Further comments**
Process Steps

Procuring
1. Perishable food is subjected to temperature abuse during transport
2. Perishable food with damaged packaging is accepted
3. Perishable food which is past the 'use by' date is accepted

Storage
1. Beef, bacon, liver are held at temperatures above 5°C
2. Beef is held for longer than 2 days

Thawing
1. Liver is not thawed completely
2. Liver is thawed in the kitchen

Handling and Preparing raw foods
1. Handler does not wash hands (generate lather) after handling raw meat
2. Vegetables not washed
3. Parsley cut on contaminated board
4. Meat packaging contaminates work surface
5. Washes chicken liver, contaminates sink area

Cooking
1. Food not cooked to internal temperature of at least 74°C

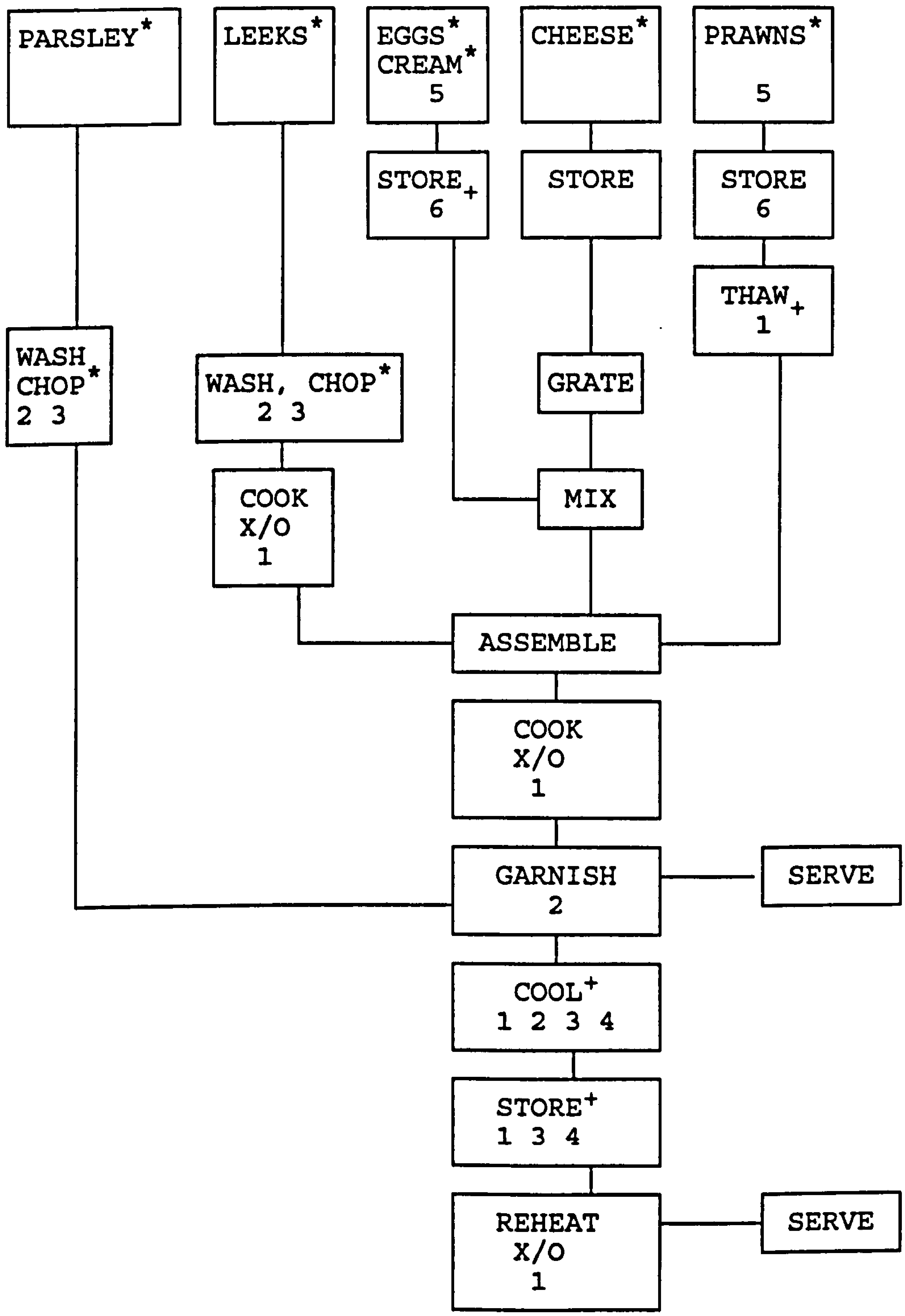
Cooling
1. Cooked food is not cooled rapidly to 21°C within 90 minutes

Room Temperature Storage
1. Cooked food is kept at room temperature for longer than 90 minutes

Refrigeration
1. Cooked food is stored in refrigerator which does not maintain a temperature of 5°C or less
2. Cooked food is stored in refrigerator for longer than 3 days

Re-heating
1. Food is not re-heated to an internal temperature of 74°C
2. Food is re-heated more than once with intervening holding periods at room temperature

Fig. 4.15 Flow diagram for Recipe 3 (Egg, leek and prawn gratinee)



Legend

* Hazard of contamination likely
\+ Hazard of bacterial growth likely
X Vegetative bacteria destruction likely
O Spore survival likely

Control Points

1. Time-temperature control
2. Personal Hygiene
3. Equipment sanitation
4. Environmental maintenance and sanitation
5. Ingredient control
6. Ingredient storage

Fig. 4.16 Form 1 Food Hazards in Recipe 3

1. High protein, average 10%
2. High a_W, probably 0.985
3. pH 6
4. Moisture content 74%

Pathogens or toxins likely to be present

	Severity* of illness	Risks**
Egg		
Salmonella species	severe	high
Raw vegetables		
Listeria monocytogenes	severe/mild	variable
Bacillus cereus	mild	high
Clostridium perfringens	mild	high
Frozen cooked prawns		
Staphylococcus aureus	mild	high
Enterococcus faecalis	mild	moderate
Vibrio parahaemolyticus	severe	moderate
Salmonella species	severe	variable
Single Cream,		
Staphylococcus aureus	mild	moderate
Enterococcus faecalis	mild	low
Cheddar Cheese		
Staphylococcus aureus	mild	moderate

* Hazards are divided into life threatening, severe or chronic and moderate or mild illness

** Degrees of risk of contamination are high, moderate, low and negligible

Fig. 4.17 Form 2 Process Hazards in Recipe 3

Operational step	Hazards
Procuring	
• Damaged packaging	Contamination of cream
• Older than 'use by' date	Growth of pathogens
• Temperature abuse during transport	Growth of pathogens
Storage	
• Cheese, cream, prawns stored above 5°C	Growth of pathogens in time
Thawing	
• Insufficient time allowed	Incomplete thawing may result in inadequate heating
• Thawed in kitchen	May contaminate environment
• Thawed in kitchen	Growth of pathogens
Handling and Preparing raw foods	
• Handler does not wash hands after handling raw leeks, eggs	Contamination of prawns, parsley
• Leeks not washed	Contamination of product
• Parsley cut on dirty board	Contamination of product
• Egg shells left on work surface	Contaminates environment
Cooking	
• Product not cooked to internal temperature of at least 74°C	Some vegetative cells and spores survive
Garnishing	
• Parsley not washed	Contamination of product
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	Spores germinate, pathogenic growth
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes.	Spores germinate, pathogenic growth
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	Pathogenic growth
• Product is stored in refrigerator longer than 3 days	Pathogenic growth
• Product is not covered	Contamination possible
Re-heating	
• Product is not re-heated to an internal temperature of 74°C	Vegetative cells survive and *B. cereus* toxin survives re-heating
• Product is re-heated more than once with intervening holding periods at room temperature	Vegetative cells survive and *B. cereus* toxin survives re-heating, bacterial growth

Fig. 4.18 Form 3 Control Measures for Recipe 3

Hazard	Control Measures
Procuring	
• Damaged packaging	Reject, check integrity in store
• Older than 'use by' date	Reject, check date in store
• Temperature abuse during transport	Low temp, short time, use insulated chilled cool bag, check time (less than 60 minutes in bag)
Storage	
• Cream, prawns above 5°C	Store at 5°C or less
• Cream stored longer than 2 days	Limit storage period to less than 48 hours.
Thawing	
• Incomplete thawing may result in inadequate heating	Thaw in refrigerator for 8 hours
• Thawed in kitchen	Discourage, use refrigerator, lower shelf, covered on plate
Handling and Preparing raw foods	
• Handler does not wash hands after handling leeks, eggs.	Handwashing (generate lather), drying
• Leeks not washed	Cut to base, wash under running water, spreading leaves to remove trapped dirt
• Parsley cut on dirty board	Use separate board or clean board wash, rinse, disinfect
• Egg shells left on work surface	Discard immediately
Cooking	
• Product not cooked to internal temperature of at least 74°C	Allow sufficient time (25 minutes), adequate temperature (Oven 180°C), pre-heat oven, use high shelf (unless fan oven) use dish not less than 8 inch diameter, mixture should be set, colour surface under grill.
Garnishing	
• Parsley not washed	Wash, chop before handling other ingredients
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	Do not cover, use water bath or ice-pack, use cool place
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes.	Limit time at ambient to 90 minutes
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	Low temperature, short time, check time and temperature
• Product is not covered, contamination possible	Cover product, store top of refrigerator
• Product is stored in refrigerator longer than 3 days	Limit storage period to less than 3 days
Re-heating	
• Food is not re-heated to an internal temperature of 74°C	Allow sufficient time (3 minutes, microwave oven), sufficient temp. (650 Watt, full-power), Adjust cooking time if the appliance has a different power rating. Or heat in a pre-heated oven set at 180°C for 15 minutes, middle shelf.
• Food is re-heated more than once, with intervening holding periods at room temperature	Discourage, re-heat once only

Fig. 4.19 Form 4 Observation Check-list for Recipe 3

Circle deficiencies in operations **Further comments**

Process Steps

Procuring

1. Cream, prawns subjected to temperature abuse during transport
2. Perishable food with damaged packaging is accepted
3. Perishable food which is past the 'use by' date is accepted

Storage

1. Cream, prawns are held at temperatures above 5°C
2. Cream is held for longer than 2 days

Thawing

1. Prawns are not thawed completely
2. Prawns are thawed in the kitchen for longer than 90 minutes

Handling and Preparing raw foods

1. Handler does not wash hands (generate lather) after handling eggs, leeks
2. Leeks, parsley not washed
3. Parsley cut on contaminated board
4. Egg shells contaminate work surface

Cooking

1. Food not cooked to internal temperature of at least 74°C

Cooling

1. Cooked food is not cooled rapidly to 21°C within 90 minutes

Room Temperature Storage

1. Cooked food is kept at room temperature for longer than 90 minutes

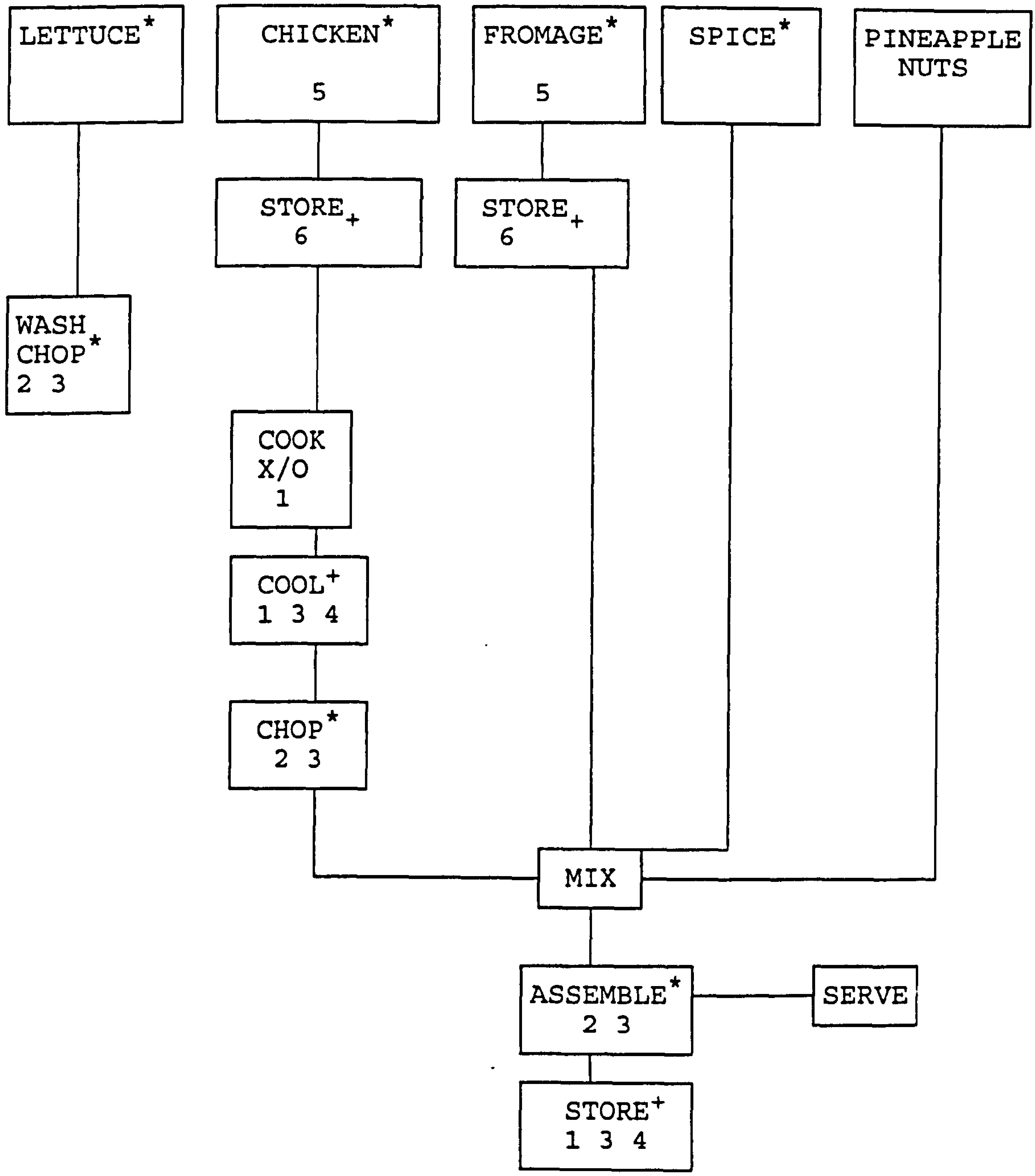
Refrigeration

1. Cooked food is stored in refrigerator which does not maintain a temperature of 5°C. or less
2. Cooked food is stored in refrigerator for longer than 3 days

Re-heating

1. Food is not re-heated to an internal temperature of 74°C
2. Food is re-heated more than once with intervening holding periods at room temperature

Fig. 4.20 Flow diagram for Recipe 4 (Tropical Chicken)



Legend

* Hazard of contamination likely

\+ Hazard of bacterial growth likely

X Vegetative bacteria destruction likely

O Spore survival likely

Control Points

1. Time-temperature control
2. Personal Hygiene
3. Equipment sanitation
4. Environmental maintenance and sanitation
5. Ingredient control
6. Ingredient storage

Fig. 4.21 Form 1 Food hazards in Recipe 4

1. High protein, average 11%
2. High a_W, 0.97
3. pH 3.9
4. Moisture content 64%

Pathogens or toxins likely to be present

	Severity*	Risks**
Raw chicken		
Salmonella species	severe	high
Campylobacter jejuni	severe	high
Yersinia enterocolitica	severe	low
Clostridium perfringens	mild	high
Listeria monocytogenes	severe/mild	variable
Raw vegetables		
Bacillus cereus	mild	high
Clostridium perfringens	mild	high
Listeria monocytogenes	severe/mild	variable
Spices		
Bacillus cereus	mild	high
Clostridium perfringens	mild	high
Fromage frais		
Staphylococcus aureus	mild	moderate
Enterococcus faecalis	mild	low
Listeria monocytogenes	severe/mild	variable

* Hazards are divided into life threatening, severe or chronic and moderate or mild illness

** Degrees of risk of contamination are high, moderate, low and negligible

Fig. 4.22 Form 2 Process Hazards in Recipe 4

Operational step	Hazards
Procuring	
• Damaged packaging	Contamination of fromage frais
• Older than 'use by' date	Growth of pathogens
• Temperature abuse during transport	Growth of pathogens
Storage	
• Chicken, fromage stored above 5°C	Growth of pathogens in time
• Chicken stored longer than 2 days	Growth of pathogens in time
Handling and Preparing raw foods	
• Leaves chicken packaging on work surface	May contaminate preparation environment
• Washes chicken	Contaminates sink and preparation environment
• Handler does not wash hands after handling raw chicken	Contamination of equipment and environment
• Lettuce not washed	Contamination of product
• Lettuce cut on dirty board	Contamination of product
Cooking	
• Product is not cooked to internal temperature of 74°C	Some vegetative cells and spores survive
Post Cooking handling	
• Chicken cut on dirty board	Contamination of product
• Cooked chicken handled	Contamination from hands
• Hot chicken mixed with other ingredients	Bacterial growth
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes.	Spores germinate, Pathogenic growth
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	Pathogenic growth
• Product is stored in refrigerator longer than 3 days	Pathogenic growth
• Product is not covered	Contamination possible

Fig. 4.23 Form 3 Control Measures for Recipe 4

Hazard	Control Measures
Procuring	
• Damaged packaging	Reject, check integrity in store
• Older than 'use by' date	Reject, check date in store
• Temperature abuse during transport	Low temp, short time, use insulated chilled cool bag, check time (less than 60 minutes in bag)
Storage	
• Chicken, fromage frais stored above 5°C	Store at 5°C or less
• Chicken stored longer than 2 days	Limit storage period to less than 48 hours
Handling and Preparing raw foods	
• Chicken packaging	Discard immediately
• Washes chicken	Discourage, wipe with paper towel
• Handler does not wash hands after handling raw food	Handwashing (generate lather), drying
• Lettuce not washed	Wash, use clean board, before preparing chicken
Cooking	
• Product not cooked to internal temperature of at least 74°C	Allow sufficient time (20 minutes), adequate temperature (Moderate), use pan with lid, use sufficient boiling water to cover, turn once, observe lack of pink colour
Post Cooking Handling	
• Chicken cut on dirty board	Use separate board or clean board wash, rinse, disinfect
• Cooked chicken handled	Use utensils
• Hot chicken mixed with other ingredients	Delay mixing until chicken has cooled
Room Temperature Storage	
• Product is kept at room temperature for periods longer than 90 minutes	Limit time at ambient to 90 minutes
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	Low temperature, short time, check time and temperature
• Product is not covered	Contamination possible Cover product, store top of refrigerator
• Product is stored in refrigerator longer than 3 days	Limit storage period to 3 days.

Fig. 4.24 Form 4 Observation Check-list for Recipe 4

Circle deficiencies in operations — Further comments

Process Steps

Procuring
1. Chicken, fromage is subjected to temperature abuse during transport
2. Perishable food with damaged packaging is accepted
3. Perishable food which is past the 'use by' date is accepted

Storage
1. Chicken, fromage are held at temperatures above 5°C
2. Chicken is held for longer than 2 days

Handling and Preparing raw foods
1. Handler does not wash hands (generate lather) after handling raw chicken
2. Lettuce not washed
3. Cooked chicken cut on contaminated board
4. Chicken packaging contaminates work surface
5. Washes chicken, contaminates sink area

Cooking
1. Chicken not cooked to internal temperature of at least 74°C

Post Cooking handling
1. Cooked chicken cut on dirty board
2. Cooked chicken handled
3. Hot chicken mixed with other ingredients

Room Temperature Storage
1. Cooked food is kept at room temperature for longer than 90 minutes

Refrigeration
1. Cooked food is stored in refrigerator which does not maintain a temperature of 5°C or less
2. Cooked food is stored in refrigerator for longer than 3 days

4.5 Verification Procedures

Each recipe was prepared four times in a domestic environment by the researcher. The designated control measures were implemented and monitored at each control point.

Temperature Measurements

Heating

At the end of the cooking process the centre temperature of the products was recorded with a Comark 9009 digital thermometer with an accuracy of +/- 0.5^{o}C. A centre end point temperature in excess of 74^{o}C for at least one second was achieved for all products.

Cooling

The temperature of the products was taken 90 minutes after assisted cooling. Use was made of water baths with eutectic ice packs and shallow, uncovered food containers (Table 4.1).

Table 4.1 Product temperature at the end of the cooling period

Mean temperature (^{o}C) after 90 mins. at ambient (21^{o}C)	
Product	
Recipe 1	46
Recipe 2	48
Recipe 3	38
Number of each product = 4	

Microbiological Examination

A microbiological examination of each product was undertaken, with the assistance of a microbiology technician, to verify that the HACCP system was working. Once it was confirmed that the recipe preparation process was under control, a recipe standard based on the implementation of the established control criteria could be set. Against this, the performance of the home cooks could be measured.

Sampling procedures

10 gram samples of cooked foods were collected with sterile metal spoons and aseptically transferred into sterile glass jars. Duplicate samples were prepared from all foods.

Laboratory procedures

The food samples were homogenised with 0.1% peptone water in a stomacher (Colworth Stomacher, Unipath Ltd, Bedford) for 60 seconds and subjected to an examination which included an aerobic plate count (APC) at 30°C and 37°C, enumeration of coliforms, *Staphylococcus aureus* and *Clostridium perfringens* using standard techniques (Microbiological Methods - Appendix 2).

Microbiological guide-lines for some products have been developed by food manufacturers (ACTCC, 1990; BSA, 1992), the Department of Health (1989) and the PHLS Food Surveillance Group (Gilbert, 1992) but these are not legally enforced. These guide-lines serve as standards that can be used by the food industry to monitor the efficacy of the manufacturing process. They should distinguish between an acceptable and an unacceptable product.

The microbiological guide-lines used by the ACTCC (1990) were applied to the results (Table 4.2).

Table 4.2 Microbiological guidelines for ready-to-eat foods

Microbiological quality (CFU*/g)	
Non-manipulated items This refers to items that are sampled directly from the oven, before any handling has taken place	
Aerobic plate count	$<10^4$
Staphylococcus aureus	$<10^2$
Clostridium perfringens	$<10^2$
Manipulated items after cooling This refers to items such as cooked and sliced chicken	
Aerobic plate count	$<10^5$
Staphylococcus aureus	$<10^2$
Clostridium perfringens	$<10^2$
Total coliform count	$<10^3$
CFU = colony forming unit	

Results

Table 4.3 Aerobic Plate Counts of Recipes (37°C, 48 hours)

Dish	Total examined	Mean Aerobic Plate Count (CFU*/g)
Recipe 1	4	90
Recipe 2	4	23
Recipe 3+	4	690
Recipe 4+	4	5800

* CFU = Colony Forming Unit
\+ Recipes contain raw ingredients

Table 4.4 Microbiological Quality of Recipes

Dish	Total examined	APC exceeds guide-line criterion (Table 4.2)
Recipe 1	4	0
Recipe 2	4	0
Recipe 3	4	0
Recipe 4	4	0

Table 4.5 Pathogens and indicator organisms in Recipes

Dish	Total examined	Number of samples with: *S. aureus* >10/g	*C. perfringens* >10/g	Coliforms >10/g
Recipe 1	4	0	0	0
Recipe 2	4	0	0	0
Recipe 3	4	0	0	0
Recipe 4	4	0	0	0

No coliforms, *S. aureus*, or *C. perfringens* were detected in 0.1 gram of any product samples and were, therefore, considered acceptable. All products would meet the stricter standards applied by the Microbiology and Food Safety Committee of the National Food Processors Association (1993) to freshly cooked food. These require products to have a coliform count of <3/g and a *S. aureus* count of <10/g. The mean APC of Recipe 1 and 2 was less than 10^3/g, which indicates a satisfactory quality. Recipe 4, which was handled after cooking and included uncooked salad ingredients had a mean APC of less than 10^5/g which meets the microbiological standard for this type of product. The APC of duplicate samples of one batch of the egg, leek and prawn gratinee (Recipe 3) exceeded 10^3/g but were less than 10^4/g. It should be noted that this product was garnished with raw parsley which might be expected to contribute to the higher APC. Since it is not possible to devise a control measure which will guarantee the removal of this hazard, it may be prudent to advise against garnishing cooked products until immediately before service. The remaining egg recipe samples met the satisfactory guide-line.

Conclusion

100% of the samples tested met the APC and the essential microbiological criteria stipulated in the guidelines. The microbiological results confirm that the critical control points in the production processes were under control.

4.6 The Food Safety Risk Score

There is no generally accepted and standardised measure of hygienic handling of food. In order to evaluate the hygiene of domestic food handling practices it was necessary to devise appropriate measurement instruments and a scale or score that could be used for reporting the results. This needed to take into account the fact that the control of some hazards was more important for the safety of the food than others. The system had, therefore, to be based on epidemiological data which has established that some food operations are, if incorrectly executed, more likely to lead to outbreaks of food poisoning than others. It needed additionally to take into account that some foods are more likely, because of their attributes to serve as vehicles of food poisoning than are others.

Zottola and Wolf (1981) evaluated the safety of recipes designed for the home cook. They analysed them for potential hazards by examining the ingredient list for foods which might be sources of pathogenic organisms and the recipe instructions for process steps which would control the hazards identified. Recipes were regarded as safe to use if the food hazards could be adequately controlled by the process.

A more sophisticated system for determining the safety of the food production process has been developed by Sainsburys, who require the use of a HACCP approach (1991), which classifies hazards into four categories and awards demerit points for failure to implement control measures on the following basis:

Classification of hazard	Demerit Points
Critical	1000
Serious	100
Major	10
Minor	1

An audit, on an unannounced basis is conducted and where control measures are being implemented no demerit points are allocated. Demerit points are allocated for failure to implement appropriate control measures. Audit scores can be compared with scores from other plants producing similar products.

Bryan (1982) devised a method for assessing the potential food safety risk of different catering establishments which used food property risk, a food operation risk and an average daily patronage risk as coefficients to compute a composite risk index. This was intended to guide Environmental Health officials in their surveillance of catering operations. The procedure identifies those establishments that have the greatest potential of having operations that could lead to outbreaks of food poisoning. Food operations and the foods that were handled were assigned a risk value rating based on their relative frequency of contributing to outbreaks of food poisoning (Bryan, 1978).

In order to evaluate the hygiene of domestic food production in the current work, a Food Safety Risk system was developed. This employed the concept of risk coefficients (Bryan, 1982) and was based where possible, on epidemiological data from the home, supplemented with information from the catering industry. The practices of cooking too far in advance coupled with storage of cooked food for periods in excess of 12 hours at room temperature, have been shown to be implicated frequently in outbreaks of food poisoning. A maximum penalty of 90 demerit marks was allocated where these practices were demonstrated. Lower demerit ratings were given where the product was held for shorter periods at room temperature. Improper cooling and re-heating, practices which are often implicated in food poisoning outbreaks were each awarded 50 demerit marks as was under-cooking. A greater weighting of demerit marks has been allocated to this factor compared with the ratings suggested by Bryan because inadequate cooking is thought to contribute to outbreaks of *Salmonella enteriditis PT4* (CDSC, 1993) and *Campylobacter*, which are held responsible for the large increase in food poisoning. Some processes, such as thawing of raw foods and storage of frozen foods contribute infrequently to food poisoning and were assigned demerit ratings of 10 marks. Other operations were assigned demerit ratings intermediate between 10 and 90, depending on their relative frequency of contributing to outbreaks of food poisoning (Table 4.7).

The demerit weightings were intended to take account of the severity and risks of each process hazard and the desirability of exerting control to reduce or eliminate the hazard at each stage of the operation.

Demerit ratings were summed to form the food operation risk (FOR). Whilst the value of the demerit rating for each process step was fixed, the precise allocation of points would depend on the detailed hazards present in the particular recipe.

During the audit, each step of the process was checked to establish that critical control measures were being implemented. Where this was the case no demerit points were allocated. Where the required criteria were not being met, demerit points were assigned and accumulated.

The foods that were handled were assigned a food risk coefficient, with a range of 1 to 5, based on their relative frequency of contributing to outbreaks of food poisoning (Table 4.6). This information was drawn from statistics that relate to general outbreaks of food poisoning, since data on reported food vehicles in family outbreaks is unavailable (PHLS CDSC, 1993).

The individual **Food Safety Risk** (FSR) was then calculated by multiplying the **Food Risk** (FR) by the **Food Operation Risk** (FOR).

Food Safety Risk = Food Risk x Food Operation Risk

FSR = FR x FOR

The Food Safety Risk system has the potential for extensive application. It could be used to evaluate hygienic operations in a wide variety of food production environments. The demerit ratings for process hazards and the food risk coefficients which form the basis of the system could be refined as more data becomes available.

Table 4.6 Food risk coefficients

Recipe	Coefficient
Contains eggs	5
Contains chicken and ham	5
Contains chicken	3
Contains beef	2.5

Table 4.7 Food Operation Risk Demerit Ratings

Process step	Demerit Points
Procuring	20
Refrigerated storage	20
Frozen storage	10
Thawing	10
Handling and Preparing raw foods	30
Cooking	50
Hot Holding	40
Cooling	50
Handling cooked products	40
Room temperature storage	90
Refrigeration	20
Re-heating	50
Handling after re-heating	40
Food operation risk	TOTAL

The Food Safety Risks for the four recipes are shown in Tables 4.8, 4.9, 4.10, 4.11

Table 4.8 The Food Safety Risk Score for Recipe 1

1. Food risk (FR)	
Recipe	**Coefficient**
Contains chicken and ham	5
2. Food Operation Risk (FOR)	
Process step	**Demerit points**
Procuring	
• Damaged packaging	5
• Older than 'use' by date	5
• Temperature abuse during transport	10
TOTAL	**(20)**
Storage	
• Ham, chicken stored above 5^{o}C	10
• Food stored longer than 2 days	10
TOTAL	**(20)**
Handling and Preparing raw foods	
• Chicken packaging contaminates work surface	1
• Washes chicken	2
• Handler does not wash hands after handling raw chicken	10
• Parsley not washed	2
• Ham cut on dirty board	10
• Chicken cut in large uneven pieces	5
TOTAL	**(30)**
Cooking	
• Product not cooked to internal temperature of at least 74^{o}C	
TOTAL	**(50)**
Cooling	
• Product is not cooled rapidly to 21^{o}C within 90 minutes	
TOTAL	**(50)**
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	30
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	60
• Product is kept at room temperature for period longer than 12 hours	90
MAXIMUM	**(90)**
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5^{o}C or less	10
• Cooked food is stored in refrigerator longer than 3 days	10
TOTAL	**(20)**
Re-heating	
• Product not cooked to internal temperature of at least 74^{o}C	
TOTAL	(50)
Handling after re-heating	
• Product is re-heated more than once, with intervening holding periods at room temperature	
TOTAL	**(40)**

Food Operation Risk (FOR) **= 370 - Maximum Score**
= 0 - Minimum Score

Maximum food safety risk (FSR) **= food risk (FR) x food operation risk (FOR)**
= 5 x 370
= 1850

Table 4.9 The Food Safety Risk Score for Recipe 2

1. Food risk (FR)

Recipe	**Coefficient**
Contains minced beef and chicken liver	5

2. Food Operation Risk (FOR)

Process step	**Demerit points**
Procuring	
• Damaged packaging	5
• Older than 'use by' date	5
• Temperature abuse during transport	10
TOTAL	(20)
Refrigerated Storage	
• Bacon, minced beef stored above 5°C	10
• Food stored longer than 2 days	10
TOTAL	(20)
Frozen Storage	
• Chicken liver stored above -18°C	
TOTAL	(10)
Thawing	
• Liver not thawed completely	5
• Thawed in kitchen at room temperature	5
TOTAL	(10)
Handling and Preparing raw foods	
• Meat packaging contaminates work surface	1
• Washes liver	2
• Handler does not wash hands after handling raw meat	10
• Parsley not washed	2
• Parsley cut on dirty board	10
TOTAL	(25)
Cooking	
• Product not cooked to internal temperature of at least 74°C	
TOTAL	(50)
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	
TOTAL	50
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	30
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	60
• Product is kept at room temperature for period longer than 12 hours	90
MAXIMUM	(90)
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	10
• Product is stored in refrigerator longer than 3 days	10
TOTAL	(20)
Re-heating	
• Product not cooked to internal temperature of at least 74°C	
TOTAL	(50)
Handling after re-heating	
• Product is re-heated more than once, with intervening holding periods at room temperature	
TOTAL	(40)

Food Operation Risk (FOR)	**= 385 - Maximum Score**
	= 0 - Minimum Score
Maximum food safety risk (FSR)	**= food risk (FR) x food operation risk (FOR)**
	= 5 x 385
	= 1925

Table 4.10 The Food Safety Risk Score for Recipe 3

1. Food risk (FR)	
Recipe	**Coefficient**
Contains eggs and prawns	5
2. Food Operation Risk (FOR)	
Process step	**Demerit points**
Procuring	
• Damaged packaging	5
• Older than 'use by' date	5
• Temperature abuse during transport	10
TOTAL	(20)
Refrigerated Storage	
• Cheese, cream stored above 5°C	10
• Cream stored for longer than 2 days	10
TOTAL	(20)
Frozen Storage	
• Prawns stored above -18°C	
TOTAL	(10)
Thawing	
• Prawns not thawed completely	5
• Thawed in kitchen at room temperature	5
TOTAL	(10)
Handling and Preparing raw foods	
• Egg shells contaminate work surface	1
• Leeks not thoroughly washed	2
• Handler does not wash hands after handling raw leeks, eggs	10
• Parsley not washed	2
• Parsley cut on dirty board	10
TOTAL	(25)
Cooking	
• Product not cooked to internal temperature of at least 74°C	
TOTAL	(50)
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	
TOTAL	(50)
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	30
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	60
• Product is kept at room temperature for period longer than 12 hours	90
MAXIMUM	(90)
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	10
• Product is stored in refrigerator longer than 3 days	10
TOTAL	(20)
Re-heating	
• Product is not re-heated to an internal temperature of 74°C	
TOTAL	(50)
Handling after Re-heating	
• Product is re-heated more than once, with intervening holding periods at room temperature	
TOTAL	(40)

Food Operation Risk (FOR) = 385 - Maximum Score
= 0 - Minimum Score

Maximum food safety risk (FSR) = food risk (FR) x food operation risk (FOR)
= 5 x 385
= 1925

Table 4.11 The Food Safety Risk Score for Recipe 4

1. Food risk (FR)

Recipe	**Coefficient**
Contains chicken	3

2. Food Operation Risk (FOR)

Process step	**Demerit points**
Procuring	
• Damaged packaging	5
• Older than 'use by' date	5
• Temperature abuse during transport	10
TOTAL	(20)
Storage	
• Fromage frais, chicken stored above 5°C	10
• Food stored longer than 2 days	10
TOTAL	(20)
Handling and Preparing raw foods	
• Chicken packaging contaminates work surface	1
• Washes chicken	2
• Handler does not wash hands after handling raw chicken	10
• Lettuce not washed	2
• Lettuce cut on dirty board	10
TOTAL	(25)
Cooking	
• Product not cooked to internal temperature of at least 74°C	
TOTAL	(50)
Post Cooking handling	
• Chicken cut on dirty board	15
• Cooked chicken handled directly	15
• Hot chicken mixed with other ingredients	10
TOTAL	(40)
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	30
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	60
• Product is kept at room temperature for period longer than 12 hours	90
MAXIMUM	(90)
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	10
• Cooked food is stored in refrigerator longer than 3 days	10
TOTAL	(20)

Food Operation Risk (FOR) = **265 - Maximum Score**
= **0 - Minimum Score**

Maximum food safety risk (FSR) = **food risk (FR) x food operation risk (FOR)**
= **3 x 265**
= **795**

4.7 Kitchen and Personal Hygiene Check-list

A check-list, developed as a result of the preliminary work on auditing hygiene in domestic kitchens, was used in the evaluation of cleaning and sanitary maintenance of the equipment, the process environment and the personal hygiene of the handler (Form 5).

Whilst equipment sanitation is likely to be a CCP in many HACCP analyses, environmental maintenance and sanitation is usually critical only when cooked food is uncovered and exposed to the environment for lengthy periods of time. The subject's score for kitchen and personal hygiene will be given in addition to the Food Safety Risk score derived from the hazard analysis.

Fig. 4.25 Form 5. Kitchen and Personal Hygiene Check-list

Circle appropriate scores

			Score
A.	**Equipment maintenance and sanitation**		
1.	Single general purpose cutting board		1
2.	Condition of cutting board:		
	a	Smooth, not scored, clean and dry	0
	b	Very lightly scored and/or stained	1
	c	Some central scoring and staining	2
	d	Heavier scoring and staining	3
	e	Very heavily scored, chipped, stained, dirty	4
3.	Method of cleaning the cutting board after use with raw ingredients:		
	a	Immersed in hot detergent water, scrubbed with clean brush, rinsed dried with paper towel. Sprayed with sanitiser, allowed to dry	0
	b	Immersed in hot detergent water wiped with cloth, allowed to drain	1
	c	Held under running hot water, wiped with cloth	2
	d	Wiped with damp cloth	3
4.	Condition/cleanliness of dishcloth/wiping cloths:		
	a	No stains, not worn, not discoloured, no odour	0
	b	Some wear, but not stained or discoloured	1
	c	Some wear, some discolouration, screwed up	2
	d	Stained or discoloured, wet	3
	e	Worn, wet, soiled, smelly	4

5.	The same cloth is used for wiping surfaces and dishwashing	1
6.	No disposable cleaning, drying cloths	1
7.	No handwashing soap	1
8.	No hand towel	1
9.	No nailbrush	1
10.	No dishwasher	1

B	**Environmental maintenance and sanitation**	**Score**
11.	Work surface not segregated into areas for handling raw/cooked	1
12.	Work surface not clear	1
13.	Condition of the work surface in the area of food preparation:	
	a No sign of food particles, grease, dirt	0
	b Some food particles or food stains	1
	c Some food particles and dirt or grime	2
	d More food particles, dirt or grease	3
	e Heavily soiled	4
14.	Cleanliness of working area adjacent to sink:	
	a No sign of food particles, grease, dirt	0
	b Some food particles or food stains	1
	c Some food particles and dirt or grime	2
	d More food particles, dirt or grease	3
	e Heavily soiled	4
15.	Single general purpose sink	1
16.	Soiled vegetables stored openly in kitchen	1
17.	Kitchen heated	1
18.	Kitchen lacks ventilation system	1
19.	Washing machine located in kitchen.	1
20.	Domestic pet in the kitchen	1
21.	Animal feeding bowls in the kitchen	1

Hygiene of handler		**Score**
1.	Handle food with infected lesions	2
2.	Smokes whilst handling food	1
3.	Does not wear any protective clothing	1
4.	Hand-washing after handling raw animal produce:	
	a Holds under hot running water or immerses hands in a bowl of hot water, uses soap or detergent, generates lather, rinses and dries	0
	b Holds hands under hot running water uses detergent or soap, generates lather, doesn't dry	1
	c Holds under hot running water, dries	2
	d Agitates fingers in water, dries	3
	e Agitates fingers, briefly in water, does not dry	4
	f Wipes fingers on dishcloth	5
	g Neither wipes or washes hands	6

Total Maximum Score 45

4.8 The Interview

In order to determine the subjects' knowledge of relevant food safety principles and to gather information on aspects of food handling which had not been available for observation, an interview schedule (Form 6) was devised, piloted and modified where necessary before being used in the main study. This acted as an *aide-memoire* in the semi-structured interview which was conducted by the researcher with the subject, after the food preparation exercise. The response rate was thought likely to be higher than would be the case if participants were asked to complete a questionnaire.

Fig. 4.26 Form 6 The Interview Schedule

1. How often is the main food shopping for this household carried out?
   a. twice a week or more
   b. once a week
   c. once a fortnight
   d. less often
2. How far away are the shops that you use for your main shopping?
   a. under 1 mile
   b. less than 5 miles
   c. more than 5 miles
3. How long does it take you to get your main shopping home?
   a. less than 15 minutes
   b. less than 30 minutes
   c. less than one hour
   d. more than one hour
4. Do you usually use an insulated cool bag or box to transport chilled or frozen food?
   a. no
   b. yes
5. Do you use the storage advice on packs of perishable foods?
   a. usually
   b. sometimes
   c. rarely
   d. never
6. When buying food how often do you look at the 'use by' date?
   a. usually
   b. sometimes
   c. rarely
   d. never

7. When buying chilled food would you reject a damaged pack?
   a. always
   b. sometimes
   c. never
8. How often is raw meat/poultry prepared in the kitchen?
   a. daily
   b. three times or more a week
   c. less than three times a week
   d. never
9. How often are raw vegetables prepared in the kitchen?
   a. daily
   b. three times or more a week
   c. less than three times a week
10. Do you prepare raw and cooked foods in separate parts of the kitchen?
   a. no
   b. yes
11. Do you use more than one chopping board?
   a. no
   b. yes
12. Where do you store raw meat in the fridge?
   a. top shelf
   b. middle shelf
   c. bottom shelf
   d anywhere there is a space
13. Where in the same fridge would you put a fresh cream trifle:
   a. top shelf
   b. middle shelf
   c. bottom shelf
   d anywhere
14. Where is hot cooked food cooled?
   a. in the larder
   b. in the kitchen
   c. in the utility room
   d. other
15. Do you prepare meals to be eaten on another day or at a later time?
   a. regularly
   b. occasionally
   c. rarely
   d. never
16. How do you usually re-heat food?
   a. in a conventional oven
   b. on the hob
   c. in the microwave
   d. more than 1 method
17. Where do you thaw food?
   a in the fridge
   b. in the larder
   c. in the kitchen
   d. in the microwave oven
   e. under the tap/in the sink
   f. use variety of places, a-e
   g. other

18. How do you know when a frozen chicken is thawed?
    a. by experience, based on the length of the thaw period
    b. take the final temperature of the bird
    c. by touch
    d. more than 1 method
19. How long would you thaw a 3lb (1.5 kg) chicken for?
    a. overnight, at room temperature
    b. about 20 hours in the fridge
    c. about 20 minutes in the microwave
    d. other
20. The temperature inside the fridge should be at or below?
    a. 10°C
    b. 5°C
    c. -18°C
    d. -40°C
    e. don't know
21. Have you ever measured the temperature of your fridge?
    a. no
    b. yes
22. Have you ever adjusted the temperature control on your fridge?
    a. no
    b. yes
23. How long would you allow a 3lb cooked chicken to cool before refrigerating it?
    a. less than one hour at room temperature
    b. up to two hours at room temperature
    c. more than two hours
    d. other
24. How do you calculate meat cooking temperatures and times?
    a. past experience
    b. instructions on the food
    c. recipe books
    d. with the help of a meat thermometer
    e. more than 1 method
25. What should the temperature be inside a piece of meat when it is well cooked?
    a. 40°C
    b. 60°C
    c. 75°C
    d. 100°C
    e. above 100°C
    f. don't know
26. Do you know the power output of your microwave oven?
    a. no
    b. yes
27. Do you know how to adjust cooking times in the microwave oven according to the wattage?
    a. no
    b. yes
28. Do you allow for standing time when cooking food in the microwave oven?
    a. no
    b. yes
29. Which of these age groups do you belong to?
    a. 16-34
    b. 35-54
    c. 55+
30. What is the occupation of the head of the household?

CHAPTER 5. RESULTS

'Words are but wind,
but seeing is believing'

Proverb

5. Results

The results are presented here in descriptive and tabular form and in detail in Appendix 3. The percentages have been rounded up or down to the nearest whole number, which may result in totals greater than 100. The Statistical Package for the Social Sciences (SPSS/PC+) was used for the statistical analysis.

5.1 Analysis of Profile data

The study used 108 subject, 100 of which were female. The subjects were fairly evenly distributed between the three age groups but the socio-economic profile was skewed towards the ABC groups.

Table 5.1 Percentage of subjects in each gender group

SEX	PERCENTAGE OF SUBJECTS
FEMALE	92.6
MALE	7.4

Number of subjects = 108

Table 5.2 Percentage of subjects in each age group

AGE GROUP	PERCENTAGE OF SUBJECTS
16 to 34	32.4
35 to 54	32.4
55+	35.2

Number of subjects = 108

Table 5.3 Percentage of subjects within each socio-economic group

SOCIO-ECONOMIC GROUP	PERCENTAGE OF SUBJECTS
A	7.4
B	22.2
C1	37.9
C2	26.9
D	4.6
E	0.9

Number of subjects = 108

5.2 Analysis of the subjects who prepared each recipe

Table 5.4 Age profile of subjects preparing each recipe

AGE GROUP	RECIPE 1	RECIPE 2	RECIPE 3	RECIPE 4
	PERCENTAGE OF SUBJECTS			
16 to 34	47	35	12	32
35 to 54	31	23	36	40
55+	22	42	52	28

Number of subjects = 108

Table 5.5 Socio-economic profile of subjects making each recipe

SOCIAL GROUP	RECIPE 1	RECIPE 2	RECIPE 3	RECIPE 4
	PERCENTAGE OF SUBJECTS			
A	6	0	8	16
B	19	27	28	16
C1	34	42	44	32
C2	34	27	20	24
D	6	4	0	8
E	0	0	0	4

Number of subjects = 108

5.3 Time of the investigation

Table 5.6 Month of home visit

MONTH	NUMBER OF VISITS
JANUARY	2
FEBRUARY	13
MARCH	14
APRIL	7
MAY	13
JUNE	8
JULY	8
AUGUST	26
SEPTEMBER	9
OCTOBER	2
NOVEMBER	3
DECEMBER	3

Number of subjects = 108

5.4 Analysis of Food Safety Risk (FSR) scores

5.41 Scores expressed as a percentage, ranged from 0 to 65% with over half of the subjects (58%) scoring below 20%.

Table 5.7 Percentage of subjects within each Food Safety Risk (FSR) score range

FSR SCORE RANGE %	PERCENTAGE OF SUBJECTS
0 to 4.9	13.8
5 to 9.9	25.0
10 to 14.9	6.5
15 to 19.9	12.9
20 to 24.9	11.1
25 to 29.9	6.5
30 to 34.9	8.3
35 to 39.9	5.6
40 to 44.9	3.7
45 to 49.9	2.8
50 to 54.9	0.0
55 to 59.9	0.0
60 to 64.9	3.7

Number of subjects = 108

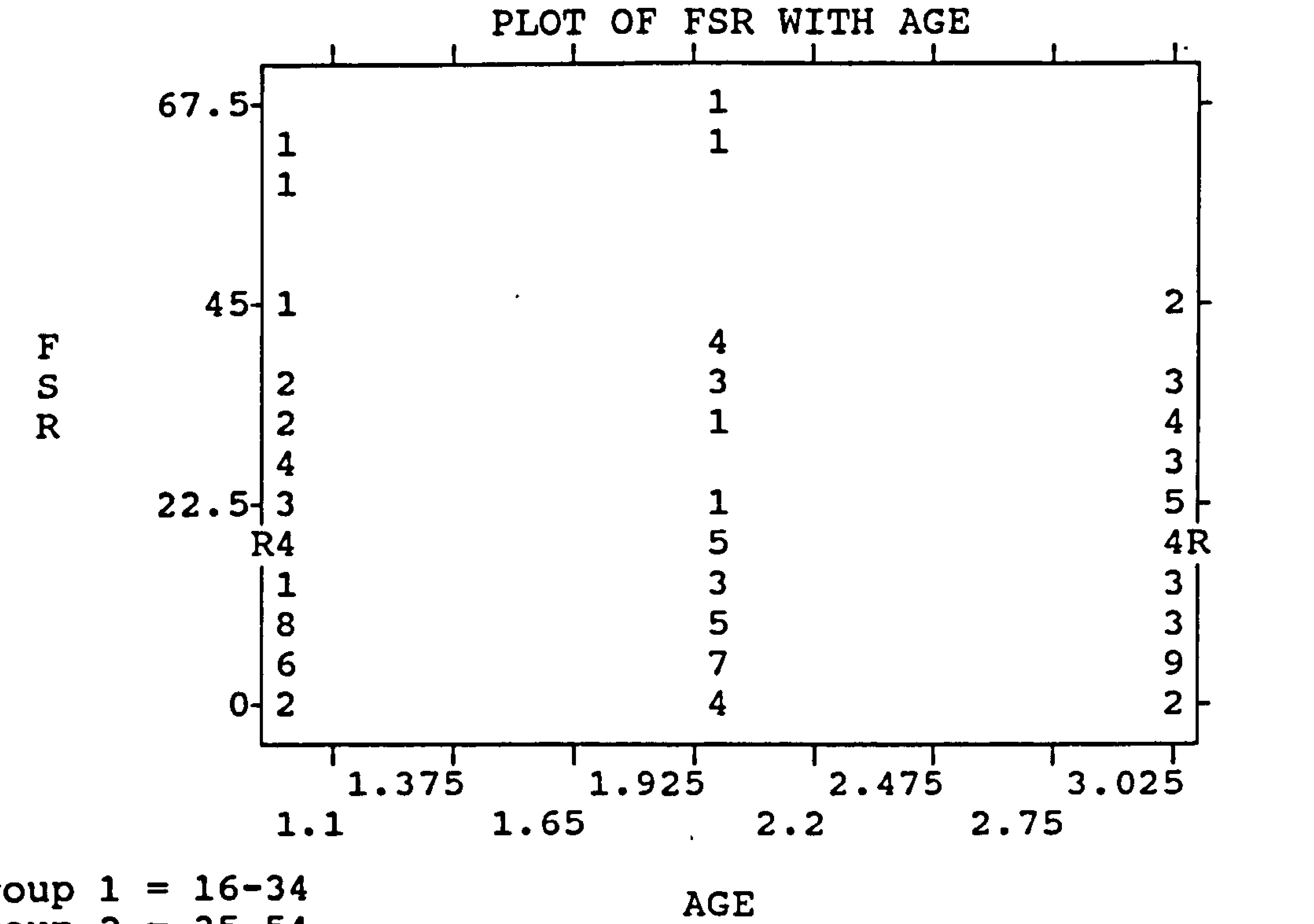
5.42 Analysis of FSR by age group

Table 5.8 Mean FSR score of each age group

AGE GROUP	NUMBER OF SUBJECTS	MEAN FSR SCORE
16-34	35	19.1 (SD 15.6)
35-54	35	18.9 (SD 17.5)
55+	38	18.7 (SD 12.4)

Number of subjects = 108

Fig. 5.1 Scatter diagram: Food Safety Score Percentage (FSR) with Age



Age group 1 = 16-34
Age group 2 = 35-54
Age group 3 = 55+

108 cases plotted. Regression statistics of FSR on AGE:
Correlation -.01238 R Squared .00015 S.E. of Est 15.39289
Sig. .8988
Intercept(S.E.) 19.38549(3.94403) Slope(S.E.) -.22983 (1.80263)

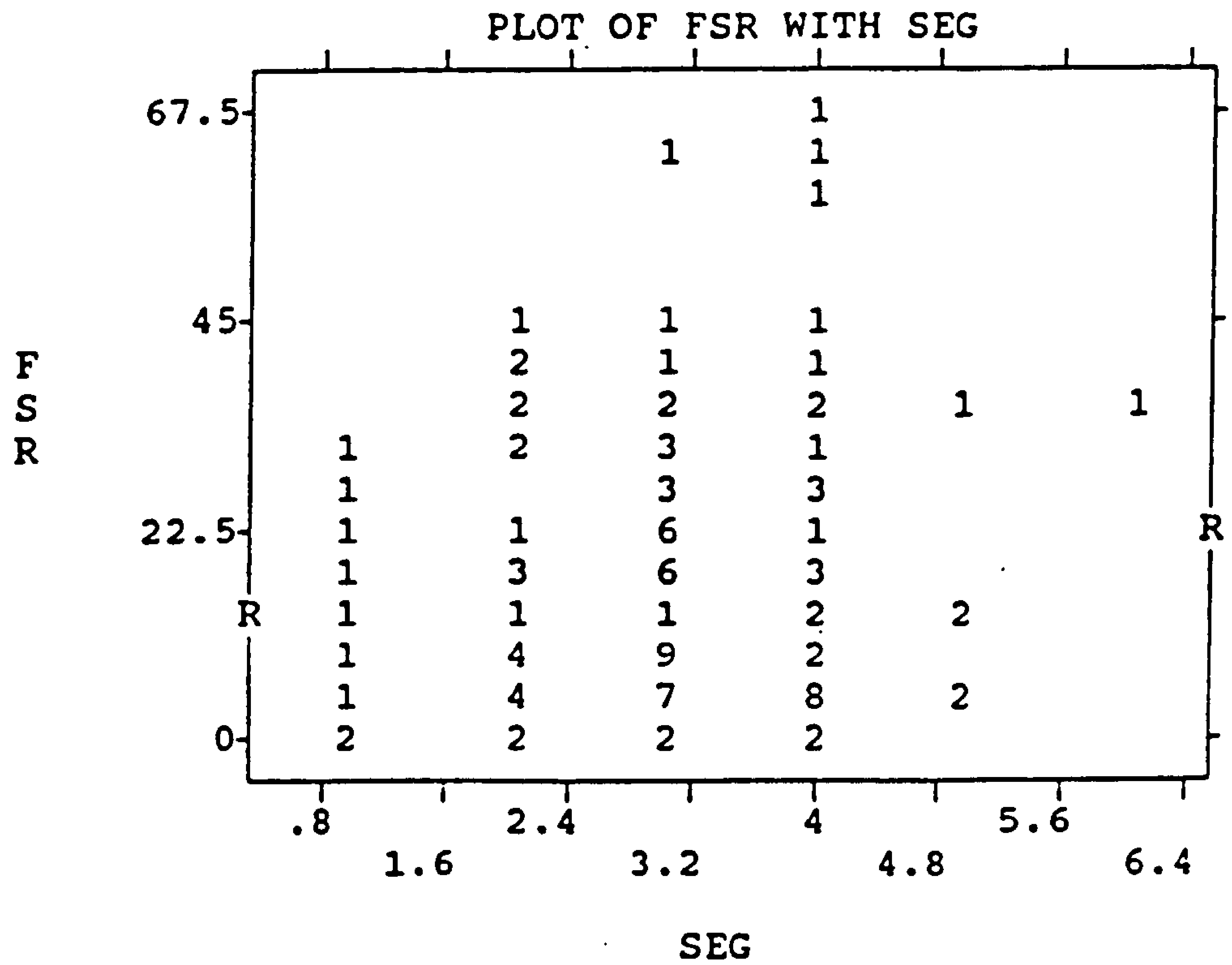
5.43 Analysis of FRS by socio-economic group

Table 5.9 Mean FSR score of each socio-economic group

SOCIO-ECONOMIC GROUP	NUMBER OF SUBJECTS	MEAN FSR SCORE
A	8	14.6 (SD 10.8)
B	24	18.4 (SD 14.4)
C1	41	18.2 (SD 13.4)
C2	29	21.9 (SD 18.5)
D	5	19.4 (SD 11.7)
E	1	34

Number of subjects = 108

Fig. 5.2 Scatter diagram: Food Safety Risk Scores (FSR) with Socio-economic group (SEG)



Socio-economic groups:
A = 1, B = 2, C1 = 3, C2 = 4, D = 5, E = 6

108 cases plotted. Regression statistics of FSR on SEG:
Correlation .10450 R Squared .01092 S.E. of Est 15.32082
Sig. .2818
Intercept(S.E.) 14.26436(4.54053) Slope(S.E.)
1.53911(1.42273)

5.44 Analysis of FRS by recipe

Table 5.10 Mean FSR score for each recipe

RECIPE	NUMBER OF SUBJECTS	MEAN FSR SCORE
1	32	19.3 (SD 18.0)
2	26	15.6 (SD 13.3)
3	25	21.7 (SD 17.2)
4	25	19.5 (SD 8.3)

Number of subjects = 108

5.5 Analysis of Food Operation Risk Scores

5.51 Food Operation Risk Score for Recipe 1

Procuring

All subjects claimed to usually or sometimes use the storage advice on packs of perishable food and to reject perishable ingredients with damaged packaging.

Temperature abuse of the perishable ingredients during transport was demonstrated by 15/32 (47%) of subjects.

Storage

Many (72%) subjects stored the chicken and ham in a refrigerator at a temperature in excess of 5°C. In all cases the perishable food was stored for two days or less. The mean temperature of the refrigerators was 6.1°C (sd=2.3). Two subjects demonstrated all control criteria except temperature control during food transport and storage.

Handling and Preparing raw foods

Nearly half (47%) of the subjects put on protective clothing before they started food preparation and 28% washed their hands. Over half (56%) neglected to wash their hands after preparation of the vegetables and 34% after cutting up the raw chicken. The chicken packaging was allowed to remain in the preparation area by 38% of subjects and 19% did not dispose of vegetable waste until the end of the exercise. 16% washed the raw chicken under a stream of water from the tap. Half of the subjects failed to wash the mushrooms and 38% neglected to wash the parsley. 13/32 (41%) used the same board for all cutting operations, including the raw chicken, vegetables and the cooked ham and (22%) failed to clean and sanitise the board adequately between operations. 6/32 (19%) carried out all preventative measures during the preparation of the raw ingredients. 9/32 (28%) failed to carry out one of the preventative measures in this process step and 4/32 (13%) were awarded at least 66% of the total demerit points for failure to implement control procedures for this step.

Cooking

Three subjects (9%) did not cook the food to an internal temperature of at least 74°C. The lowest temperature that was recorded was 63°C. The mean internal temperature of the food was 81.5°C (sd=6.7). Most (75%) subjects took less than five minutes to seal the chicken but did stir the meat frequently so ensuring that the pieces of chicken were well exposed to the heat source. Most (94%) of the subjects prepared the chicken so that the pieces were of a small, uniform size and the majority (91%) allowed the sauce to come to the boil and ensured that the food was cooked for at least one minute after the parsley and ham were added. Many subjects extended the cooking by at least 10 minutes beyond this point. 19% used a lid on the cooking container.

28% (9/32) of subjects ate the dish immediately or within one hour of cooking.

Cooling

Eight subjects refrigerated the product within 60 to 90 minutes of cooking but only one of these used any means of speeding the cooling rate. Five subjects transferred the food to another container and six covered the product whilst it was cooling. Laboratory trials have shown that the product was likely to be in excess of 40°C when refrigerated (see 4.4).

Room temperature storage

15/23 (65%) kept the product at ambient temperature for more than 90 minutes. A single subject (4%) aided cooling by placing the covered pan in a cooler room. 7/15 (47%) transferred the product to a new container and 4/15 (27%) covered the container. The mean holding period at room temperature was 3.82 hours (sd=1.9). Five subjects (22%) kept the product at room temperature for at least 3 hours but less than 6 hours, whilst 4/23 (17%) kept it at ambient for at least 6 hours but less than 12 hours.

Refrigerated Storage

11/23 (48%) refrigerated the product and one froze the product for three days. 5/11 (45%) held the product in a refrigerator which operated at 5^{o}C or less, whilst the remainder held it in an appliance which operated at a temperature higher than recommended. The mean storage period of the product was 9.18 hours (sd=6.2). The storage period ranged from 4 hours to 24 hours.

Re-heating

14/23 (61%) were able to estimate the time required to re-heat the product. The mean estimate of eleven subjects for re-heating in the microwave oven at full power was 6.15 minutes (sd=1.9) and for re-heating on the hob was 8.66 minutes (sd=4.8).

Based on the information supplied by the subjects, three (13%) were judged likely to under-heat the product during re-heating.

Nine subjects were unable to estimate the time required to re-heat the product. They talked in terms of re-heating until the product was very hot or until it bubbled or gave off steam.

Handling after re-heating

5/23 (22%) of the subjects re-heated the product more than once.

Table 5.11 Food Operation Risk Score for Recipe 1

Process step	% of Occurrences
Procuring	
• Damaged packaging	0
• Older than 'use by' date	0
• Temperature abuse during transport	47
Storage	
• Ham, chicken stored above 5°C	72
• Food stored longer than 2 days	0
Handling and Preparing raw foods	
• Chicken packaging contaminates work surface	38
• Washes chicken	16
• Handler does not wash hands after handling raw chicken	34
• Parsley not washed	38
• Ham cut on dirty board	22
• Chicken cut in large uneven pieces	3
Cooking	
• Product not cooked to internal temperature of at least 74°C	9
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	47
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	16
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	13
• Product is kept at room temperature for period longer than 12 hours	0
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	28
• Cooked food is stored in refrigerator longer than 3 days	0
Re-heating	
• Product not cooked to internal temperature of at least 74°C	9.4
Handling after re-heating	
• Product is re-heated more than once, with intervening holding periods at room temperature	12.5

Number of subjects = 32

5.52 Food Operation Risk Score for Recipe 2

Procuring

All subjects claimed to usually or sometimes use the storage advice on packs of perishable food and to reject perishable ingredients with damaged packaging. Temperature abuse of the perishable ingredients during transport was demonstrated by 12/26 (46%) of subjects.

Storage

Many (69%) subjects stored the bacon and minced beef in a refrigerator at a temperature in excess of 5°C. In all cases the perishable food was stored for two days or less. The mean temperature of the refrigerators was 6.4°C (sd=1.8). A single subject demonstrated all control criteria except temperature control during food transport and storage. 88% of the subjects stored the frozen chicken livers in the freezer. 2 subjects stored this ingredient in the refrigerator.

Thawing

Eight subjects thawed the liver in the kitchen at room temperature whilst ten thawed it in the refrigerator. In all cases the liver was thawed adequately. Eight subjects declined to use the ingredient.

Handling and Preparing raw foods

Some (31%) of the subjects put on protective clothing before they started food preparation and 42% washed their hands. 65% neglected to wash their hands after preparation of the vegetables and 50% after cutting up the raw meat. The meat packaging was allowed to remain in the preparation area by a single subject and 15% did not dispose of vegetable waste until the end of the exercise. 50% washed the thawed chicken liver under a stream of water from the tap. Some subjects failed to wash the red peppers (61%) and neglected to wash the parsley (54%). Many (65%) used the same board for all cutting operations, including the raw meat and the vegetables and (42%) did not clean and sanitise it adequately between operations. A clean tin opener was used by the majority (92%) of people. Most (77%) completed the preparation of the ingredients in less than thirty minutes. 3/26 (11.5%) carried out all preventative measures during the preparation of the raw ingredients. 5/26 (19%) failed to carry out one of the preventative measures in this process step and 3/26 (11.5%) were awarded at least 88% of the total demerit points for failure to implement control procedures for this step.

Cooking

All the subjects cooked the food to an internal temperature of at least 74°C. The mean internal temperature of the food was 84.6°C (sd=5.1). Most (96%) used a suitable cooking pan, a moderate heat source and stirred the minced beef whilst it was cooking, ensuring even heat penetration.

Over half (54%) subjects did not eat the dish immediately or within one hour of cooking.

Cooling

None of the subjects used any means of speeding the cooling rate. Three subjects refrigerated the product within 60 to 90 minutes of cooking. Laboratory trials have shown that the temperature of the product at the time of refrigeration would have been in excess of 40°C (see 4.4). Three subjects transferred the food to another container and all but one covered the product whilst it was cooling.

Room temperature storage

Many people (11/14, 79%) kept the product at ambient temperature for more than 90 minutes. Only two subjects (14%) aided cooling by placing the covered pan in a cooler room. The mean holding period at room temperature was 2.3 hours (sd=1.1). Four subjects (29%) kept the product at room temperature for more than 3 hours but less than 6 hours.

Refrigerated Storage

Five people refrigerated the product, three using an appliance which operated at a temperature higher than recommended. The mean storage period of the product in the refrigerator was 16.8 hours. A single subject kept the product for longer than three days.

Re-heating

6/14 (43%) were able to estimate the time required to re-heat the product. The mean estimate of five subjects for re-heating in the microwave oven at full power was 6.6 minutes and for re-heating on the hob was 10 minutes. Based on the information supplied by the subjects, two were judged likely to under-heat the product during re-heating.

8/14 (57%) subjects were unable to estimate the time required to re-heat the product. They talked in terms of re-heating until the product was very hot or until it bubbled or gave off steam.

Handling after re-heating

3/14 (21%) of the subjects re-heated the product more than once.

Table 5.12 Food Operation Risk Score for Recipe 2

Process step	% of Occurrences
Procuring	
• Damaged packaging	0
• Older than 'use by' date	0
• Temperature abuse during transport	46
Refrigerated Storage	
• Bacon, minced beef stored above 5°C	69
• Food stored longer than 2 days	0
Frozen Storage	
• Chicken liver stored above -18°C	0
Thawing	
• Liver not thawed completely	0
• Thawed in kitchen at room temperature	31
Handling and Preparing raw foods	
• Meat packaging contaminates work surface	4
• Washes liver	50
• Handler does not wash hands after handling raw meat	50
• Parsley not washed	54
• Parsley cut on dirty board	42
Cooking	
• Product not cooked to internal temperature of at least 74°C	0
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	39
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	15
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	0
• Product is kept at room temperature for period longer than 12 hours	0
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	12
• Product is stored in refrigerator longer than 3 days	4
Re-heating	
• Product not cooked to internal temperature of at least 74°C	8
Handling after re-heating	
• Product is re-heated more than once, with intervening holding periods at room temperature	12

Number of subjects = 26

5.53 Food Operation Risk Score for Recipe 3

Procuring

All subjects claimed to usually or sometimes use the storage advice on packs of perishable food and to reject perishable ingredients with damaged packaging.

Temperature abuse of the perishable ingredients during transport was demonstrated by 9/25 (36%) of subjects.

Storage

Over half (56%) of subjects stored the cream and eggs in a refrigerator at a temperature in excess of 5^{o}C. Most people (92%) stored the frozen prawns in a freezer whilst the remainder stored them in the refrigerator. In all cases the perishable food was stored for two days or less. The mean temperature of the refrigerators was 5.9^{o}C (sd=2.6).

Thawing

Only 4/25 (16%) thawed the prawns in the refrigerator, the majority thawed this ingredient at room temperature or in the microwave oven. In no case were the prawns held for longer than 90 minutes at ambient temperature. Thawing was sometimes assisted by holding the product under a stream of cold water, by immersion in cold water and by removal from the packaging and exposure to the air. Only 16% of subjects made no attempt to thaw the prawns before cooking.

Handling and Preparing raw foods

32% of the subjects put on protective clothing before they started food preparation and 40% washed their hands. Many people (80%) neglected to wash their hands after breaking the eggs and the egg shells were allowed to remain in the preparation area by 8% of subjects. Half of the people (52%) washed the leeks thoroughly, cutting the vegetables to expose the interior leaves. Only two failed to wash the leeks whilst the remaining subjects used cleaning techniques that would have allowed some soil to remain. 28% neglected to wash the parsley. Many (64%) used the same board for all cutting operations and 24% did not clean it adequately between operations.

4/25 (16%) carried out all preventative measures during the preparation of the raw ingredients. 10/25 (40%) failed to carry out one of the preventative measures in this process step and 4/25 (16%) were awarded at least 88% of the total demerit points for failure to implement control procedures for this step.

Cooking

The mean centre end-point temperature (EPT) of the food was 78.2°C (sd=8.3). Seven subjects (28%) failed to cook the product to an internal temperature of at least 74°C. The mean centre EPT of these products was 67.8°C (sd=3.5). One of the subjects failed to pre-heat the oven, another pre-heated to a lower temperature than directed, another used an oven setting of 150°C and a fourth used a solid fuel cooker.

Most subjects pre-heated their ovens for a period of 10 to 15 minutes to the temperature indicated on the recipe sheet. Three used fan assisted ovens which were set at temperatures between 150°C and 160°C. One oven was set at 200°C and one subject used a table top oven which was set at 180°C but appeared to operate at a lower temperature, taking 50 minutes to cook the dish.

The majority of people cooked the leeks as directed in the recipe but two cooked them in water and two cooked them in a microwave oven.

16/25 (64%) did not complete the cooking by placing the product under a hot grill.

12/25 (48%) of subjects ate the dish immediately or within the hour.

Cooling

None of the thirteen subjects who held the product used any means of speeding the cooling rate. A single subject refrigerated the product within 60 minutes of cooking. Laboratory trials indicate that this product would have been in excess of 40°C (see 4.4).

One person allowed the product to remain in the oven for 2.5 hours after it was switched off.

Room temperature storage

Most people (12/13, 92%) kept the product at ambient temperature for more than 90 minutes. No one transferred the product to a cooler place and two subjects covered the product whilst it cooled. The mean holding period at room temperature was 3.7 hours (sd=2.2). Four subjects (31%) kept the product at room temperature for at least 3 hours but less than 6 hours, whilst 3/13 (23%) kept it at ambient temperature for at least 6 hours but less than 12 hours.

Refrigeration

Only one subject refrigerated the product in an appliance which operated at under 5°C. The product was held for 24 hours.

Re-heating

All subjects were able to estimate the time required to re-heat the product. The mean estimate for re-heating in the microwave oven at full power was 2.4 minutes.(5 subjects) and for re-heating in the oven was 13.3 minutes at 148°C (6 subjects).

Based on the information supplied by the subjects, seven (54%) were judged likely to under-heat the product during re-heating. The lowest oven temperature estimated was 100°C and the shortest time was 10 minutes.

2 subjects indicated that they would eat the product at room temperature.

Handling after Re-heating

No one indicated that they would re-heat the product more than once.

Table 5.13 Food Operation Risk Score for Recipe 3

Process step	% of Occurrences
Procuring	
• Damaged packaging	0
• Older than 'use by' date	0
• Temperature abuse during transport	36
Refrigerated Storage	
• Cheese, cream stored above 5°C	56
• Cream stored for longer than 2 days	0
Frozen Storage	
• Prawns stored above -18°C	0
Thawing	
• Prawns not thawed completely	16
• Thawed in kitchen for longer than 90 minutes	0
Handling and Preparing raw foods	
• Egg shells contaminate work surface	8
• Leeks not thoroughly washed	32
• Handler does not wash hands after handling raw leeks, eggs	80
• Parsley not washed	28
• Parsley cut on dirty board	24
Cooking	
• Product not cooked to internal temperature of at least 74°C	28
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	48
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	16
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	12
• Product is kept at room temperature for period longer than 12 hours	0
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	0
• Product is stored in refrigerator longer than 3 days	0
Re-heating	
• Product is not re-heated to an internal temperature of 74°C	28
Handling after Re-heating	
• Product is re-heated more than once with intervening holding periods at room temperature	0

Number of subjects = 25

5.54 Food Operation Risk Score for Recipe 4

Procuring

All subjects claimed to usually or sometimes use the storage advice on packs of perishable food and to reject perishable ingredients with damaged packaging. Temperature abuse of the perishable ingredients during transport was demonstrated by 13/25 (52%) of subjects.

Storage

44% of subjects stored the chicken and fromage frais in a refrigerator at a temperature in excess of 5°C. In all cases the perishable food was stored for 2 days or less. The mean temperature of the refrigerators was 5.3°C (sd=2.4).

Handling and Preparing raw foods

40% of the subjects put on protective clothing before they started food preparation and 28% washed their hands. Many (76%) neglected to wash their hands after handling the raw chicken. The chicken packaging was allowed to remain in the preparation area by 16% of subjects. 40% washed the raw chicken under a stream of water from the tap. 48% of the subjects failed to wash the lettuce. 19/25 (76%) used the same board for more than one cutting operations. 3 (12%) cut the lettuce on a board contaminated by the raw chicken without adequate cleaning. 80% completed the preparation of ingredients within 20 minutes.

2/25 (8%) carried out all preventative measures during the preparation of the raw ingredients. 8/25 (32%) failed to carry out one of the preventative measures in this process step and 2/25 (8%) were awarded at least 88% of the total demerit points for failure to implement control procedures for this step.

Cooking

Six subjects (24%) did not cook the food to an internal temperature of at least 74°C. The lowest temperature that was measured was 62°C. The mean internal temperature of the food for all subjects was 76.7°C (sd=6.9). Most (72%) subjects covered the chicken with hot water as directed in the recipe and poached the chicken for 20 minutes. Eight people (32%) did not use a lid during cooking and the majority did not turn the chicken breast during heating, to ensure even heat distribution. Two people used the microwave oven to cook the chicken, one cooking it to a safe temperature of 75.5°C and the other only achieving a centre temperature of less than 70°C.

Post-Cooking handling

Three subjects placed the hot cooked chicken breast on a wire rack to facilitate cooling but no other method was used to speed the cooling rate of the cooked meat. 10/25 (40%) mixed the hot diced chicken with the dressing ingredients, despite the recipe directions to allow the cooked chicken to cool. 9/25 (36%) cut the chicken on a board than had not been effectively cleaned after contact either with raw chicken or unwashed lettuce. 10/25 (40%) handled the cooked chicken directly when cutting it. Only three people washed their hands immediately prior to assembly of the pitta breads. Over half of the people (60%) did not eat the product immediately or within the hour. The mean holding period at room temperature before consumption was 55.5 minutes (sd=44.0).

Room temperature storage

The product was held at room temperature for a mean period of 22 minutes (sd=20.4) prior to refrigeration. Only 1/15 (6.6%)

person kept the product at ambient for longer than 3 hours but less than 6 hours. No one kept the product at ambient temperature any longer than 6 hours.

Refrigerated Storage

Five people refrigerated the product immediately, and all refrigerated it within one hour. Several people (40%) failed to cover the product when they refrigerated it and an equal number (6/15, 40%) held it in a refrigerator which operated above 5°C. The average temperature was 8.04°C (sd=2.3). The mean storage period of the product was 8.7 hours (sd=18.1) with a range from 1 to 76 hours. A single subject kept the product for more than three days.

Table 5.14 Food Operation Risk Score for Recipe 4

Process step	% of Occurrences
Procuring	
• Damaged packaging.	0
• Older than 'use by' date.	0
• Temperature abuse during transport.	52
Storage	
• Fromage frais, chicken stored above 5°C.	44
• Food stored longer than 2 days.	0
Handling and Preparing raw foods	
• Chicken packaging contaminates work surface.	16
• Washes chicken.	40
• Handler does not wash hands after handling raw chicken.	76
• Lettuce not washed.	48
• Lettuce cut on dirty board.	12
Cooking	
• Product not cooked to internal temperature of at least 74°C.	24
Post Cooking handling	
• Chicken cut on dirty board.	36
• Cooked chicken handled directly.	40
• Hot chicken mixed with other ingredients.	40
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	4
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	0
• Product is kept at room temperature for period longer than 12 hours	0
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less.	24
• Cooked food is stored in refrigerator longer than 3 days.	4

Number of subjects = 25.

5.55 Food operation risk scores: a summary

Procuring

All subjects claimed usually or sometimes to use the storage advice on packs of perishable food and to reject perishable ingredients with damaged packaging. Temperature abuse of the perishable ingredients during transport was demonstrated by 49/108 (45%) of subjects.

Table 5.15 Temperature abuse during transport

RECIPE	PERCENTAGE OF OCCURRENCES
1	47
2	46
3	36
4	52

Number of subjects = 108

Storage

Over half (58%) of subjects stored ingredients in a refrigerator at a temperature in excess of 5°C. In all cases the perishable food was stored for two days or less. The mean temperature of the refrigerators was 5.9°C (sd=2.3). No one subjected frozen products to temperature abuse during storage.

Table 5.16 Temperature abuse during storage

RECIPE	PERCENTAGE OF OCCURRENCES
1	72
2	69
3	56
4	44

Number of subjects = 108

Table 5.17 Percentage of refrigerators within each temperature range

TEMPERATURE RANGE °C	RECIPE 1	RECIPE 2	RECIPE 3	RECIPE 4
-2.0 to -1.1	0	0	4	0
-1.0 to -0.1	0	0	0	0
0.0 to 0.9	0	0	0	4
1.0 to 1.9	3	0	0	0
2.0 to 2.9	0	0	4	8
3.0 to 3.9	16	8	8	16
4.0 to 4.9	16	19	4	20
5.0 to 5.9	9	19	28	16
6.0 to 6.9	19	8	24	16
7.0 to 7.9	22	27	8	8
8.0 to 8.9	6	8	8	4
9.0 to 9.9	6	8	4	4
10.0 to 10.9	0	4	0	0
11.0 to 11.9	0	0	0	0
12.0 to 12.9	3	0	0	4
13.0 to 13.9	0	0	0	0

Number of refrigerators = 108

Thawing

Only 4% of people did not allow frozen ingredients to thaw completely but 23% thawed the frozen ingredients at room temperature.

Table 5.18 Food thawed at room temperature

RECIPE	PERCENTAGE OF OCCURRENCES
2	31
3	84

Number of subjects = 51

Handling and Preparing raw foods

Protective clothing was worn by 38% of the subjects when preparing food. Many (66%) neglected to washed their hands before starting work and 58% failed to do this after handling raw animal ingredients. Some (18%) of subjects allowed the meat/poultry packaging to remain in the work area during preparation. 33% washed raw poultry under a stream of water from the tap but 41% of the subjects failed to wash some of the vegetable ingredients. More than half (60%) used the same board for all cutting operations and 25% failed to clean it adequately between food operations.

Table 5.19 Use of protective clothing

RECIPE	PERCENTAGE OF OCCURRENCES
1	47
2	31
3	32
4	40

Number of subjects = 108

Table 5.20 Handwashing prior to food preparation

RECIPE	PERCENTAGE OF OCCURRENCES
1	28
2	42
3	40
4	28

Number of subjects = 108

Table 5.21 Use of unwashed vegetables

RECIPE	PERCENTAGE OF OCCURRENCES
1	38
2	54
3	28
4	48

Number of subjects = 108

Table 5.22 Use of single cutting board

RECIPE	PERCENTAGE OF OCCURRENCES
1	41
2	65
3	64
4	76

Number of subjects = 108

Table 5.23 Use of a soiled cutting board

RECIPE	PERCENTAGE OF OCCURRENCES
1	22
2	42
3	24
4	12

Number of subjects = 108

Cooking

A minority (15%) of the subjects failed to cook the food to an internal temperature of at least 74°C. The mean EPT of the food was 80.3°C (sd=7.5). More than half (60%) of the subjects delayed the consumption of the food they had prepared.

Table 5.24 Food cooked to a minimum of 74°C

RECIPE	PERCENTAGE OF OCCURRENCES
1	91
2	100
3	72
4	76

Number of subjects = 108

Table 5.25 Percentage of products in each end point temperature range

FOOD TEMP. RANGE °C	RECIPE 1	RECIPE 2	RECIPE 3	RECIPE 4
55 to 59.9	0	0	0	0
60 to 64.9	3	0	4	4
65 to 69.9	0	0	12	8
70 to 74.9	9	8	16	24
75 to 79.9	28	12	20	40
80 to 84.9	22	12	20	4
85 to 89.9	25	62	20	12
90 to 94.9	13	8	4	8
95 to 99.9	0	0	4	0

Number of products = 108

Table 5.26 Food prepared in advance

RECIPE	PERCENTAGE OF OCCURRENCES
1	72
2	54
3	52
4	60

Number of subjects = 108

Cooling

Over half of the people (58%) who held their product, failed to cool the product to 21°C in 90 minutes.

Table 5.27 Unaided cooling of cooked food

RECIPE	PERCENTAGE OF OCCURRENCES
1	69
2	54
3	48
4	88

Number of subjects = 108

Post-Cooking handling

10/108 (9%) subjects failed to cool the cooked ingredients quickly before mixing with perishable ingredients. 9/108 (8%) handled the cooked ingredients during preparation and an equal number cut the ingredients on a board than had not been effectively cleaned after contact with raw ingredients.

Room temperature storage

38/65 (58%) kept the product at ambient temperature for more than 90 minutes. The mean holding period at room temperature was 2.1 hours (sd=1.9). 13/65 (20%) kept the product at room temperature for more than 3 hours but less than 6 hours and 8/65 (12%) kept the product for more than 6 hours but less than 12 hours.

Table 5.28 Food held for longer than 90 minutes at room temperature

RECIPE	PERCENTAGE OF OCCURRENCES
1	47
2	42
3	48
4	4

Number of subjects = 108

Table 5.29 Food held for longer than 3 hours at room temperature

RECIPE	PERCENTAGE OF OCCURRENCES
1	28
2	15
3	28
4	4

Number of subjects = 108

Refrigerated Storage

18/65 (28%) held the product in a refrigerator which operated above 5°C. Two people kept the product for longer than three days.

Table 5.30 Refrigerated storage of cooked food

RECIPE	PERCENTAGE OF OCCURRENCES
1	34
2	19
3	4
4	60

Number of subjects = 108

Re-heating

A minority (12/65, 19%) were judged likely to under-heat the product during re-heating.

Table 5.31 Food re-heated to less than 74°C

RECIPE	NUMBER OF OCCURRENCES
1	3
2	2
3	7

Number of subjects = 83

Handling after re-heating

A few (7/65, 11%) of the subjects re-heated the product more than once.

Table 5.32 Food re-heated more than once

RECIPE	NUMBER OF OCCURRENCES
1	5
2	3
3	0

Number of subjects = 83

Table 5.33 Food Operation Risk Score: a summary

Process step	% of Occurrences
Procuring	
• Damaged packaging	0
• Older than use by date	0
• Temperature abuse during transport	45
Refrigerated Storage	
• Ingredients stored above 5°C	58
• Food stored longer than 2 days	0
Frozen Storage	
• Ingredients above -18°C	0
Thawing	
• Food not thawed completely	4
• Thawed in kitchen at room temperature	7
Handling and Preparing raw foods	
• Packaging contaminates work surface	18
• Washes raw poultry/offal	33
• Handler does not wash hands after handling raw meat/poultry	58
• Vegetables not washed	41
• Ingredients cut on dirty board	25
• Ingredients not prepared correctly	1
Cooking	
• Product not cooked to internal temperature of at least 74°C	15
Cooling	
• Product is not cooled rapidly to 21°C within 90 minutes	35
Post Cooking handling	
• Cooked food cut on dirty board	8
• Cooked food handled directly	9
• Cooked food not cooled quickly before mixing	9
Room temperature storage	
• Product is kept at room temperature for period longer than 3 hours but less than 6 hours	12
• Product is kept at room temperature for period longer than 6 hours but less than 12 hours	7
• Product is kept at room temperature for period longer than 12 hours	0
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	17
• Product is stored in refrigerator longer than 3 days	2
Re-heating	
• Product not cooked to internal temperature of at least 74°C	11
Handling after re-heating	
• Product is re-heated more than once, with intervening holding periods at room temperature	6

Number of subjects = 108

5.6 Analysis of re-heating exercise

Nineteen subjects re-heated a chilled version of Recipe 1 (Chicken Surprise) and Recipe 2 (Mexican Beef) prepared by the researcher (see 4.2). Nine subjects used a microwave oven either at full power or with a combination of medium and high power settings. The power output of the ovens ranged from 600 to 800 Watts. Recipe 1 was heated for a mean time of 6.5 minutes (sd=1.1, 4 subjects) and Recipe 2 for a mean time of 8 minutes (sd=3.1, 5 subjects). All the subjects stirred the food at least once during re-heating. The temperature was taken after stirring but before standing time was given.
Eight subjects re-heated the dish on the hob. Recipe 1 was heated for 7 minutes (sd=2.2, 3 subjects) and Recipe 2 was heated for a mean time of 12.2 minutes (sd=3.1, 5 subjects).
A single subject used the oven (pre-heated for 10 minutes to 180^{o}C, for 35 minutes) and another steamed the product for 30 minutes. The mean EPT for Recipe 1 was 67.5^{o}C (sd=7.5) with a range from 55 - 83^{o}C. Only 2/9 (22%) subjects achieved a safe EPT in the product during re-heating.
The mean EPT for Recipe 2 was 78.3^{o}C (sd=12.5) with a range from 58 - 91^{o}C. 3/10 (30%) of subjects failed to re-heat the product to a safe temperature.
More than half (10/19, 53%) subjects re-heated the dish more than once, most leaving it at ambient temperature for less than two hours between heatings. One person left the product for approximately five hours at ambient temperature before a second heating.

Table 5.34 Re-heating chilled food

INTERNAL TEMPERATURE OF FOOD IN ^{o}C	NUMBER OF OCCURRENCES RECIPE 1	RECIPE 2
50 to 59.9	2	1
60 to 69.9	3	2
70 to 79.9	3	1
80 to 89.9	1	2
90 to 99.9	0	4

Number of subjects = 19

5.7 Analysis of Kitchen and Personal Hygiene Check-list

5.71 The scores expressed as a percentage, ranged from 20 to 76% with a mean score of 47% (sd=11.2).

Table 5.35 Percentage of subjects within each kitchen and personal hygiene score range

KITCHEN & PERSONAL HYGIENE SCORE RANGE %	PERCENTAGE OF SUBJECTS
20 to 24.9	3
25 to 29.9	7
30 to 34.9	6
35 to 39.9	10
40 to 44.9	19
45 to 49.9	13
50 to 54.9	13
55 to 59.9	12
60 to 64.9	8
65 to 69.9	6
70 to 74.9	2
75 to 79.9	1
80 to 84.9	0
85 to 89.9	0
90 to 94.9	0
95 to 99.9	0

Number of subjects = 108

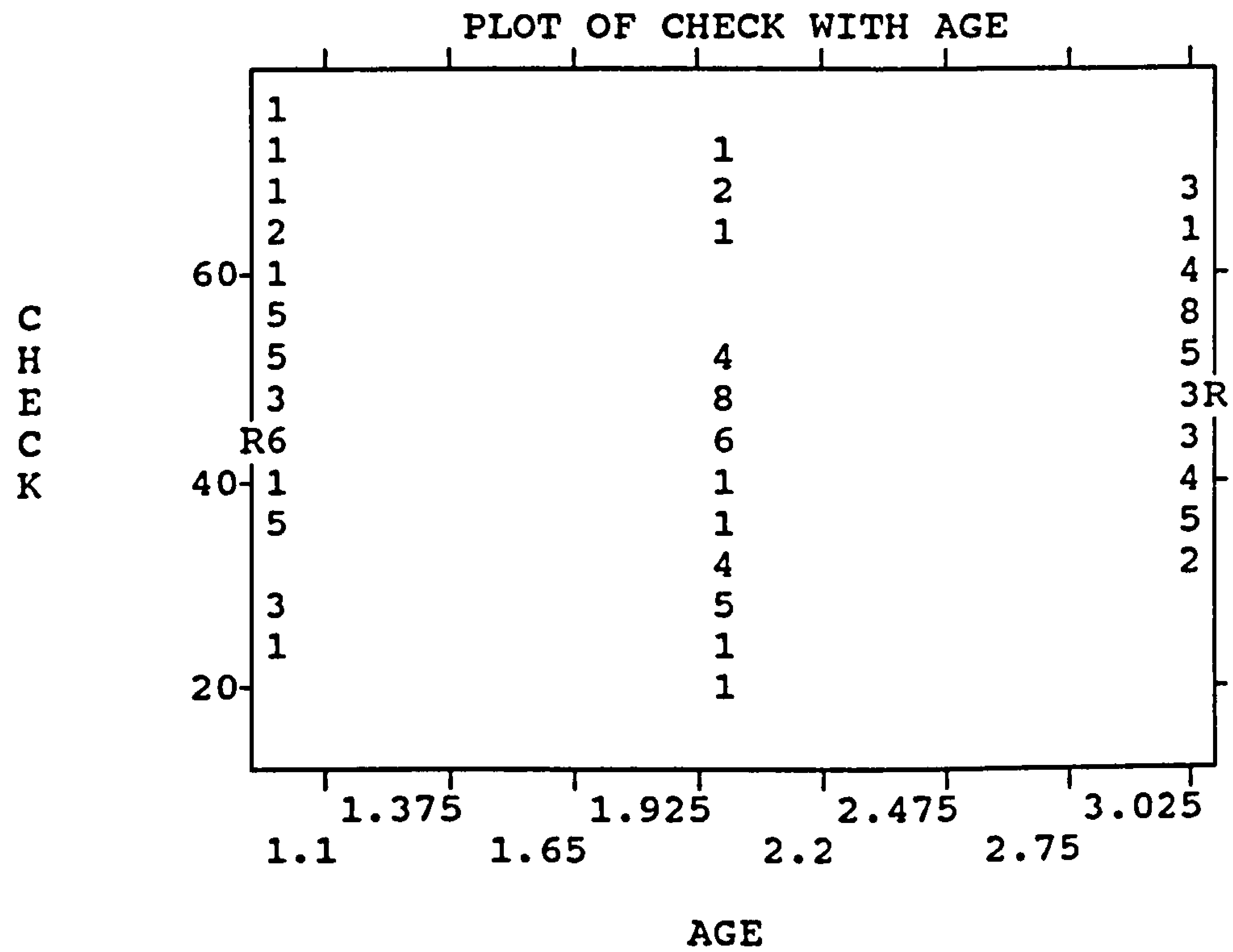
5.72 Analysis of kitchen and personal hygiene scores by age

Table 5.36 Mean Kitchen and Personal Hygiene score of each age group

AGE GROUP	NUMBER OF SUBJECTS	MEAN SCORE %
16-34	35	48.0 (SD 12.6)
35-54	35	43.2 (SD 12.5)
55+	38	50.1 (SD 10.4)

Number of subjects = 108

Fig. 5.3 Scatter diagram: Kitchen and Personal hygiene check-list score percentage (Check) with age



Age group 1 = 16-34
Age group 2 = 35-54
Age group 3 = 55+

108 cases plotted. Regression statistics of CHECK on AGE:
Correlation .07671 R Squared .00588 S.E. of Est 12.25948
Sig. .4301
Intercept(S.E.) 44.87040(3.14117) Slope(S.E.)
1.13720(1.43568)

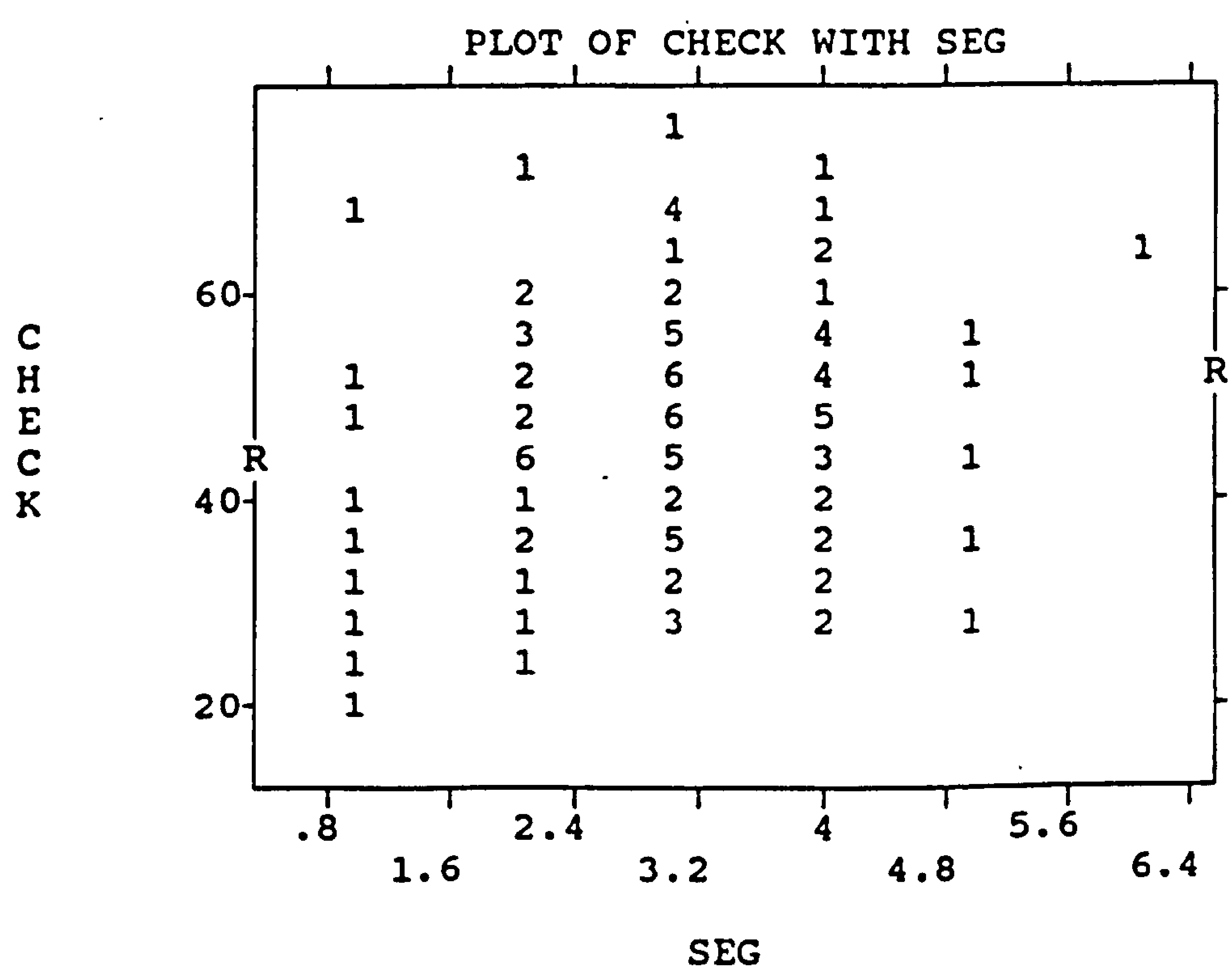
5.73 Analysis of kitchen scores by socio-economic group

Table 5.37 Mean Kitchen hygiene and Personal hygiene score of each socio-economic group

SOCIO-ECONOMIC GROUP	NUMBER OF SUBJECTS	MEAN SCORE %
A	8	39.3 (SD 14.3)
B	24	46.5 (SD 11.2)
C1	41	48.4 (SD 11.9)
C2	29	48.5 (SD 11.6)
D	5	43.1 (SD 10.2)
E	1	64

Number of subjects = 108

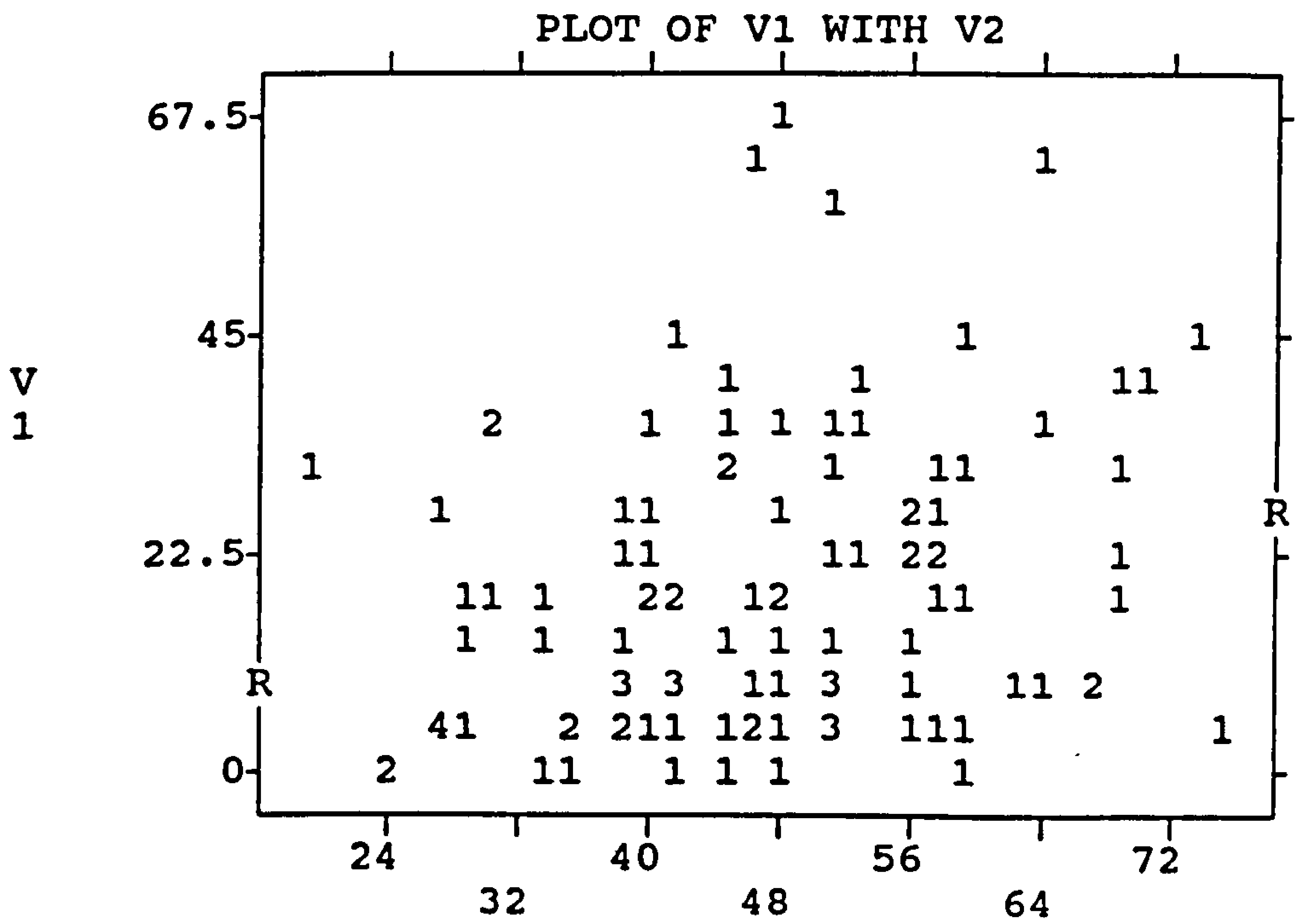
Fig. 5.4 Scatter diagram: Kitchen and Personal Hygiene Check-list score percentage (Check) with Socio-economic group (SEG)



Socio-economic groups:
A = 1, B = 2, C1 = 3, C2 = 4, D = 5, E = 6

108 cases plotted. Regression statistics of CHECK on SEG:
Correlation .15084 R Squared .02275 S.E. of Est 12.15502
Sig. .1192
Intercept(S.E.) 41.82391(3.60231) Slope(S.E.)
1.77321(1.12875)

Fig. 5.5 Scatter diagram: Food Safety Score (V1) by Kitchen and Personal Hygiene Check-list (V2)



108 cases plotted. Regression statistics of V1 on V2:
Correlation .24869 R Squared .06185 S.E. of Est 14.91042
Sig. .0094
Intercept(S.E.) 4.24295(5.73431) Slope(S.E.)
.31138(.11779)

5.8 Analysis of the interviews

Responses were obtained from 93 subjects.

Shopping Patterns/Habits

Most (70%) subject do their main food shopping for food at least once a week. All subjects claim sometimes or always to look at the 'use by' date code on perishable food packs and the condition of the packaging. The majority (80%) claim sometimes or always to use the storage instructions.

Over half (53.8%) of the subjects used shops that were more than 5 miles from their home. Most (79%) used a car to transport food purchases with almost everyone (98%) returning home in less than 30 minutes. Most (75%) of the subjects did not use an insulated container for transporting chilled or frozen food.

Storage

Many (71%) of subjects have never measured the temperature of their refrigerator but claim to adjust the temperature of the appliance. Some (42%) correctly identified the recommended refrigerator operating temperature. Raw meat would be stored at the bottom of the refrigerator by 40% of people and 77% would place a fresh cream trifle on a top or middle shelf in the same appliance. But 22% would store raw meat at the top of the refrigerator and 12% would place products wherever there was room.

Thawing

Some (20%) of subjects normally use the refrigerator for thawing frozen food and 6% use a microwave oven. The majority use the kitchen, a larder or a utility room for thawing frozen food. Most (67%) would thaw a frozen chicken overnight in the kitchen. They would determine that thawing was complete by calculating the thawing time and by checking the carcass for the presence of ice.

Food preparation

The majority prepare raw meat or poultry at least three times a week and all subjects handle raw vegetables on a daily basis.

Over half (56%) of the subjects claimed to use a general purpose cutting board but only 22% claimed to use separate parts of the kitchen for preparing raw and cooked foods. 69% of subjects regularly or occasionally prepare food in advance.

Cooking

Most people (80%) did not know the recommended internal temperature of well cooked meat. They claimed to make use of their past experience to determine meat cooking times and temperatures. A small number used recipe books/cards and the instructions on food packs as cooking guides.

Many people (78%) owned a microwave oven, which was used mainly for re-heating food. Few (5%) used it for prime cooking. Most claimed to know the power rating of their microwave oven, to understand how to adjust cooking times in the oven to accord with the wattage and to give standing time. The hob and oven are used by a smaller number of subjects (24%) for re-heating food.

Cooling

Most people (69%) cool hot cooked food prior to refrigeration in the kitchen. 21% estimated that they would allow a 1.5 kg cooked chicken to cool for less than one hour at room temperature and 41% would allow more than two hours.

CHAPTER 6. DISCUSSION

'Eating out could seriously
damage your health but cooking
at home may not be as safe
as you'd think'

Press Release
Consumer Association
1989

6. Discussion

6.1 Introduction

Food poisoning notifications in England and Wales increased from a rate of 28 per 100,000 population in 1982 to 127.4 per 100,000 in 1992 (Steering Group on the Microbiological Safety of Food, 1993). Over the same period isolates of *Campylobacter* increased from 25.8 to 75.7 per 100,000 population. Epidemiological data suggest that certain practices contribute more frequently to the causation of general outbreaks of food poisoning than others. These include inadequate cooling of foods, inadequate time or temperature or both during cooking, cross-contamination from raw foods to cooked foods, a lapse of a day or more between preparing food and serving, inadequate cleaning of equipment, infected handlers touching food which is not subsequently cooked and inadequate time or temperature or both during re-heating of previously cooked foods (Bryan, 1978).

How typical these practices are and the extent to which they may contribute to food poisoning originating in the home is unknown because of lack of epidemiological data.

The food handling practices of the subjects in this study were analysed to determine how frequently these factors were exhibited.

6.2 Preparation of food in advance

More than half (60%) of the subjects delayed the consumption of the food they had prepared (Fig. 6.1). There is little or no hazard of food poisoning if foods are thoroughly cooked and eaten promptly but as the time between cooking and eating increases, temperature control during the interim becomes of increasing importance. It might be argued that the behaviour observed in this study was not representative of the regular pattern of production and consumption. Subjects may have separated production and consumption of the food in order to minimise inconvenience to the family. However 69% of the respondents to the questionnaire indicated that they either regularly or occasionally prepared food to be eaten later (Fig. 6.2).

Hot Holding

The Food Hygiene (Amendment) Regulations (1990) require the catering industry to maintain the temperature of food, during hot holding, to be maintained at or above 63°C. This will prevent bacterial growth. Domestic homes lack the hot holding equipment found in the catering industry such as bain maries, hot air cabinets, steam tables and infra red lamps. None of the food that was prepared in this investigation was kept hot whilst waiting service.

6.3 Holding foods at room temperature

In this study, food that was cooked in advance was most likely to be re-heated in the microwave oven. The problem of cooling and then holding the cooked food at a safe temperature-time combination is paramount. A national survey in the US (Jones and Weimer, 1977) indicated that there was a common belief that meat and poultry could be kept at room temperature after cooking and that refrigeration was unnecessary. Forty-six percent of consumers were not concerned about leaving cooked meat at room temperature for 2 hours or longer. Some of the housewives in Beddows's survey (1983) on the handling of cooked chicken in the home showed a

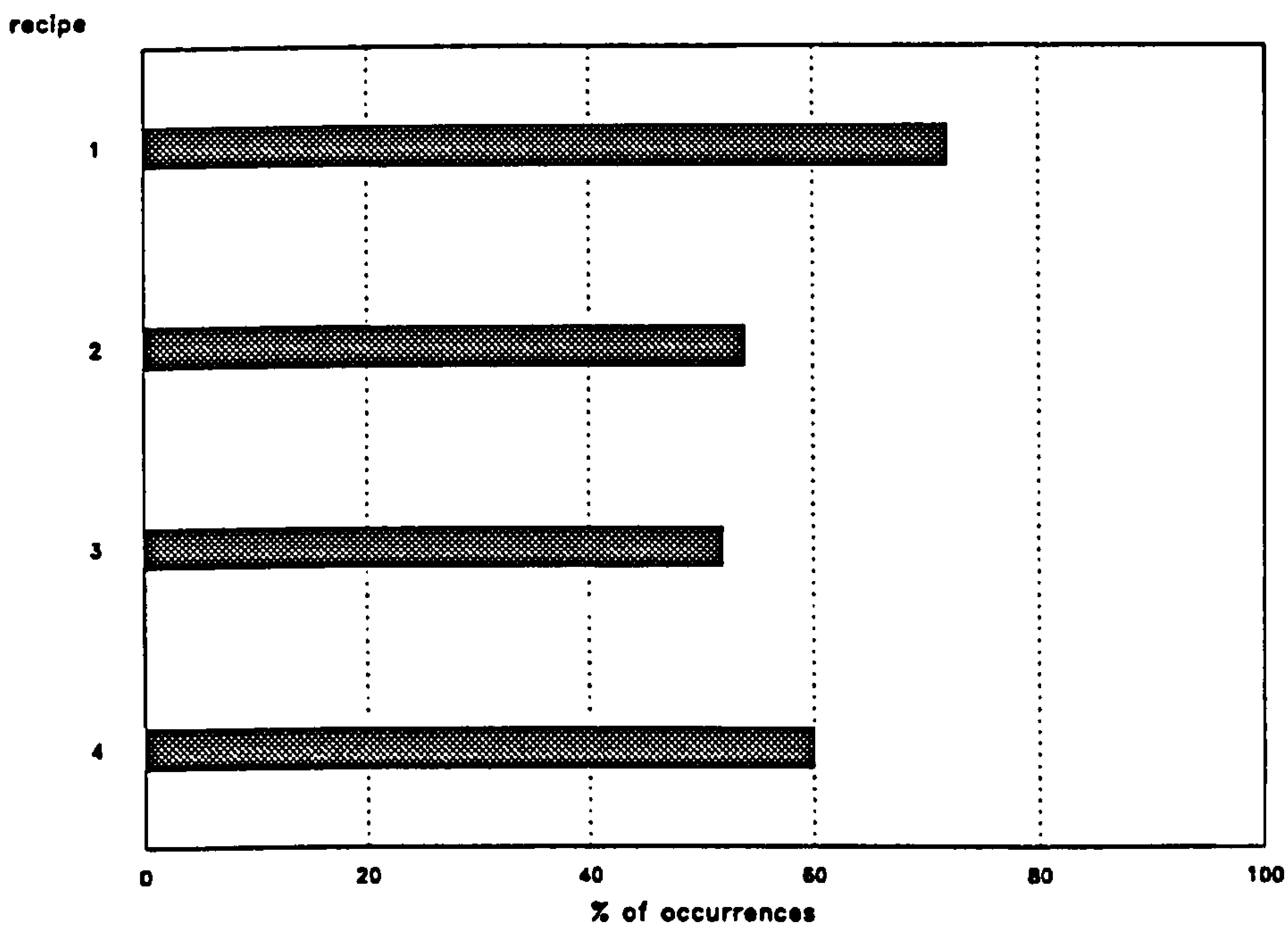


Fig. 6.1 Food prepared in advance

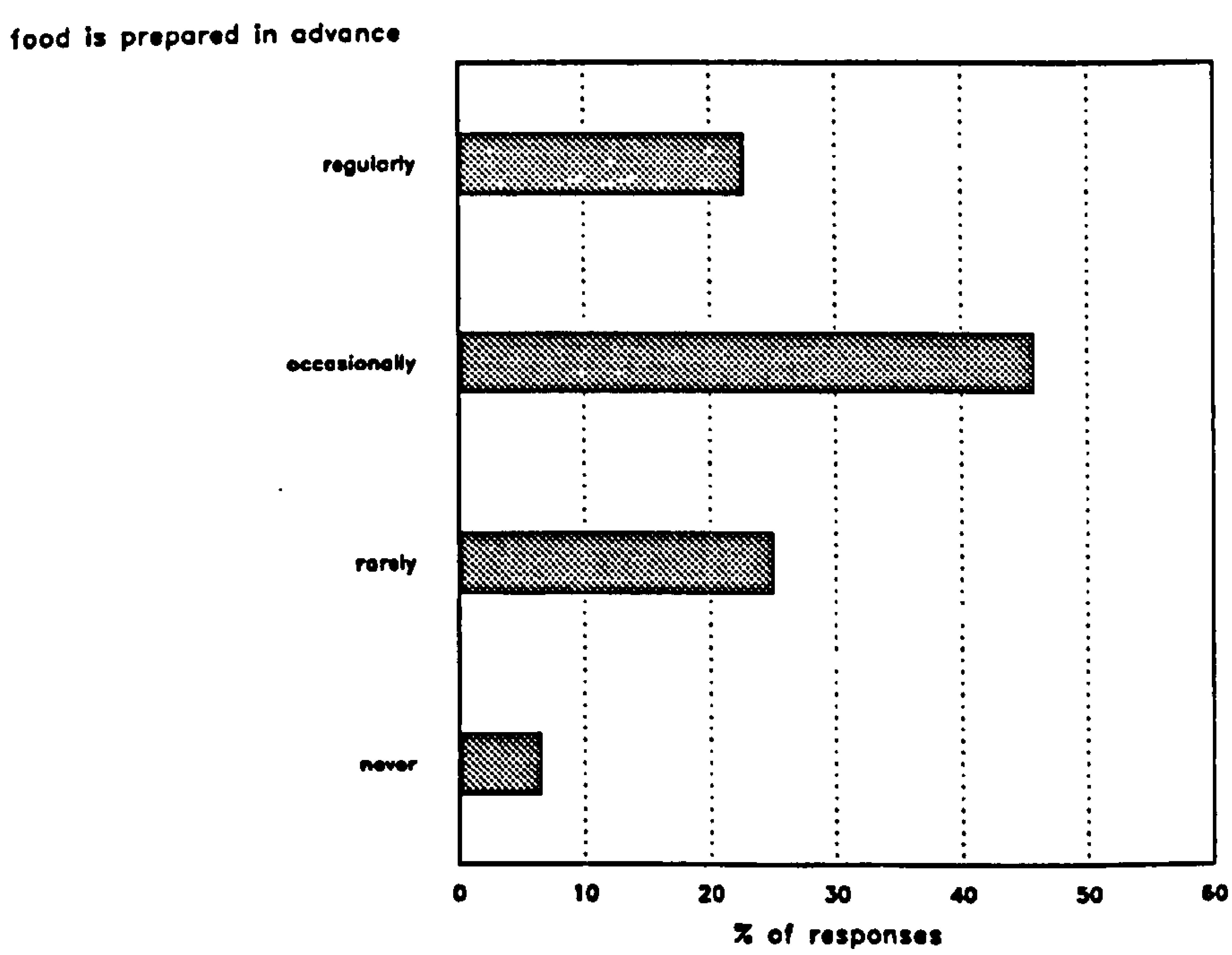


Fig. 6.2 Frequency of preparing food in advance

similar lack of concern, with 10% prepared to leave the cooked food at ambient temperature for longer than 4 hours. Worsfold and Griffith (1992) noted the practice of holding filled rolls and sandwiches, for packed meals, at temperatures in excess of 18°C for periods up to fifteen hours. Few (18%) of the respondents in the MAFF survey (1988) recognised the dangers of keeping food at room temperature. Half of the respondents in the present study and 58% in the West Glamorgan Public Health Promotion Group survey (1991) indicated that either they or the cook in the household prepared meals in advance.

Time is a primary consideration in determining whether or not food poisoning will occur. Time is required for spores to germinate into vegetative cells, for these cells to multiply and for the production of exotoxins. A period of up to 12 hours between cooking and consumption has frequently been identified in outbreaks caused by *C. perfringens, B. cereus, Salmonella* and *Staphylococcus*.

Over half (58%) of the subjects in the present study, who kept the cooked food for later consumption, held it at room temperature for longer than 90 minutes (Fig. 6.3). The mean holding period at ambient was 2.1 hours (sd=1.9). Some (13/65, 20%) held the product for more than 3 hours (Fig. 6.4) and some (8/65, 12%) kept it at room temperature for more than 6 hours, but none for more than 12 hours. Caution must be exercised when the holding period exceeds four hours and concern must increase with every additional hour the product is kept (Bryan, 1988). Most subjects in this study (41/65, 63%) eventually stored the product in a refrigerator (Fig. 6.5). In the MAFF survey only 7% of the respondents

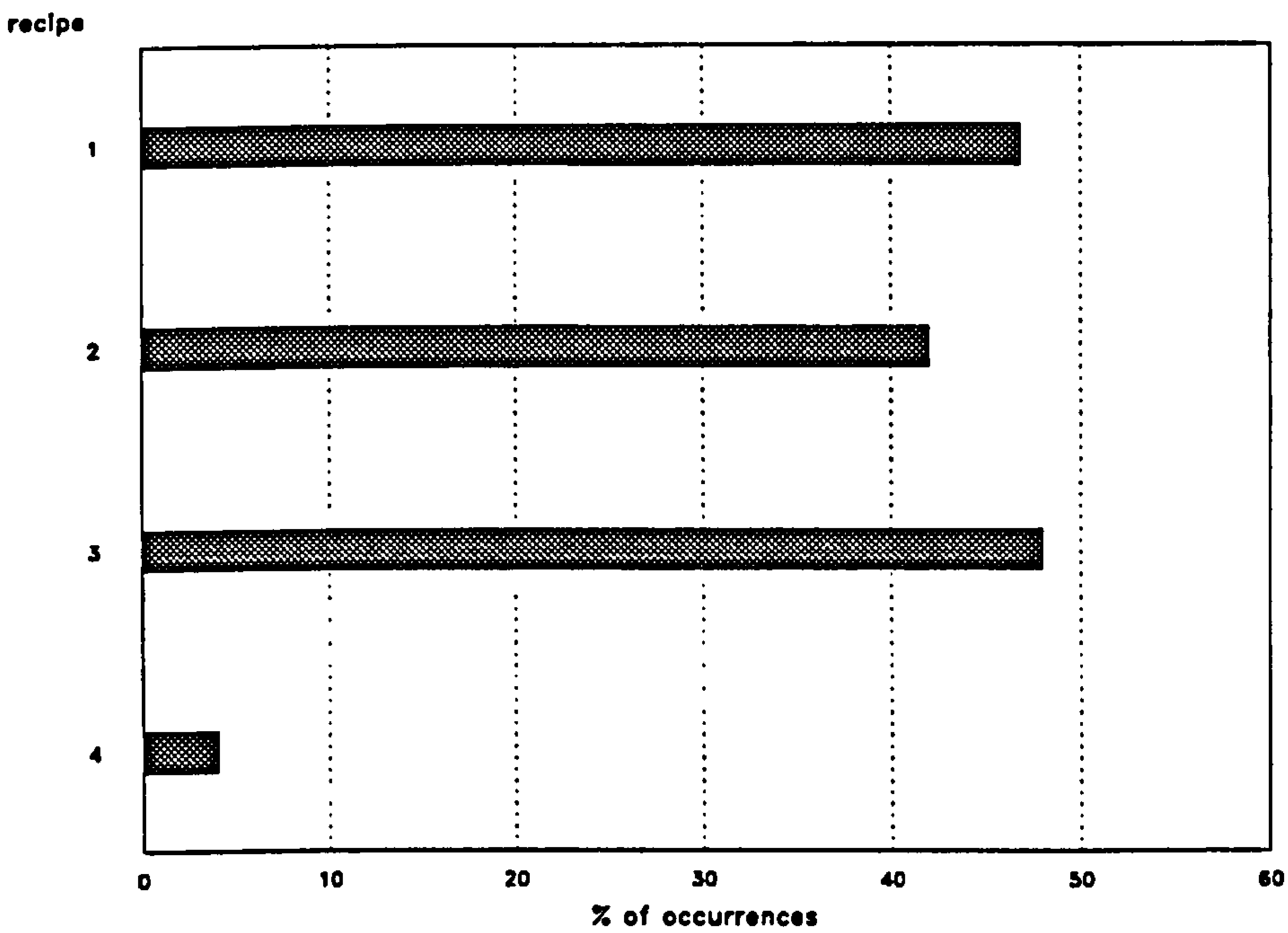


Fig. 6.3 Food held for longer than 90 mins at room temp.

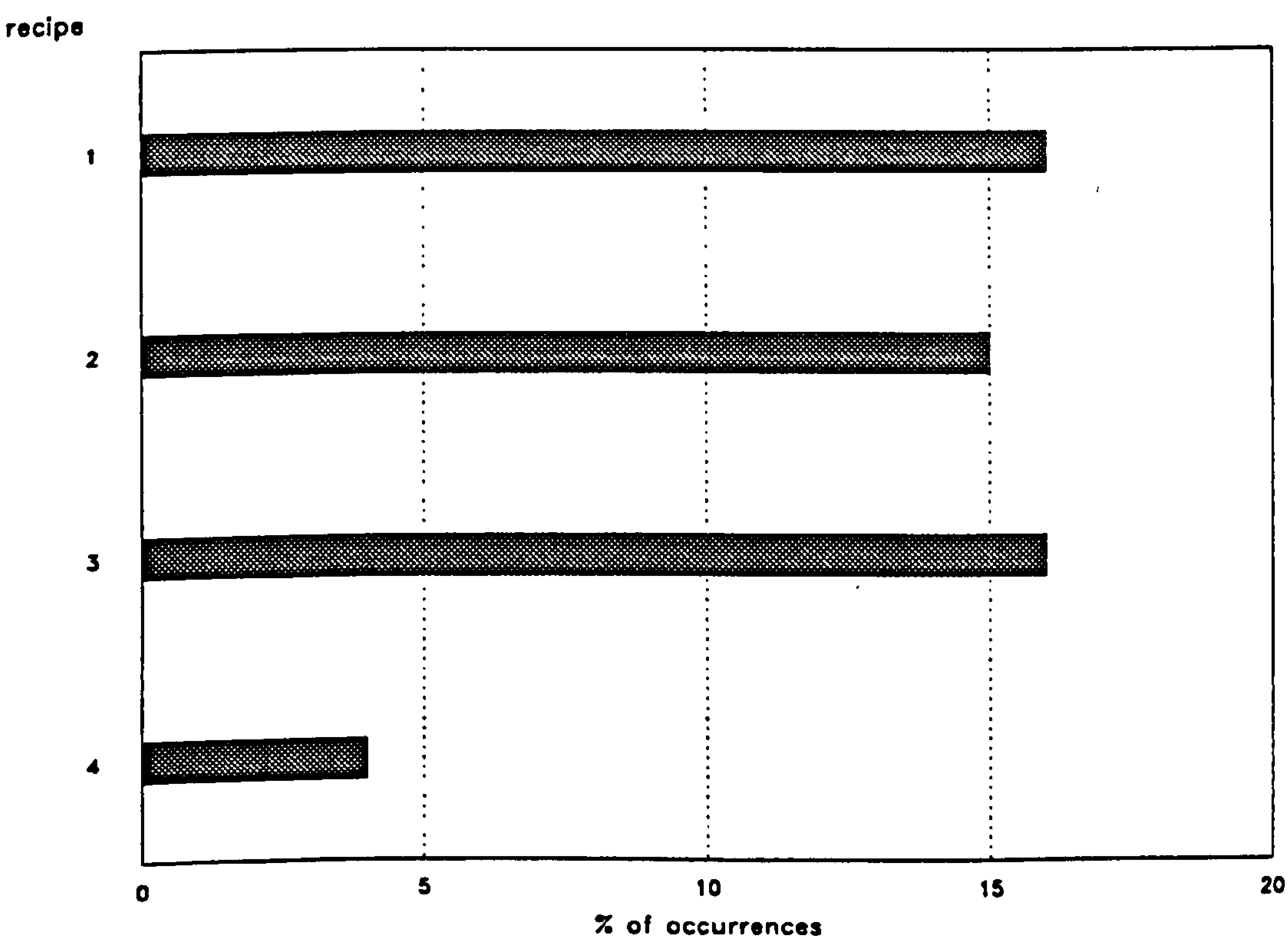


Fig. 6.4 Food held for longer than 3 hours at room temp.

indicated they would hold cooked food at room temperature. This may be an underestimate of those who mis-handled cooked food since the answers were based on storage rather than holding practices.

6.4 Cooling

It has been suggested that improper cooling is the most frequent factor contributing to outbreaks of food poisoning. It is one of the most hazardous operations and is, therefore, one of the most critical control points in domestic food production (Fig. 6.6).

The Food Hygiene (Amendment) Regulations 1990 require the catering industry to cool cooked food which contains fish, meat, vegetables or other relevant foods without any delay once cooking has finished. Cooling should therefore start within 30 minutes and should be carried out as quickly as possible, ideally using blast chillers to reduce the temperature to below 5^{o}C within a further 90 minutes.

No information on the methods used to cool cooked food in the home has been gathered by the surveys of the public (MAFF, 1988; Ackerley, 1990, Spriegel, 1991, FDF IEHO, 1993a).

Several factors affect cooling rates: the state of the food, the mass of the food, the size and shape of solid food, the surface to volume ratio of food stored in containers, the coefficient of heat transfer of the food and its container, the initial temperature of the food, the type and temperature of the cooling medium, the velocity of the air or water at the food surfaces and whether the food is agitated. Many of these factors can be controlled to aid cooling efficiency.

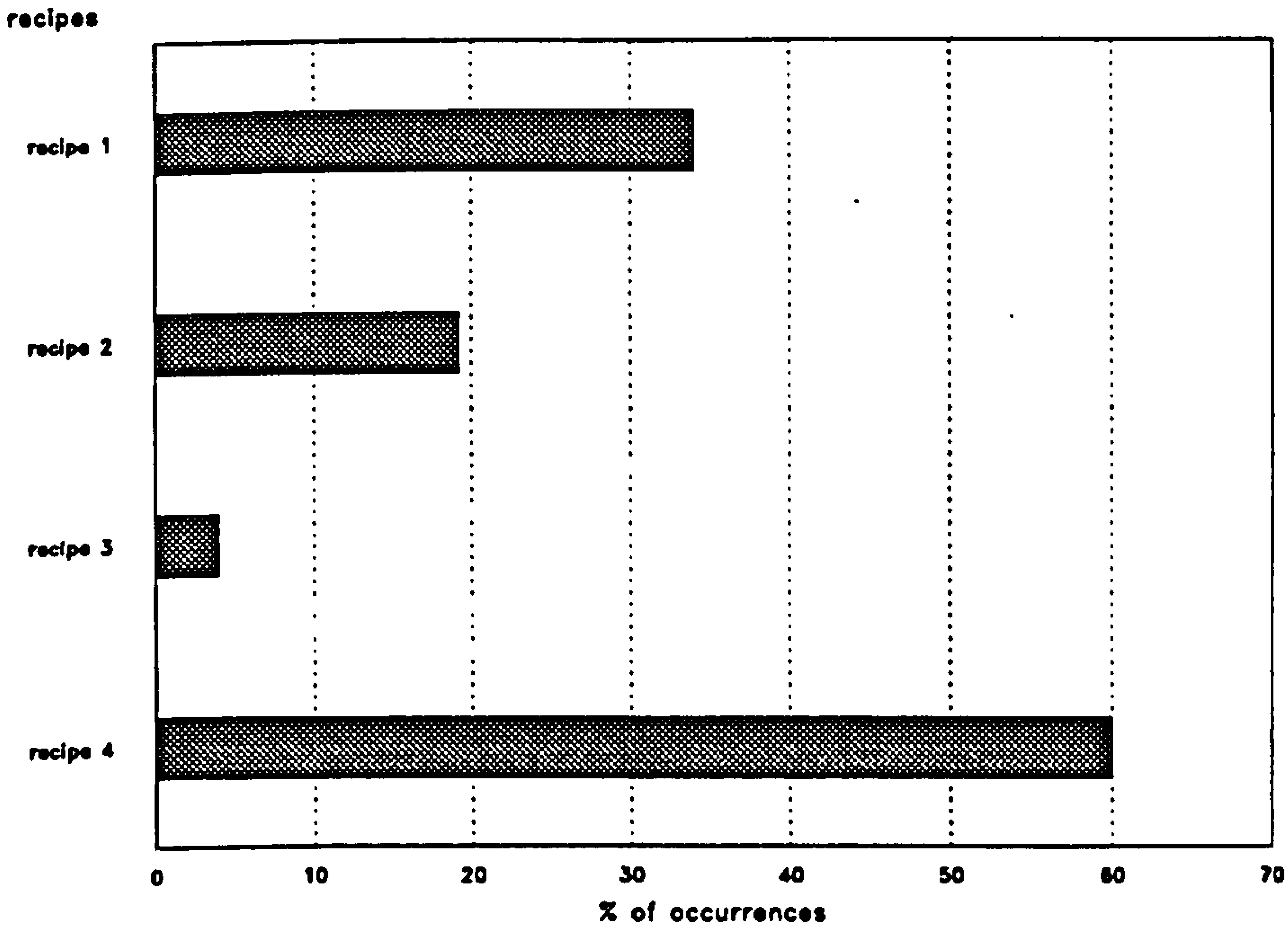


Fig. 6.5 Refrigerated storage of cooked food

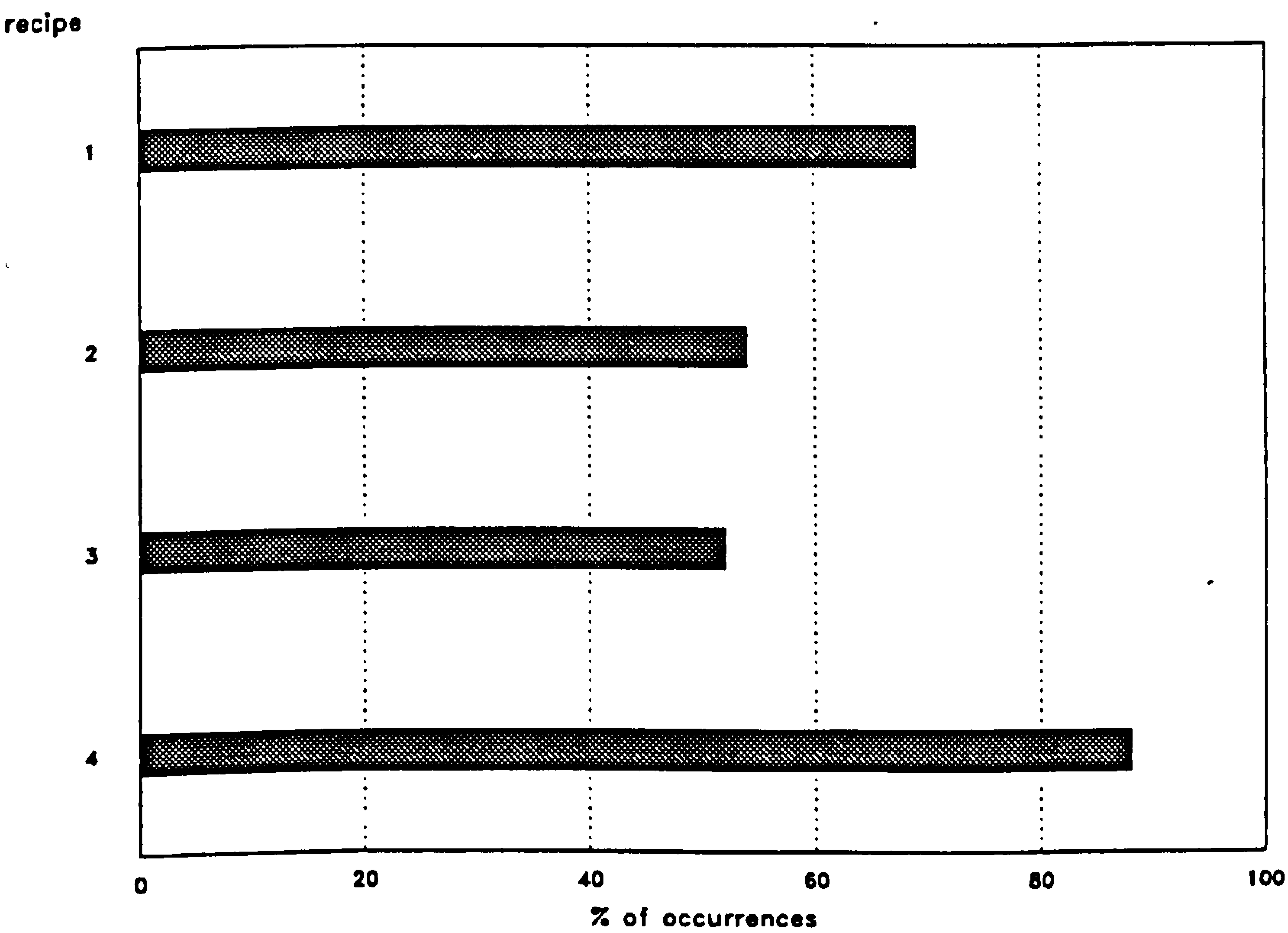


Fig. 6.6 Unaided cooling of cooked food

Cooling at room temperature

Cooling at room temperature is slow because of the small temperature differential between the food and the air. Evans *et al.* (1991) found that the greatest number of people (72.2%) kept their kitchens at between 17°C and 23°C with an overall mean temperature of 20.6°C. Over 90% of the people in the present study had centrally heated houses and the majority (69%) used their kitchens for cooling food. Many (67%) of the kitchens had mechanical extract ventilators but few subjects were seen to use them during food preparation.

A minority of subjects (7%) claimed to use a larder and (17%) a utility room for cooling hot food (Fig. 6.7). However very few subjects (5%) were observed to transfer the cooked food to a cooler place. A common practice was to move the cooked food in its container to the back of the hob to cool.

The shape and size of the container and the extent to which it is filled (mass and surface-to-volume ratio) greatly influence cooling times. The internal temperature of a given volume of food falls faster in a shallow pan than the same volume will in a deep container. Cooling rate is also affected by the material of the container and its thickness. Foods stored in containers made of good conductors of heat such as stainless steel cool faster than foods in containers of crockery, glass or plastic. Many subjects (34/48, 71%) who cooked Recipe 1 and 2 held the cooked food in the original cooking container. Those that did transfer it to a new container usually selected a plastic or glass one, with a lid. No subjects were observed to select a shallow broad-based container to hold the food during cooling. The size of the food mass in this study was limited but larger quantities

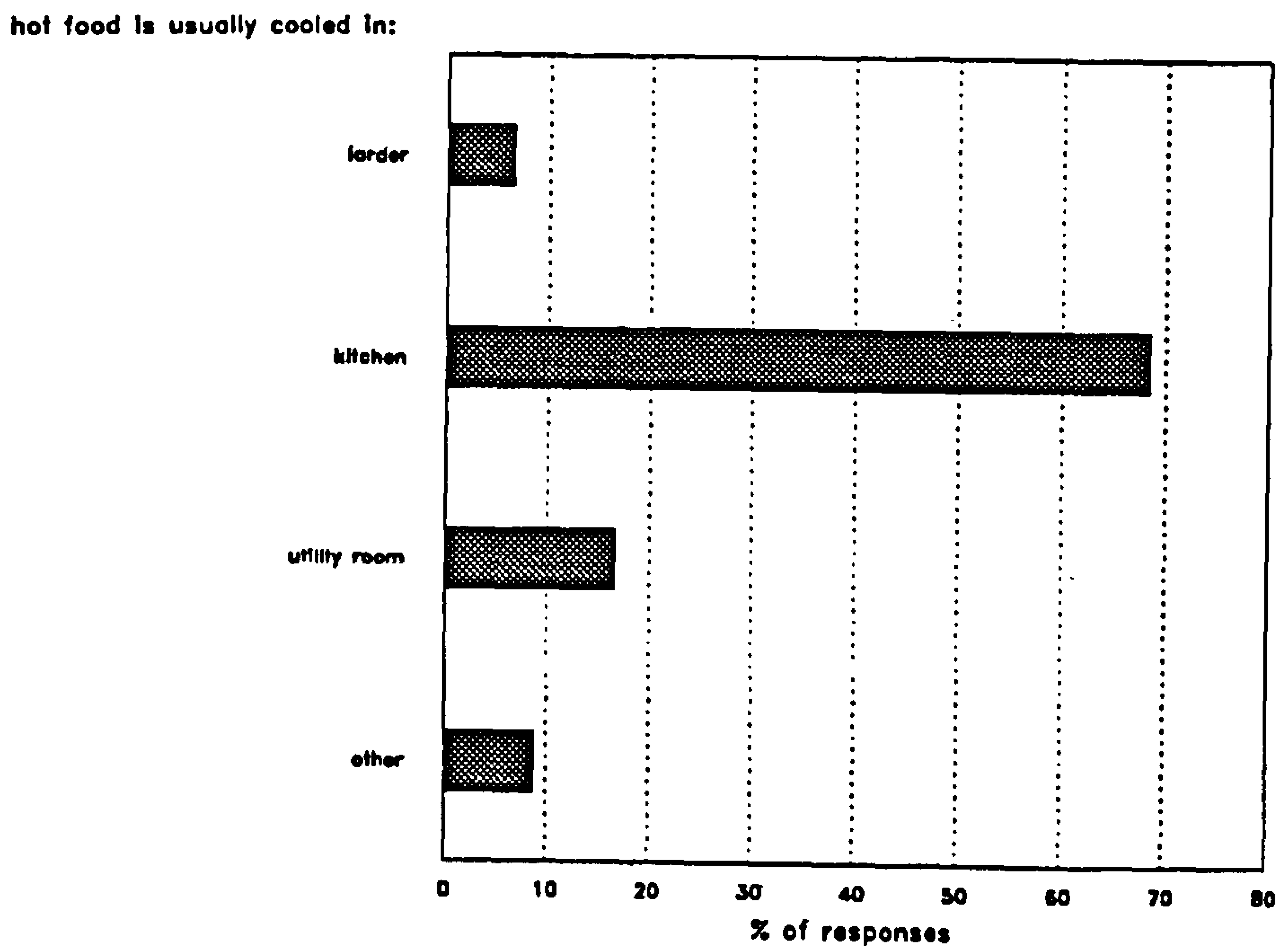


Fig 6.7 Cooling of hot cooked food

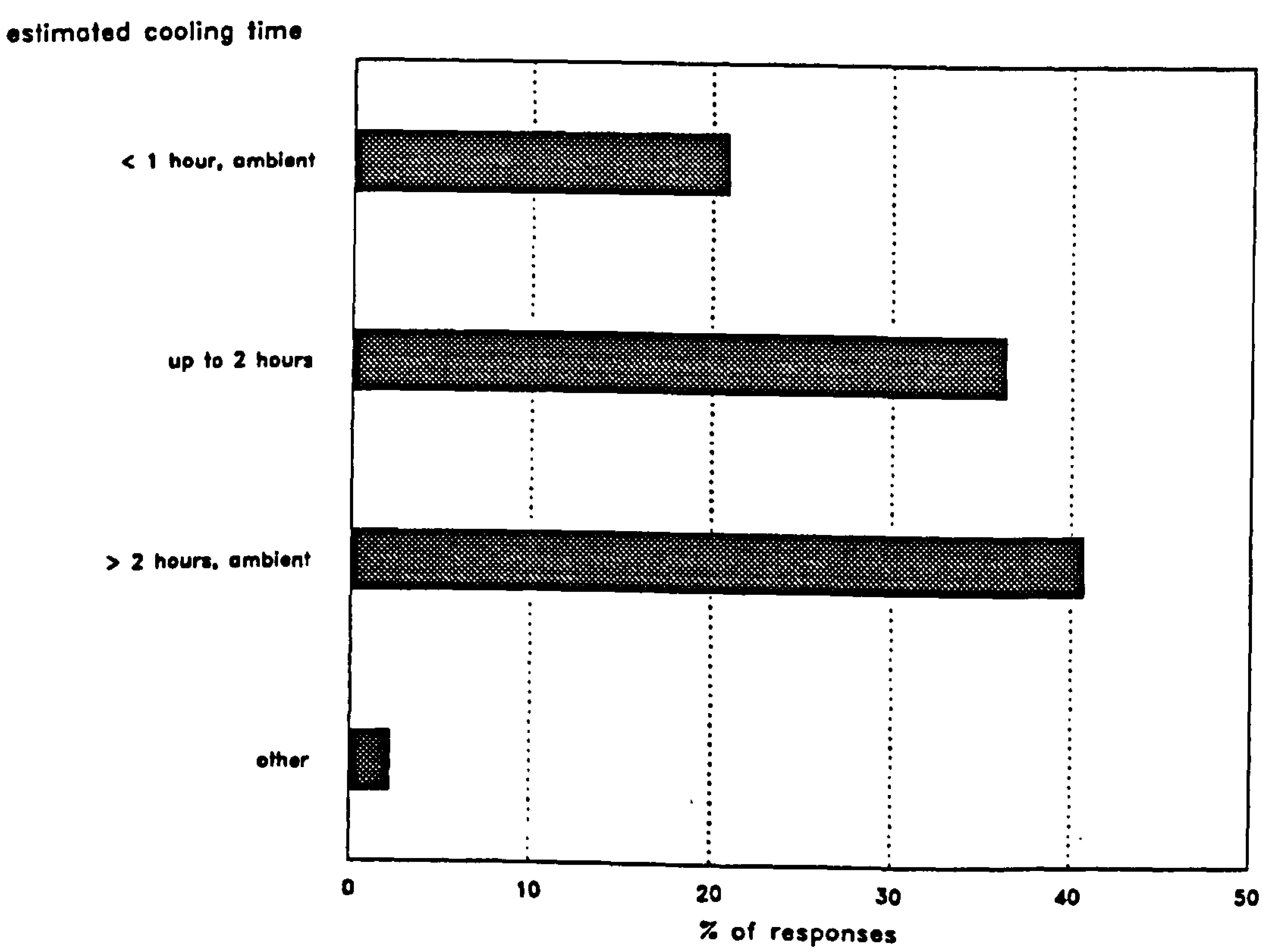


Fig.6.8 Cooling cooked chicken

of food might normally be cooked and held by many of the subjects. It should be noted that many domestic refrigerators are too small to accommodate broad-based shallow containers.

Assisted cooling

Movement of air around the food dissipates heat faster than still air. Many subjects (38/65, 58%) covered the cooked food whilst it cooled thereby slowing the cooling rate. A few people who prepared Recipe 4, transferred the cooked chicken breast to a wire cooling rack at the end of cooking but none of the subjects placed the cooling food near to an open window or used a fan to assist cooling. In covering the cooling food, people appear to be more concerned about preventing contamination, than shortening the cooling period. A single subject used a net umbrella cover to protect the cooling food, whilst enabling the heat to escape.

Conventional refrigerators are not designed to chill food rapidly and the introduction of hot foods may cause the temperature to rise so that all foods within the cabinet are above $5^{o}C$. There is a lack of suitable chilling equipment designed for use in the home.

Rapid cooling has been accomplished by placing sliced cooked meat in pans in contact with ice (Bryan and McKinley, 1974). A single subject used eutectic ice packs to cool the cooked product. No one used a cooling water or ice bath to assist cooling.

Cooling rates can be speeded by stirring the food. Recipe 3 was a set product and therefore not amenable to agitation, but no subjects were observed to stir Recipe 1 or 2 to assist cooling.

6.5 Refrigerated storage

Pathogens will grow better on cooked products than on raw ingredients, either because there may be little competition from other bacteria or because more nutrients are available to them in the cooked products. The rapid chilling of cooked foods (i.e. cooling to 21°C within 90 minutes) and subsequent storage in shallow containers (not exceeding 10 cm in depth) in a refrigerator at or below 5°C will slow spoilage and prevent pathogenic bacteria from multiplying.

Over half (35/65, 54%) of the subjects who held food refrigerated it within 90 minutes. Since none of these subjects used any method of rapid chilling it can be assumed that the food temperature was in excess of 21°C when placed in the appliance (Table 4.1). Evans *et al.* (1991) found that if 'warm' food was placed in the refrigerator, the air temperature in the appliance could be over 8°C higher than the undisturbed value 4 hours after loading.

All but one subject refrigerated Recipe 4, which is encouraging since this product would receive no further heat treatment. The low number of subjects who refrigerated Recipe 3 (12/13, 92%) is a cause for concern, particularly when the egg was under-cooked. People may be less aware of the necessity of refrigerating egg products than meat or poultry dishes. Some intended to eat the product at room temperature and for some there may have been a problem in accommodating this product in its original cooking container in the refrigerator.

21% of the interviewees indicated that they would allow a 1.5 kg cooked chicken to cool for less than 1 hour before refrigerating it (Fig. 6.8). If no rapid chilling methods were used, and this seems to be the common practice, the food would almost certainly be too warm to be stored safely in the refrigerator

Some (18/65, 28%) stored the cooked food in a refrigerator which operated above 5°C. Temperature control in domestic refrigerators is commonly very poor. The overall mean air temperature for all the refrigerators in a survey by Evans *et al.* (1991) was 6.04°C whilst an earlier study in the US. (Jones and Weimer, 1977) revealed that 32% of refrigerators operated above 7°C.

The Department of Health Cook-Chill Guide-lines (1989) recommend that chilled foods be maintained between 0 and 3°C throughout storage. The storage period should be for no longer than five days, counting production as day one and re-heating as day five. Only two subjects kept the product for longer than three days.

6.6 Cooking

Cooking improves the eating quality of many foods and makes them safe to eat by destroying vegetative food poisoning pathogens (Angelotti *et al.*, 1961). The Food Services Sanitation Manual of the US Department of Health, Education and Welfare stipulates that the centre temperature of poultry and poultry products should be 74°C. or above. The Cook Chill Guide-lines (1989) recommend heating food until the centre temperature is at least 70°C for a minimum of 2 minutes. Other combinations of temperature and time can also give an equivalent heat treatment (60°C for 45 minutes, 65°C for 10 minutes, 75°C for 30 seconds, 80°C for 2 seconds, Safer Cooked Meat Production Guide-lines, DoH, 1992).

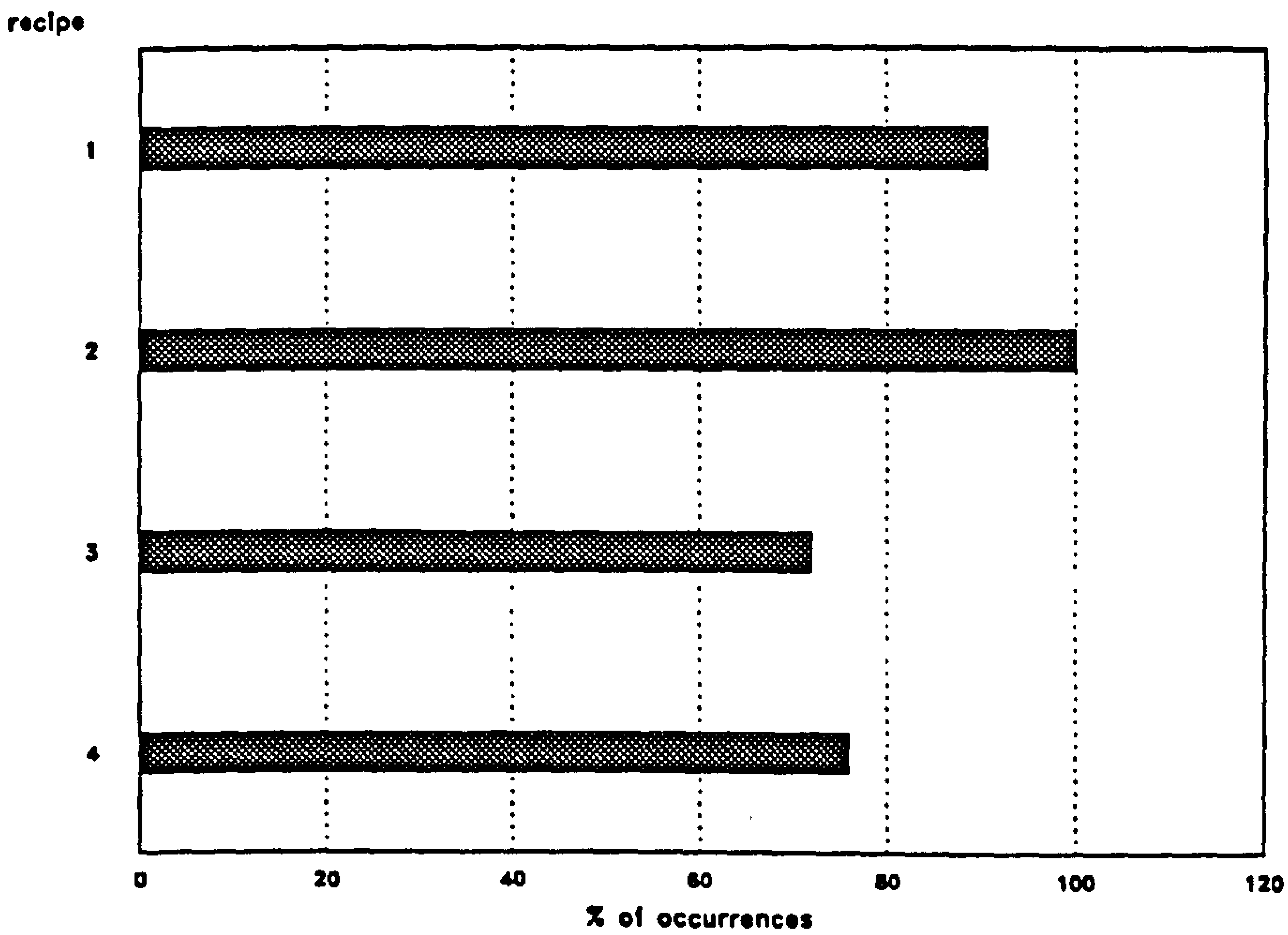


Fig. 6.9 Food cooked to a minimum of 74oC

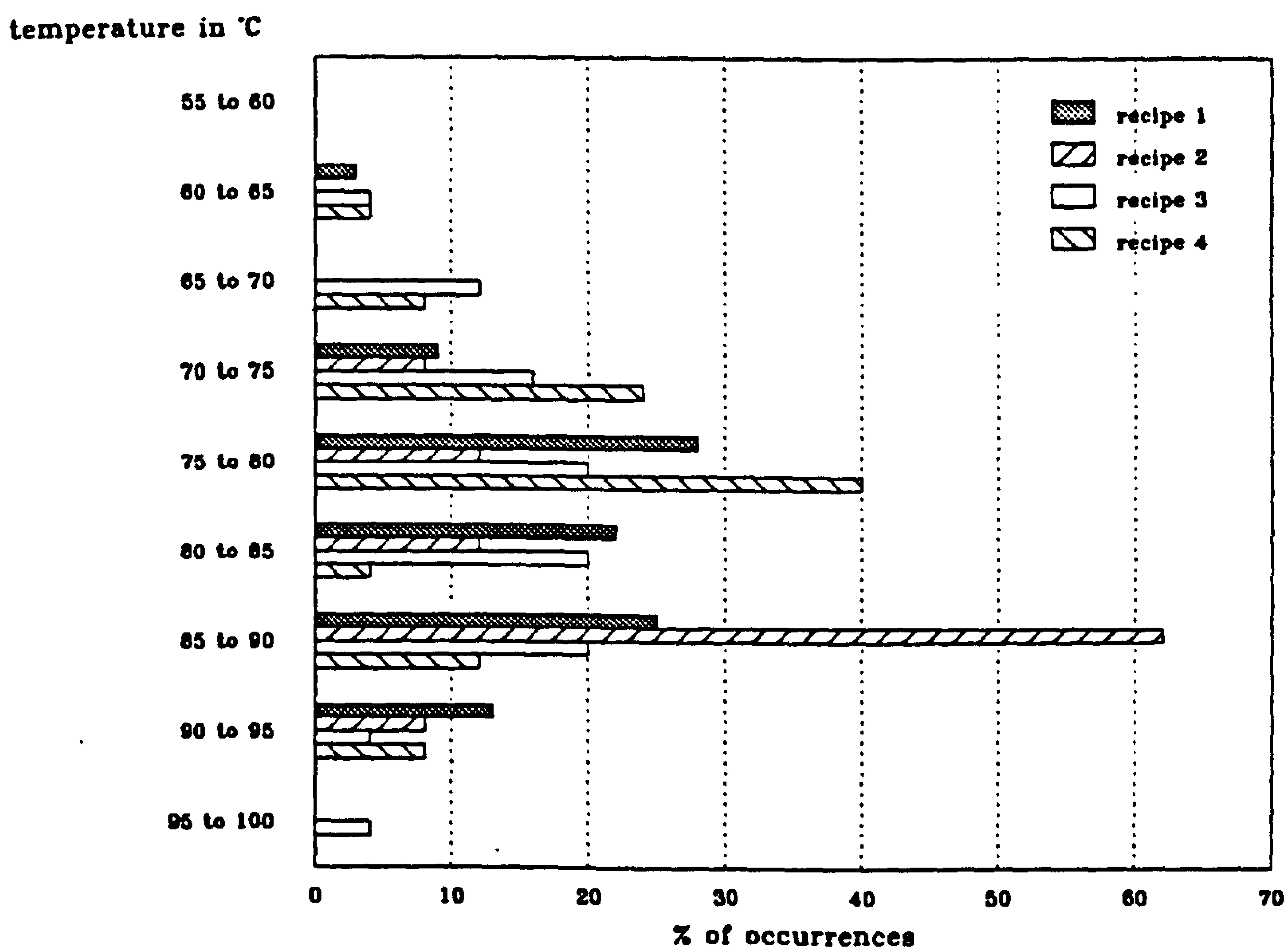


Fig 6.10 Percentage of products in each EPT range

If cooking is properly executed, risks are low; otherwise, risks that insufficiently heated food serve as vehicles of food poisoning are high. Inadequately cooked turkey and chicken have contributed to several outbreaks of salmonellosis. Evidence has shown that any form of cooking where all or some of the yolk of eggs remains liquid can permit the survival of *S. enteritidis*, even from a very small inoculum (Humphrey *et al.*, 1989).

Many bacterial spores and some enterotoxins can survive the time-temperature combinations of cooking. Heat kills organisms that compete with spore formers and drives out oxygen, causing the food to become more anaerobic. Heat also activates spore germination. Outbreaks of food poisoning by *C. perfringens* and *B. cereus* may be facilitated by cooking if subsequent proliferation of survivors is not prevented by temperature control.

A small number of subjects (9/57, 15.7%) failed to cook the chicken to a safe temperature when preparing the poultry dishes (Fig. 6.9). More subjects under-cooked the chicken when using the poaching rather than the frying method (Fig. 6.10). This cooking method which uses a lower temperature may also be less familiar than frying. Seven people failed to cook Recipe 3 (egg, leek and prawn gratinee) to an internal temperature of 74°C but all subjects cooked Recipe 2 (Mexican beef) satisfactorily. The egg product was in all cases heated for the recommended period, but the oven temperature was judged to be less than directed. This was a consequence of a failure to pre-heat the appliance, incorrect setting of the controls, or faulty oven temperature control. Many of the subjects (64%) neglected to complete the cooking by placing the dish under a hot grill. It was fairly difficult to determine whether or not the egg dish had been safely cooked without the aid of thermometer. The surface of the egg/cream mix set well before the centre contents became solid. Some subjects expressed a preference for lightly cooked egg dishes thereby placing themselves at an increased risk of food poisoning.

Consumer surveys (FDF IEHO, 1993; West Glamorgan Public Health Promotion Group, 1991) reveal that most people are aware that under-cooking is a cause of food poisoning. Yet 15% of these subjects did not demonstrate control at this critical control point. The majority of interviewees were unaware of the internal temperature (Fig. 6.11) that should be achieved when cooking meat. Since only 2% claim to use a meat thermometer this information may seem academic. Interviewees relied heavily on their previous experience to calculate adequate cooking times and temperatures.

6.7 Re-heating

Re-heating is the last line of defence in preventing food poisoning and is therefore an important critical control point. If bacteria have survived cooking, or if there has been post-cooking contamination, improper cooling and prolonged storage at room temperature, the large population of bacteria that can result must be killed during re-heating. Re-heated food must reach 74^{o}C for 30 seconds (or equivalent lethal time-temperature combinations). Thorough re-heating will kill vegetative bacteria but it will not destroy spores or the toxins of *B. cereus* or *Staphylococcus aureus*, which are heat stable.

Re-heating methods should be quick, provide an even temperature throughout the food and avoid leaving under-heated areas. In the catering industry, procedures for re-heating are given in the Department of Health Guide-lines for Cook-Chill and Cook-Freeze systems. These state that re-heating should start as soon as possible after removing items from the refrigerator and re-heated food should be discarded where the temperature has fallen below 63°C. Food should not be re-heated more than once.

There is evidence that re-heating is often done poorly in many commercial catering units (Bryan, 1981). Wide ranges of End Point Temperatures (EPT) in re-heated food at point of service have been reported in the literature. Dahl *et al.* (1980) reported temperatures of 47.5°C for 100 gram portions of beef loaf microwave re-heated for 50 seconds. Bryan and Kilpatrick (1971) mention ranges as wide as 38°C in beef roast at point of service. Dahl and Matthews (1979) reported interior oven temperatures in a forced air convection oven set at 121°C ranged from 106°C to 113°C and temperatures of beef loaf prepared in the same oven range from 58°C to 79°C. Sawyer *et al.* (1983) found that 83% of re-heated products in a hospital cook/chill food service system did not meet the Food and Drug Administration recommended standard (>74°C).

Re-heating practice

Many consumers (MAFF, 1988) are aware that inadequate re-heating may be a cause of food poisoning but the results from the present study are not encouraging. Observations could not be made of the re-heating of the food prepared by the

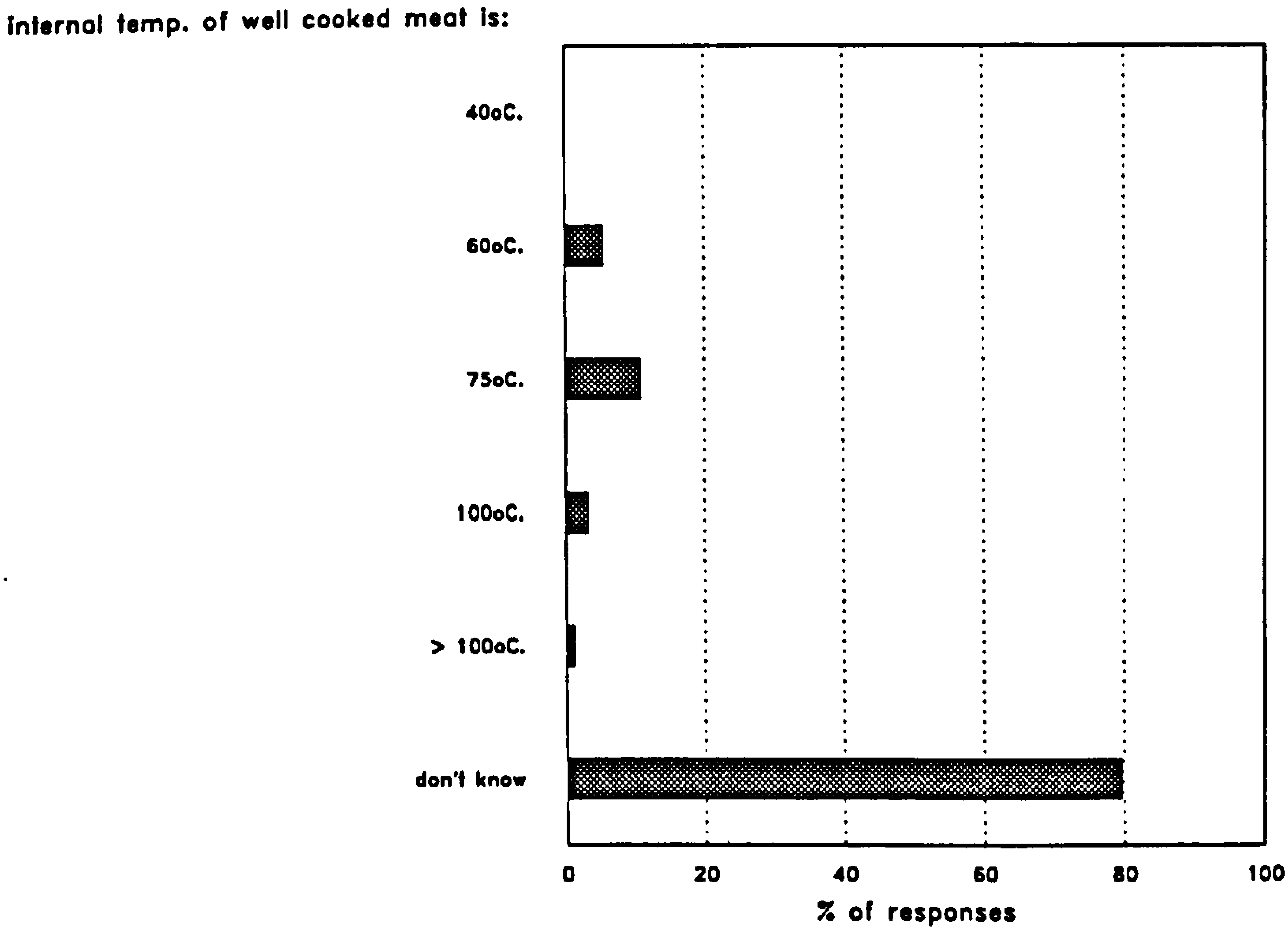


Fig. 6.11 Knowledge of recommended meat cooking temperature

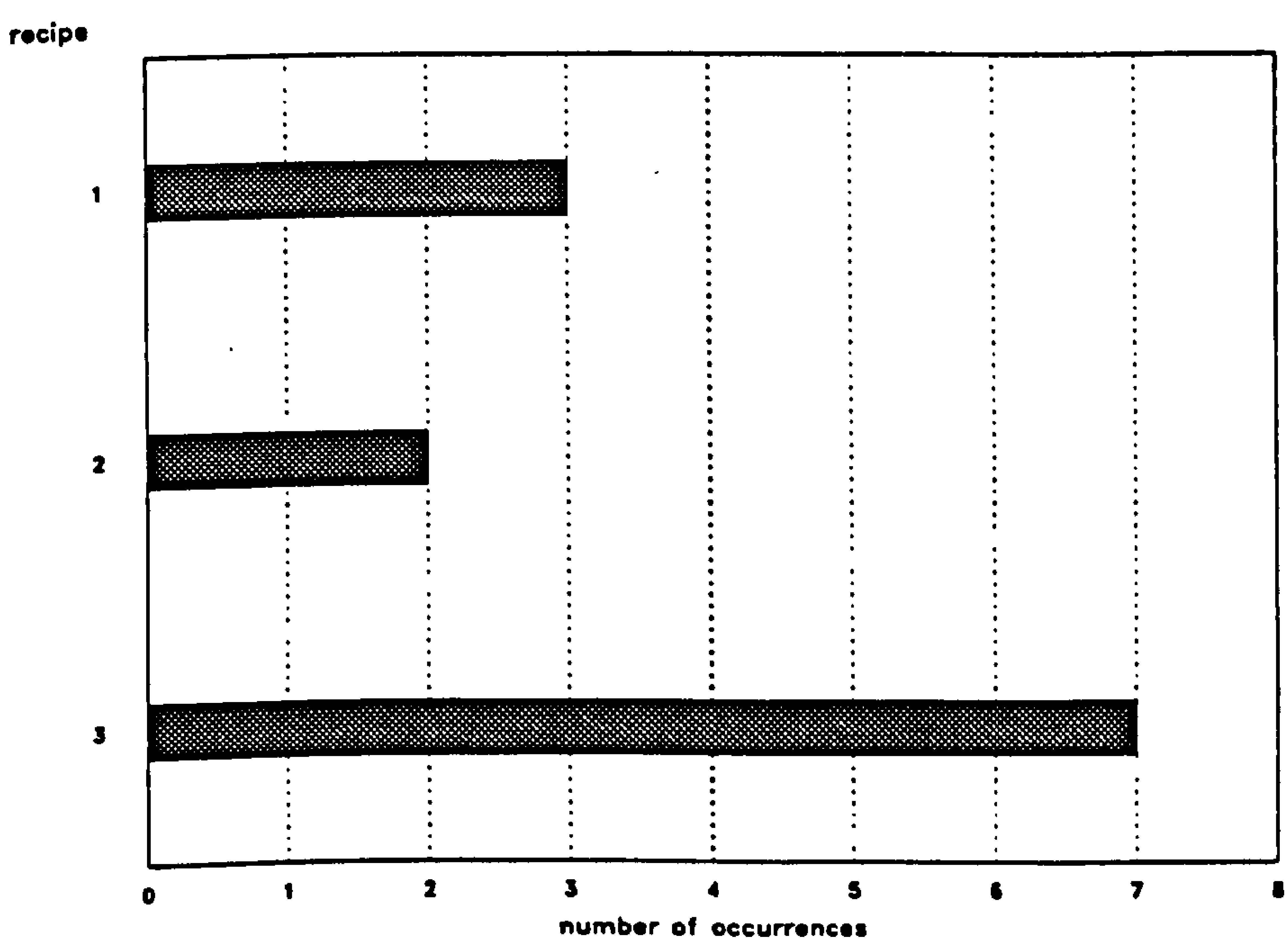


Fig. 6.12 Food reheated to less than 74oC

subjects. Consequently, they were asked for details of the re-heating method that would be employed. Based on the information supplied, demerit points were awarded where it was evident that the time or temperature or both would be inadequate to heat the product to 74°C. 12/48 (25%) were judged likely to under-heat the product (Fig. 6.12). It was recognised that the re-heating times supplied by the subjects were estimates. Since none of them had re-heated the product before, they had to base these times on their experience of re-heating similar products. It is possible that those subjects who seriously under-estimated cooking times would have realised that the product would be under-heated and would have extended the heating period. Those subjects who were unable to stipulate a heating time, but indicated that they would heat the product until it was piping hot throughout, were given the benefit of the doubt.

Because of uncertainty about the adequacy of the re-heating techniques, observations were conducted on the re-heating of a chilled version of the product by a sample of subjects who had previously cooked the food. 10/19 (53%) failed to re-heat the products to an internal temperature of 74°C (Fig. 6.13). Subjects were more likely to under-heat the product when using a microwave oven than other heating methods. The time, rather than the power setting, used for re-heating was under-estimated.

Over half (10/19, 53%) the subjects re-heated the dish more than once, most leaving it at ambient temperature for less than two hours between heatings, although one person left it for approximate five hours at ambient temperature before a second heating (Fig. 6.14).

Use of microwave ovens

Many (78%) of the subjects had a microwave oven. Some (21/50, 42%) reported that they would use the appliance for re-heating the product they had cooked and 47% (9/19) used it when re-heating the chilled dish prepared by the researcher. The widespread ownership and use of microwave ovens for re-heating food has been reported by several surveys (MAFF, 1988; FDF IEHO, 1993; West Glamorgan Public Health Promotion Group, 1991).

Awareness of the power rating of the microwave oven (Fig. 6.15) was higher (88%) than amongst those surveyed by West Glamorgan Public Health Promotion Group (1991) and the Food and Drink Federation (1993a). Most claimed to understand how to adjust cooking times according to the power rating of the oven and to respect the standing times advised by the manufacturer.

Many consumers appear to be aware of media reports of microwave ovens not heating food properly (FDF IEHO, 1993a). 17% of the respondents in the West Glamorgan Public Health Promotion Group survey thought that microwaving was a cause of food poisoning and only 23% thought that microwave cooking could make a food safe from food poisoning. There is clearly a need to educate the public on the safe use of the microwave oven.

6.8 Cross-contamination during food preparation

The ingredients which were used in the recipes would have a flora of micro-organisms characteristic of the products and the processes to which they have been subjected. *Salmonella* has been associated with eggs and this organism, as well as

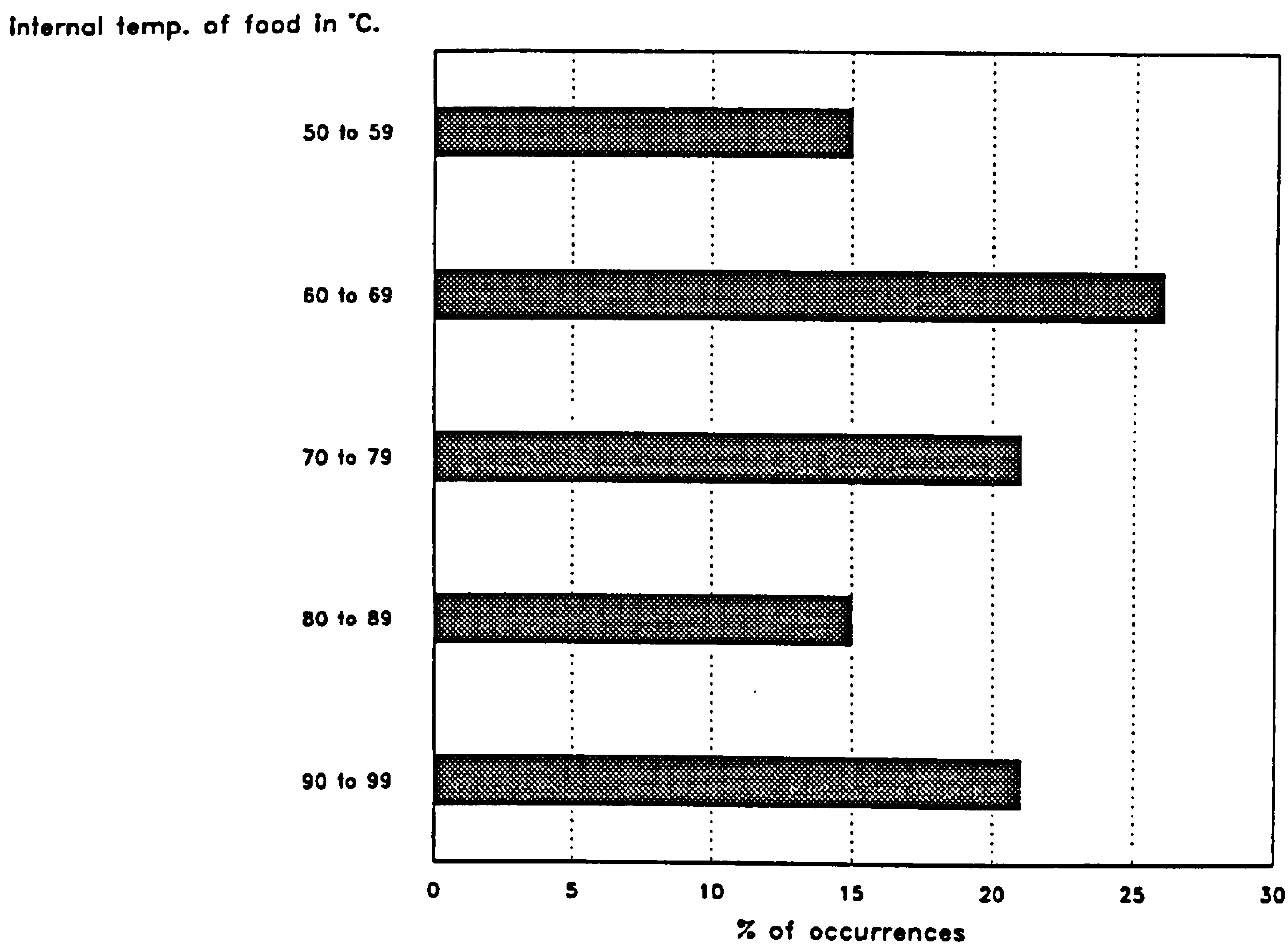


Fig 6.13 Reheating chilled food

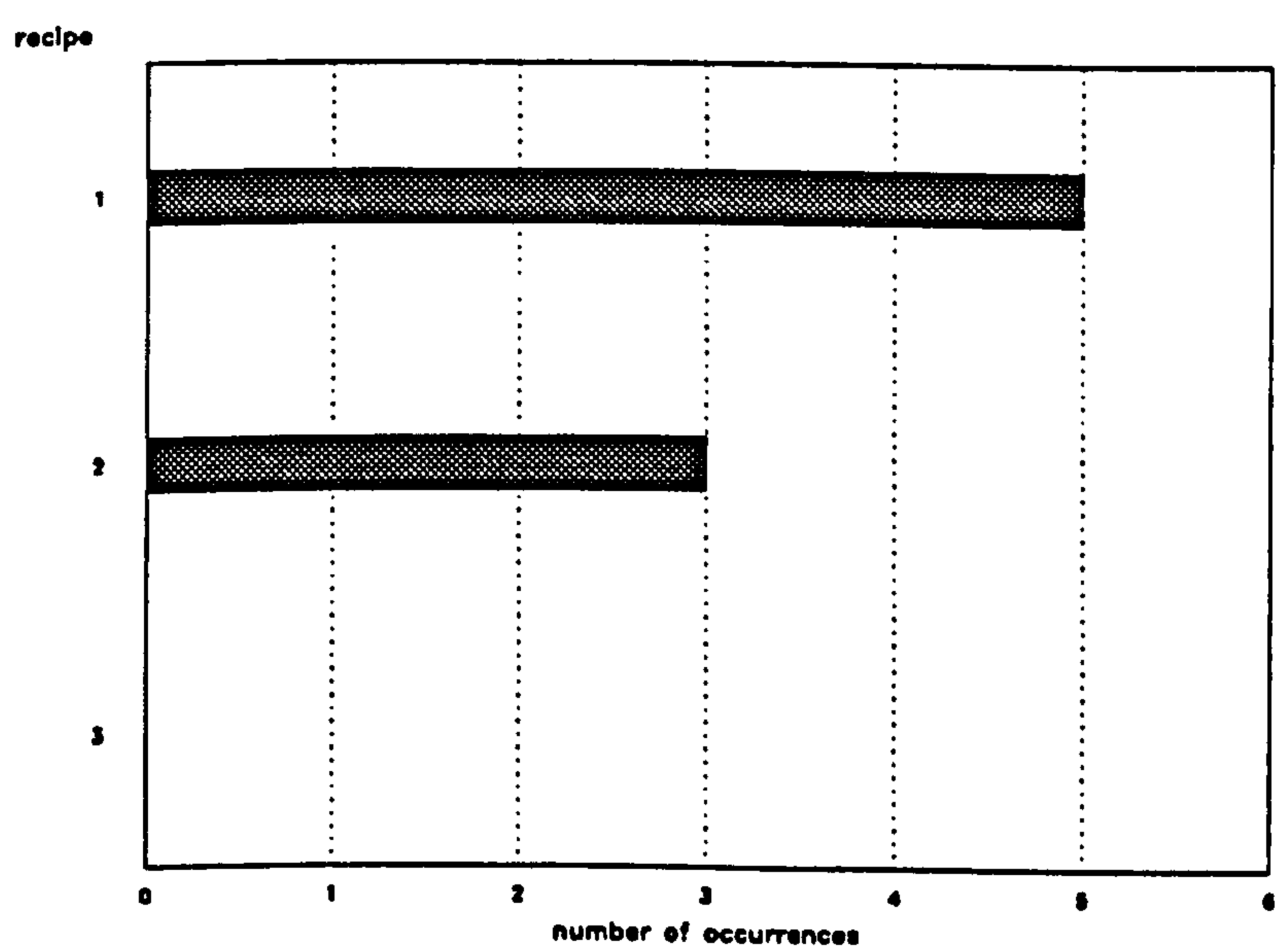


Fig. 6.14 Food reheated more than once

C. perfringens, *S. aureus* and *Campylobacter*, are frequently associated with raw poultry and raw meat. Raw vegetables also present a microbiological risk during preparation, primarily due to soil and dirt. The main risk during food preparation is cross-contamination to other foods. Cross-contamination can occur in a number of ways, e.g.:

- raw foods directly touching other foods
- handlers touching raw foods, then other foods especially those not cooked prior to consumption
- using preparation equipment and work surfaces for raw foods followed by other foods
- allowing raw foods to drip onto other foods, especially those requiring no further cooking
- using soiled dishcloth/wiping cloths.

The involvement of cross-contamination as a contributory factor in food poisoning is probably under-estimated in the surveillance statistics (Bryan, 1988) as it is difficult to detect during short routine inspections or during retrospective epidemiological investigations. Nevertheless the potential risks of cross-contamination are high and the high probability of its occurrence became apparent during observations of subjects preparing food.

Some (23%) subjects allowed the meat or poultry packaging to remain in the work area during preparation.

One person used the unwashed raw chicken container to hold the finished cooked product. Some (28%) of the subjects washed the raw chicken or chicken livers prior to preparation. Washing poultry under a stream of water from a tap will remove few salmonellae or other organisms but may be a first step in the cross-contamination of other foods. Most

Knowledge and use of microwave ovens

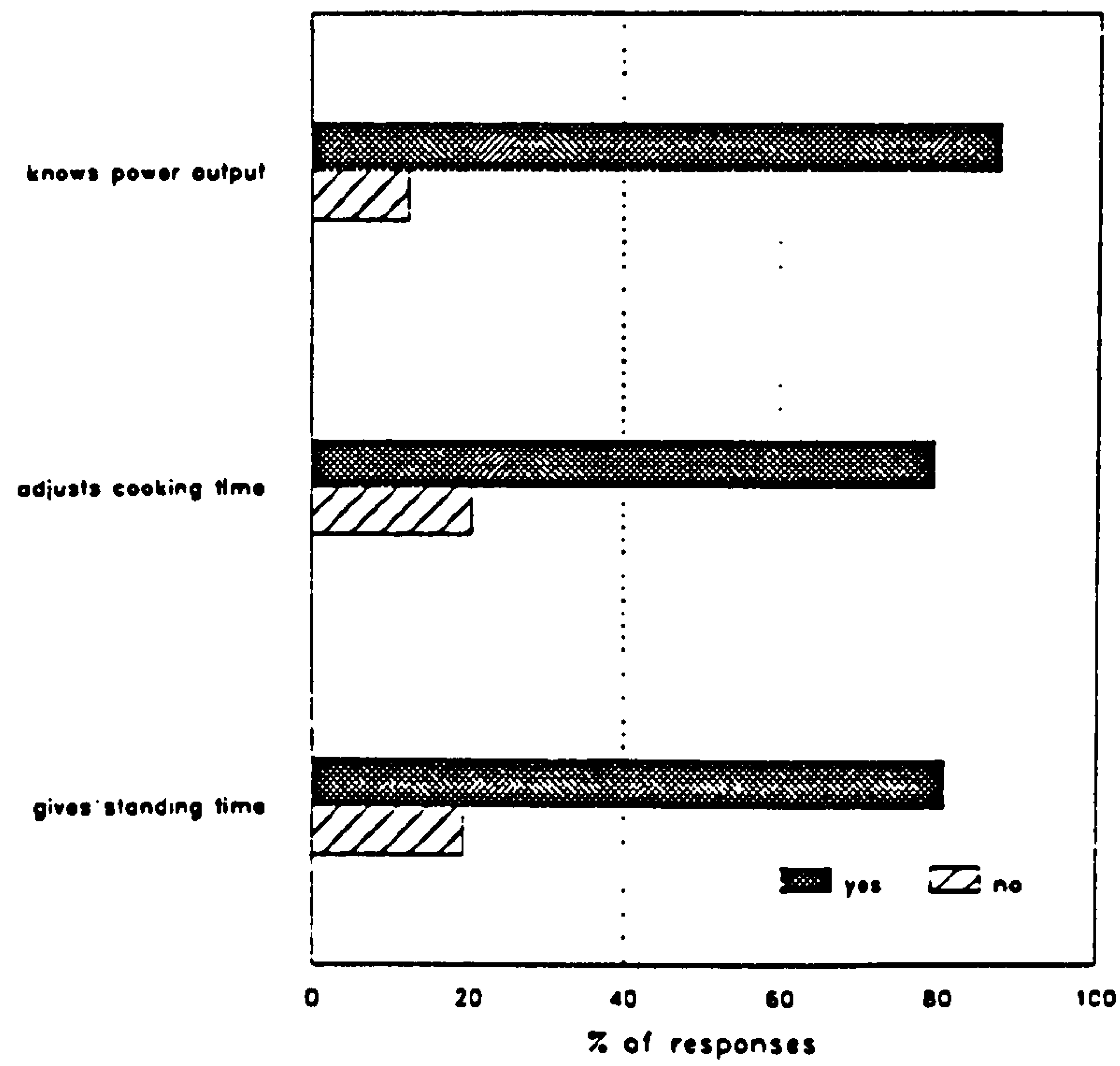


Fig.6.15 Knowledge and use of microwave ovens

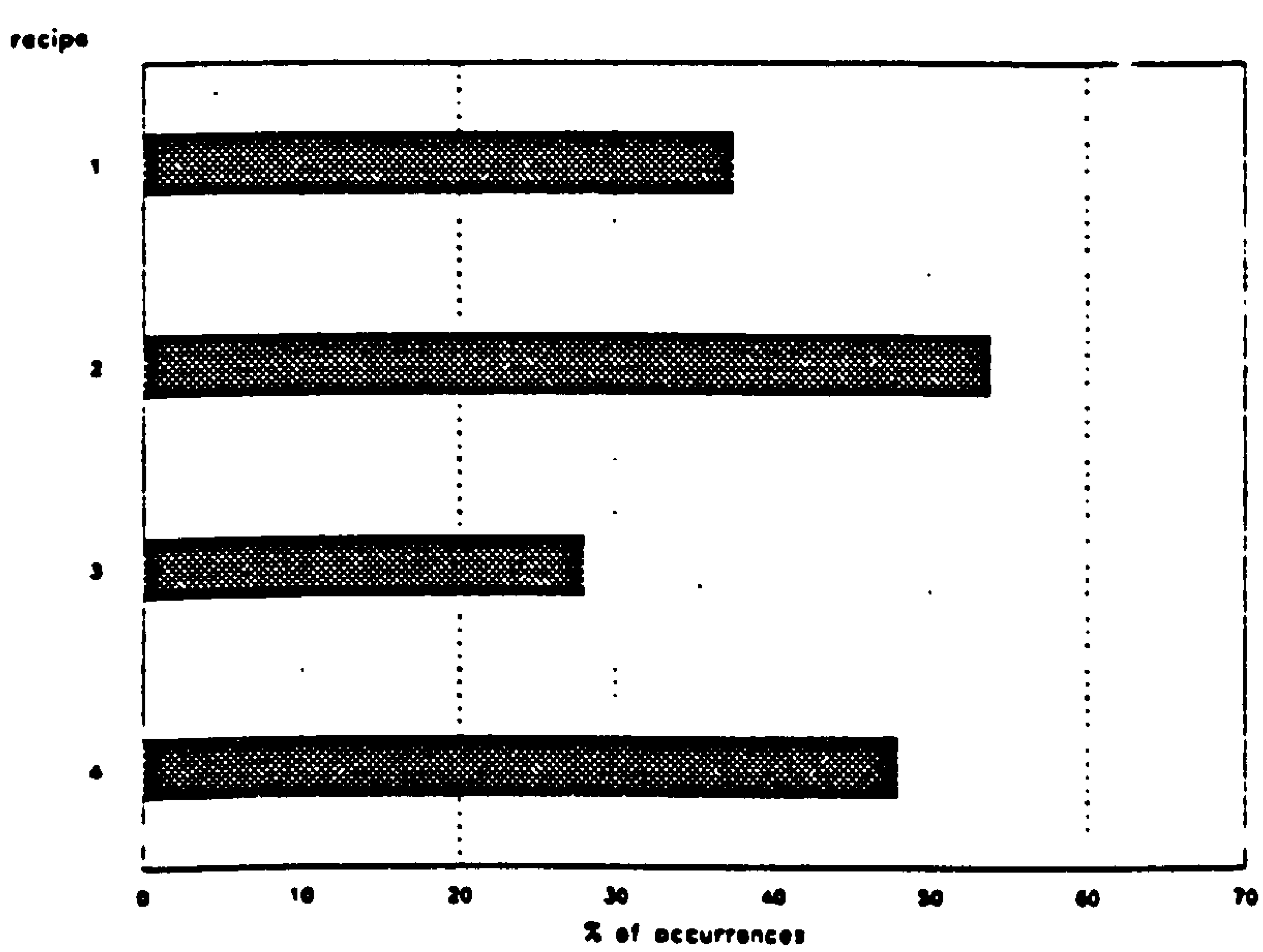


Fig. 6.16 Use of unwashed vegetables

(75%) of the kitchens had a single sink which had to be used for washing raw ingredients, hands, dishes and sometimes clothes. Raw vegetables were processed daily by almost all respondents (96%) whilst the majority (62%) claim to handle raw meat or poultry on a daily basis. Many subjects (41%) failed to wash some of the vegetable ingredients which were then prepared on a general purpose cutting board (Fig. 6.16). This result, which is much higher than the FDF IEHO survey where only 18% did not claim that they washed vegetables before eating them, again raises doubts about the reliability of surveys.

The same board was used for all cutting operations by 60% of the subjects (Fig. 6.17). A study by De Boer and Hahne (1990) showed that *Campylobacter* could be recovered from 50% of cutting boards that had been in contact with raw chicken. In the present study, boards were inadequately cleaned between food operations by 25% of the people (Fig. 6.18), thereby increasing the risks of cross-contamination and the possibility of food poisoning.

Other potential sources of contamination in the kitchen were identified as open-stored soiled vegetables (19%), clothes washing machine (59%) and a domestic pet (41%). A RSGB survey (1991) commissioned by Dettox revealed that 20% of respondents with pets allowed them access to kitchen surfaces. In the present study one cat was found on a work surface during food preparation, a cage of gerbils and an ancient terrapin in a container were found on draining boards, a budgerigar in a cage on a window sill kicked grit over the adjacent work surface and a cardboard box of day-old chicks were incubated on an Aga cooker. The presence of

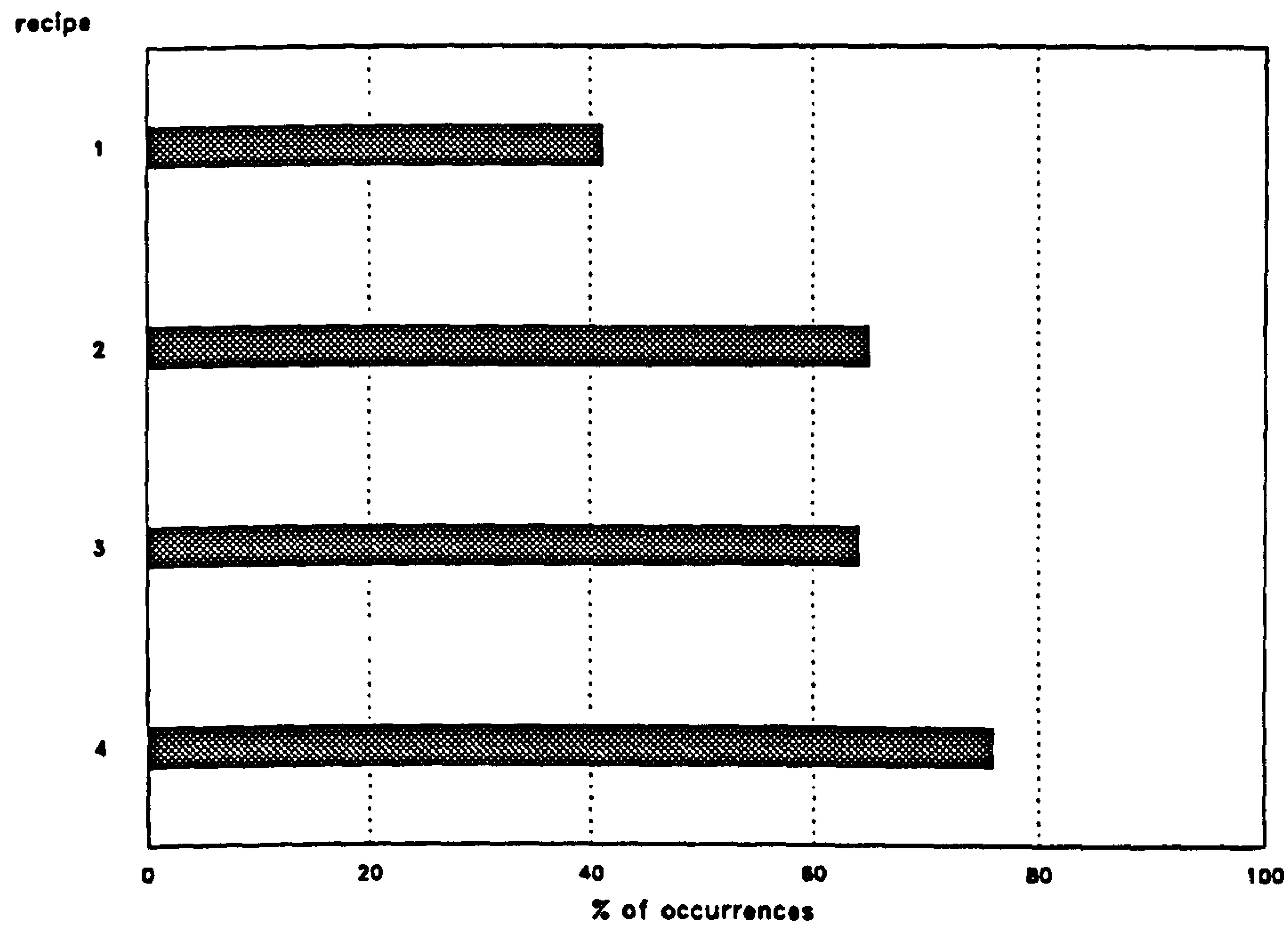


Fig. 6.17 Use of a single cutting board

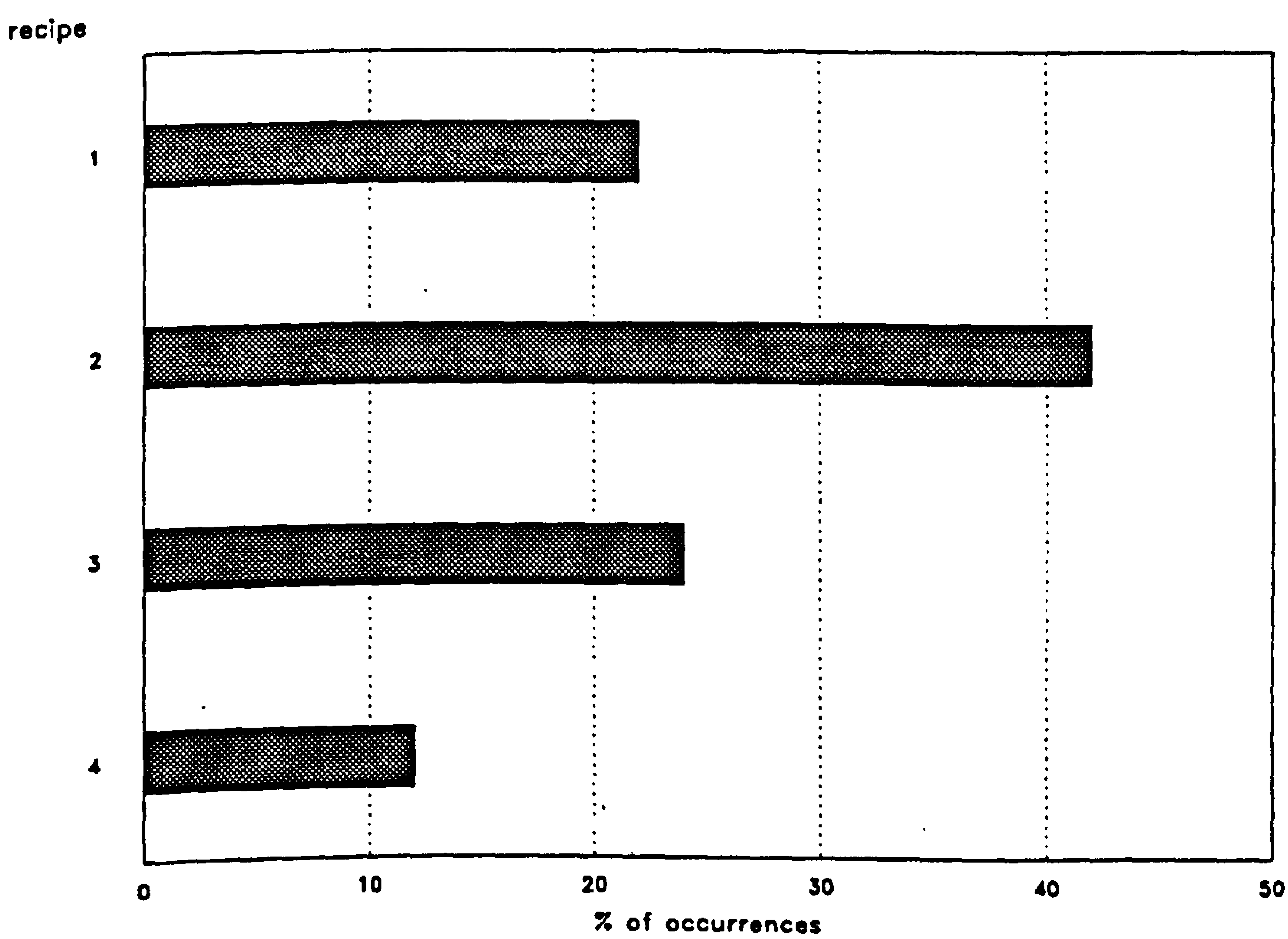


Fig. 6.18 Use of a soiled board

hibernating tortoises, a Myna bird and hamsters in a hutch on the kitchen floor would not be regarded as best practice but probably did not offer a great risk of contamination. The feeding bowls, bedding materials and cat litter might present a contamination hazard if they were handled on or near work surfaces and if the hands were not washed subsequently.
Cats and dogs are recognised as a source of *Campylobacter* infection. Skirrow (1981) estimated that 5% of cases in humans were associated with these animals. If the incidence of domestic pets in kitchens in the present study is representative, the public need to be made more aware of the necessity for a high standard of pet hygiene to ensure their own health.

6.9 Handwashing

The Food Hygiene (General) Regulations 1970 require the catering industry to provide suitable and sufficient handwashing facilities for food handlers and industry guide-lines give advice on handwashing procedures (IFST, 1992). Guidance for the domestic food handler is provided in leaflets produced by food retailers and the government (MAFF, 1991).
A large number of subjects (65.7%) neglected to wash their hands when starting food preparation (Fig. 6.19). Of more concern were those who failed to wash their hands prior to handling cooked food that would receive no further heat treatment and might be subjected to a delay before consumption. More than half of those who handled raw chicken or minced beef failed to wash their hands after touching the product or its packaging.

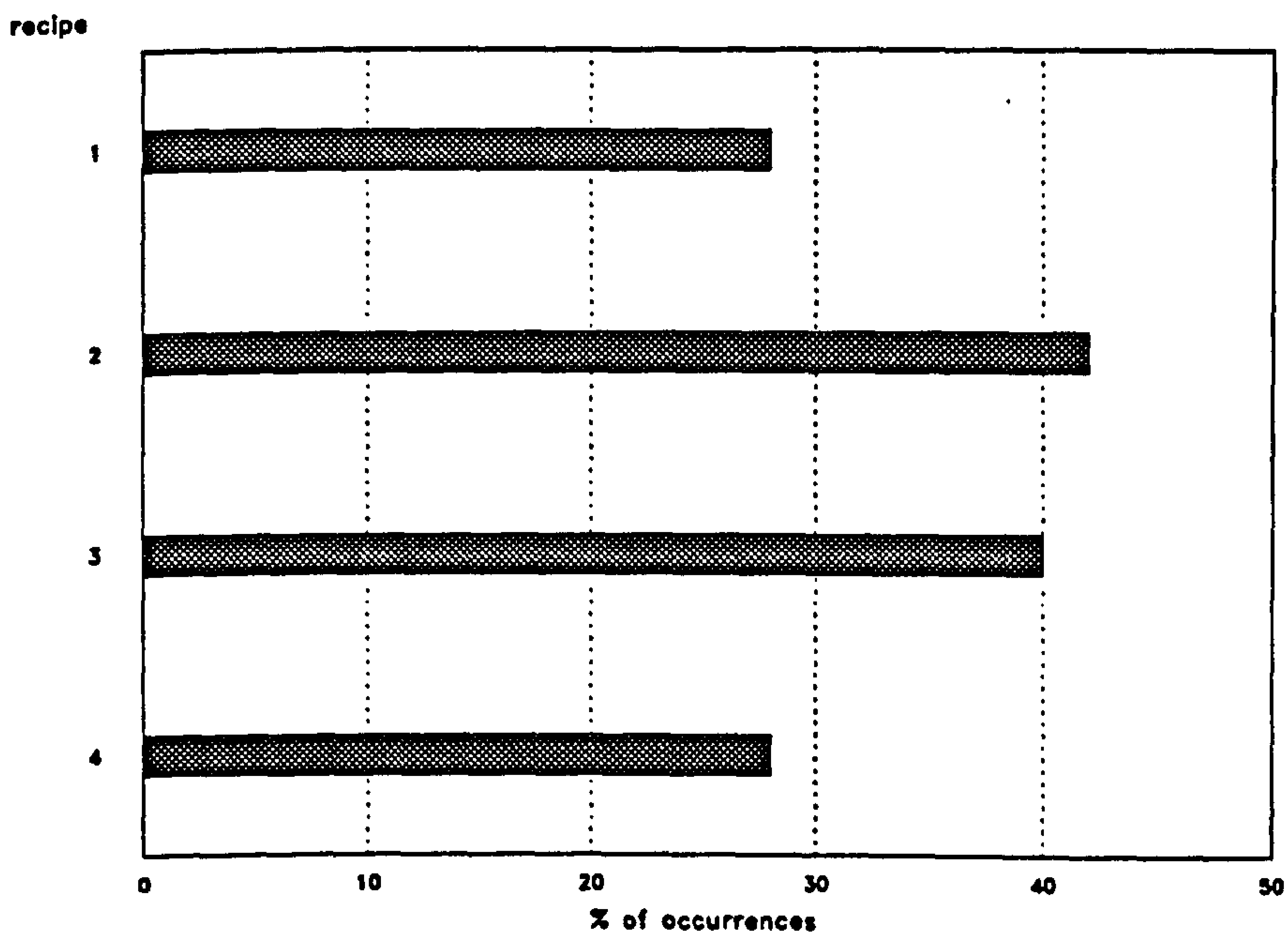


Fig. 6.19 Handwashing prior to food preparation

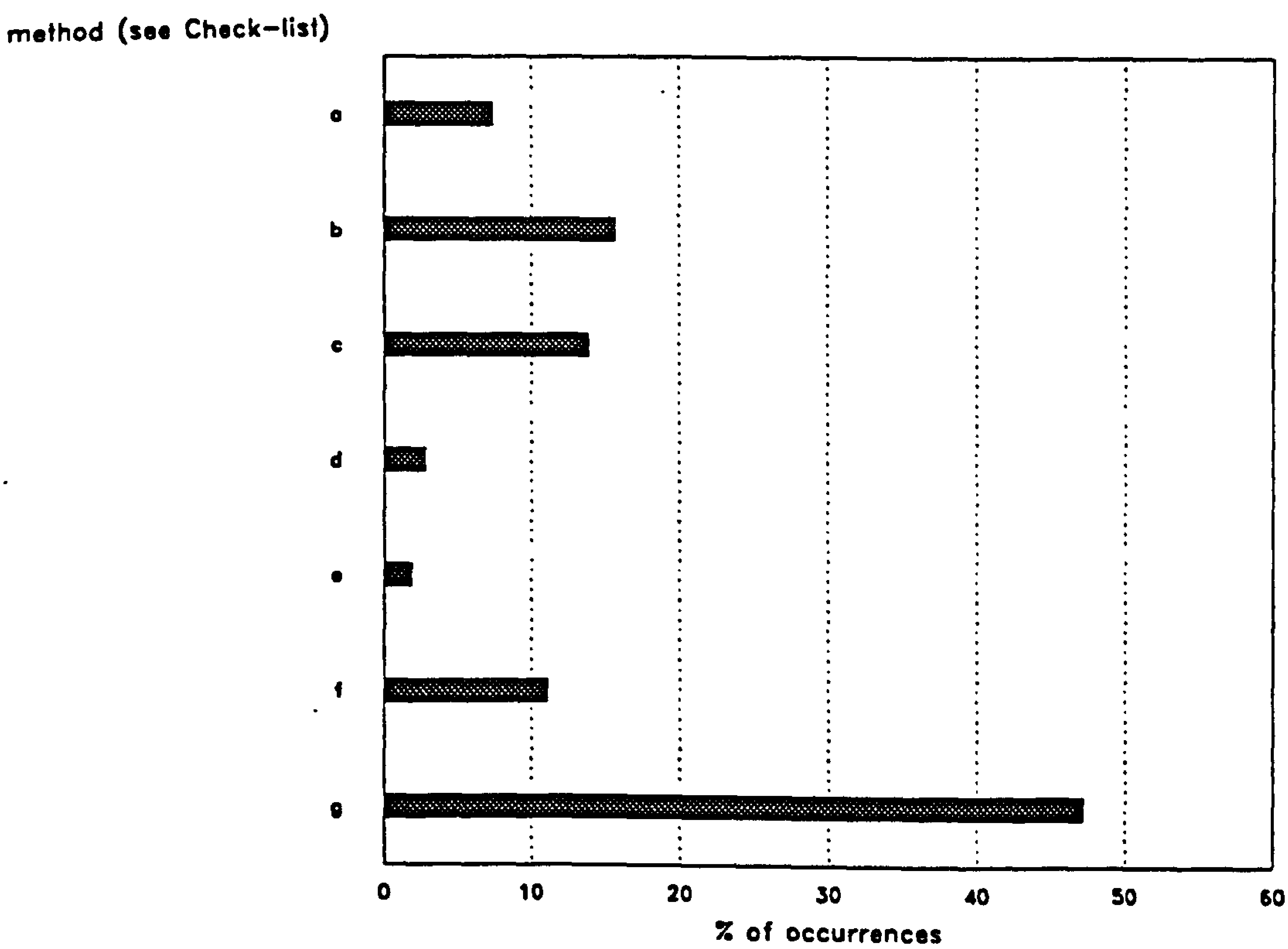


Fig. 6.20 Handwashing methods

De Boer and Hahne (1990) isolated *Campylobacter* from 73% of previously clean hands that had touched contaminated chicken. Even three minutes after handling the chicken, the bacteria were recovered from 55% of hands.

Most people (76%) did not wash their hands after breaking the eggs and a small minority did not wash their hands at any stage throughout the food preparation process.

A total of (62/108, 57%) subjects violated the elementary but essential control measure of regular and thorough handwashing when handling food. The hands were sometimes wiped on the dishcloth, the tea towel or the apron thereby increasing the opportunities for cross contamination.

The investigations by Coates *et al.* (1987) have shown that washing the hands with either soap and water combined with drying on paper towels can remove a heavy inoculum of *Campylobacter* from the fingertips. If the hands were not dried some *Campylobacter* were likely to remain.

In the present study handwashing was usually accomplished by allowing the hands to become wetted under a stream of tap water. Detergent or soap was used infrequently and the hands were often not dried (Fig. 6.20). The majority (79%) of homes did not have a nailbrush near the sink, some (37%) had no soap and many (46%) had no separate hand towel for drying the hands (Fig. 6.21).

Subjects who failed to wash their hands after handling potentially contaminated raw ingredients were observed to touch a wide variety of surfaces including equipment handles, boards, work surfaces, drying cloths, dishcloths and crockery.

Tap handles were unavoidably subjected to contamination from soiled hands but no subjects were observed to clean them at the end of the preparation period. Cleaning may however have taken place after the period of observation. Whilst the risk of indirect cross-contamination during the observed episode of food preparation was variable, depending in part on whether cooked food was held and the manner in which it was handled, unless contaminated food or hand contact surfaces were effectively cleaned they represented a potential threat to food which was subsequently prepared in the kitchen. Between 30 and 50% of the population carry *S. aureus* and one third to one half of these carry enterotoxigenic strains (Wieneke *et al.*,1993). Food handlers may also be intestinal carriers of *Shigella, hepatitis A virus, Salmonella typhi*, organisms which can be transferred to food if the hands are not washed after defaecating.

It would appear that the principle of indirect cross-contamination may not be well understood. Domestic food handlers must be better educated on the need for proper personal hygiene and the avoidance of cross-contamination.

6.10 Cleaning of equipment

Cross-contamination of food can be reduced or prevented if food handlers do not use the same equipment and utensils for raw and cooked foods. If, however, the items and surfaces are used for both raw and cooked food, then they should be thoroughly cleaned and disinfected between operations. The majority of kitchens visited were equipped with more than one cutting board, but a single board was used by over half of the subjects for all cutting operations. The condition of

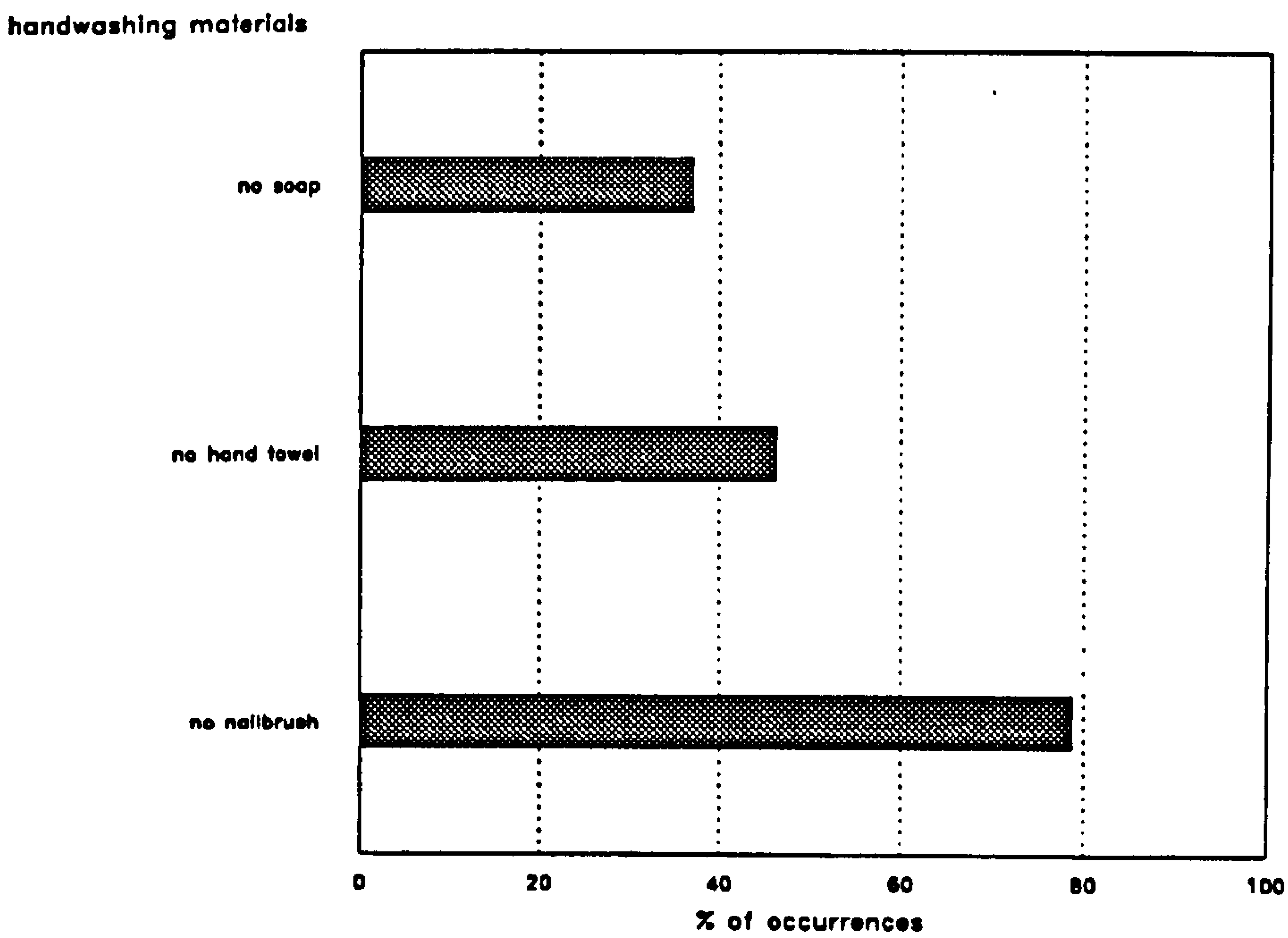


Fig. 6.21 Lack of handwashing materials

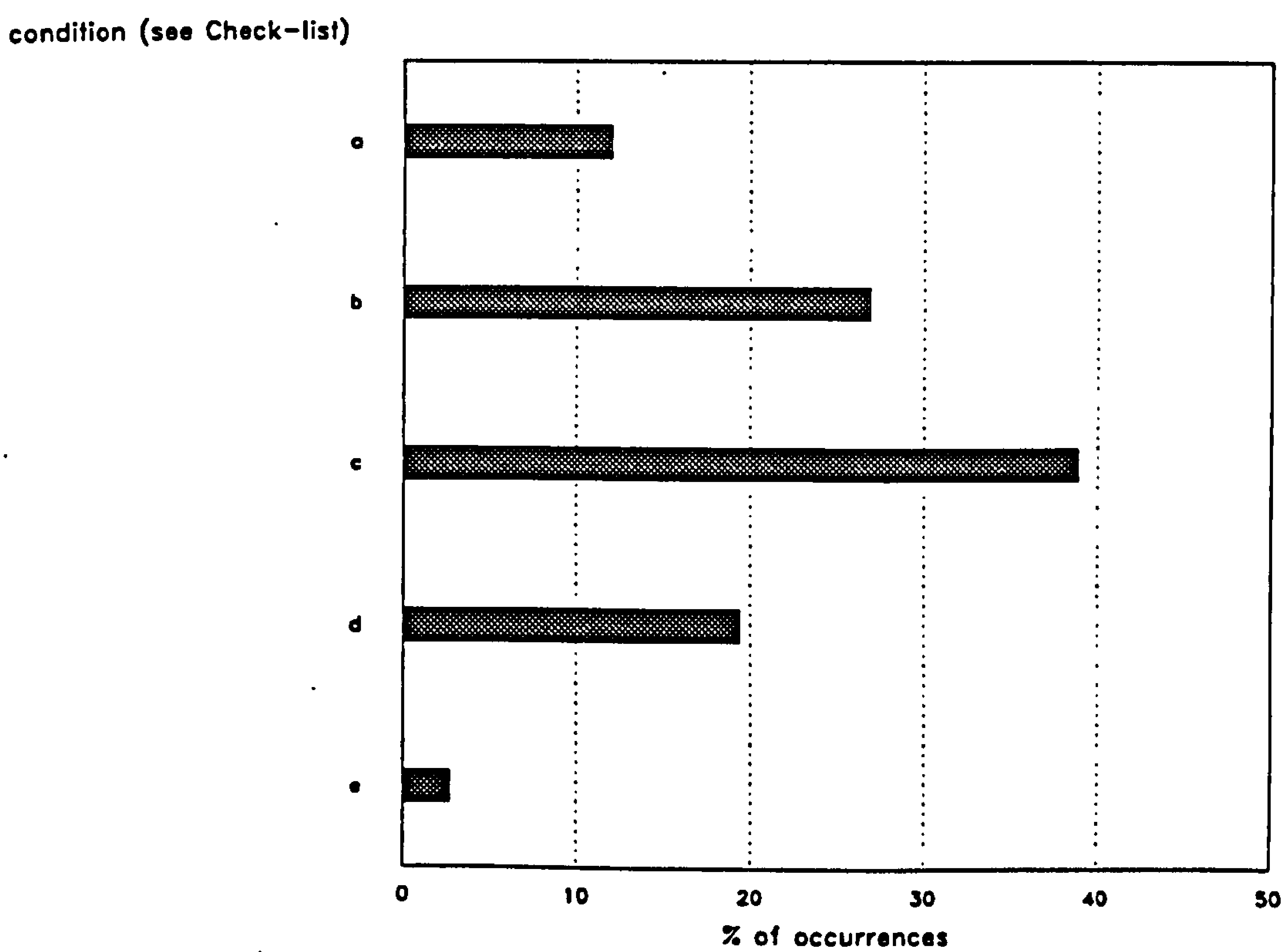


Fig. 6.22 Condition of the cutting board

some (22%) of the boards would have made them difficult to clean (Fig. 6.22). The recommended method of cleaning and disinfecting the board (See Fig. 4.25) was used by less than 10% of the subjects (Fig. 6.23).

Dishwashers, which use high temperature wash and rinse waters to clean and disinfect items are considered to be more hygienic than manual washing-up. Over 40% of the subjects had dishwashers, but less than half of them were observed to use the appliance during this food preparation exercise. Some washed the soiled items by hand and some left the bulk of the washing-up until the end of the visit, although boards were usually cleaned or wiped during the preparation process.

Most of the kitchens had work surfaces organised to provide at least two working areas, yet most subjects were observed to conduct all steps of the process in one area, usually close to the sink. Whilst very few subjects were observed to use the work surface directly for food preparation, the concentration of all activities in a small area increases the potential for cross-contamination and makes the task of cleaning and disinfection more important. None of the subjects were observed to clean the work surface or preparation board immediately prior to food preparation.

Cloths used to wipe surfaces can spread contamination. Many people (55%) were observed to use the same cloth for wiping surfaces and dishwashing. This is a lower percentage than that presented in Beddows's survey (1983) where 89% of respondents used a general purpose wiping/dishcloth. A small number (14%) of the cloths in the present study were observed to be soiled and wet at the start of food preparation (Fig. 6.24). These conditions would encourage microbial growth.

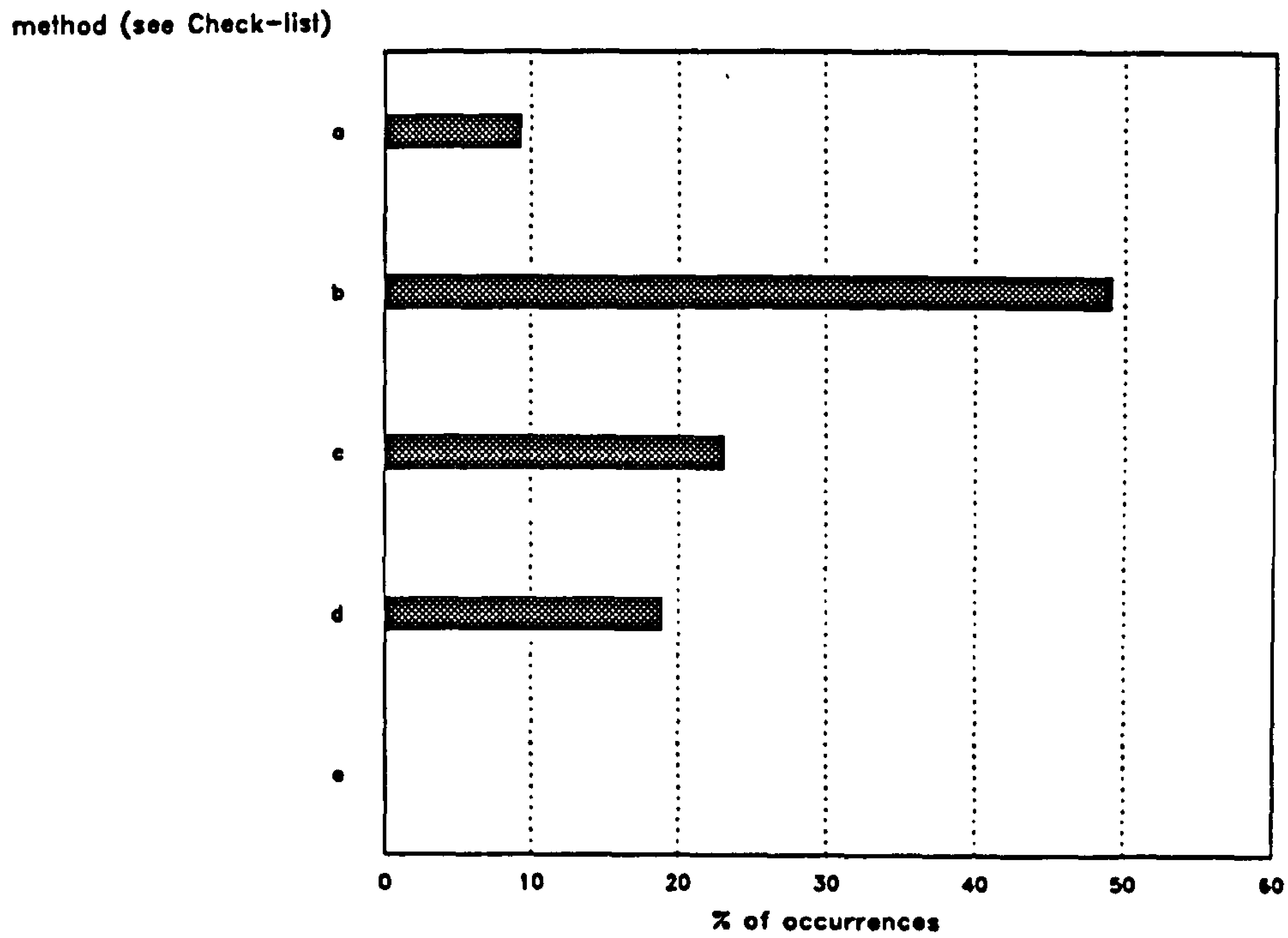


Fig.6.23 Method of cleaning the board

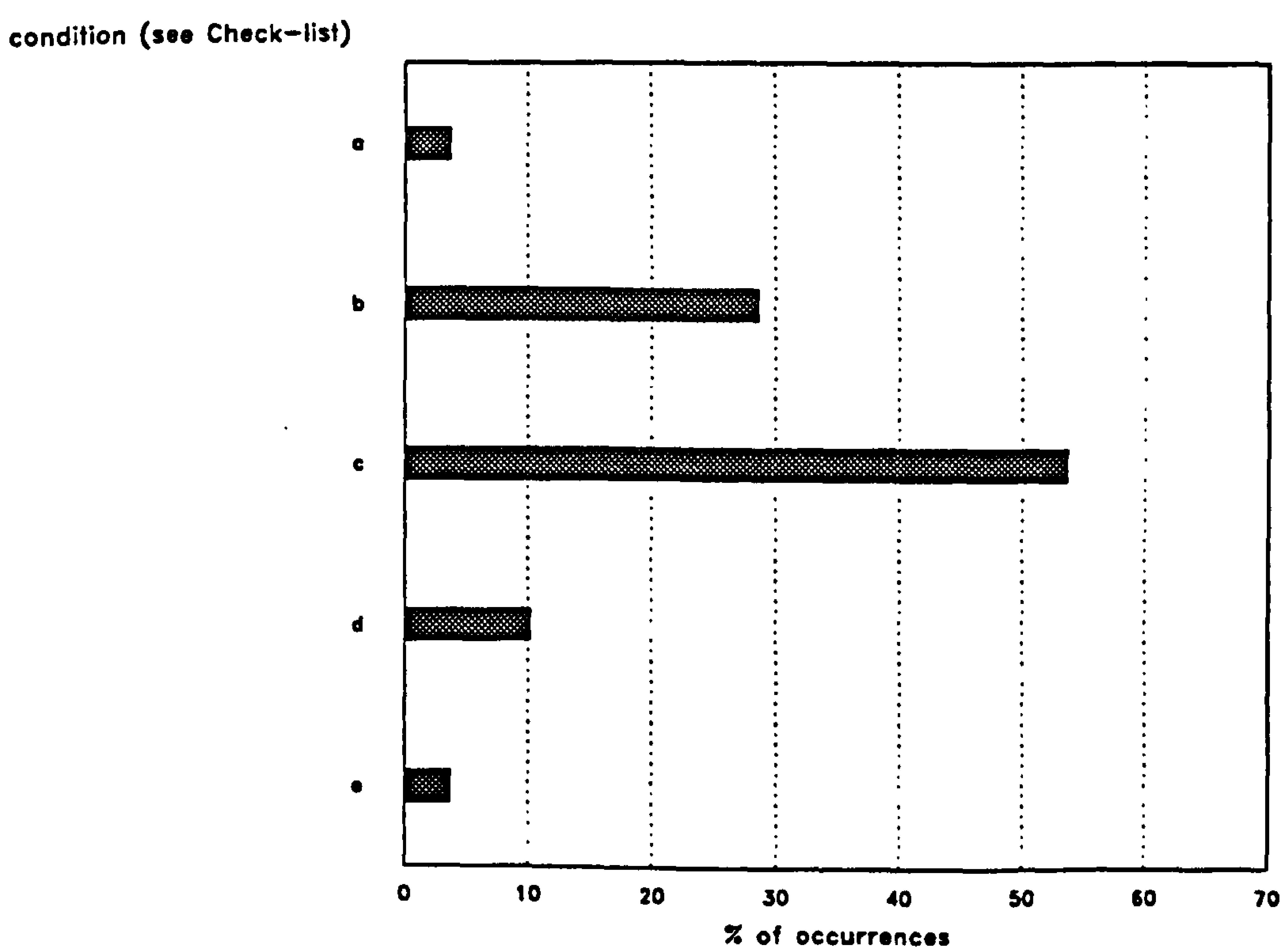


Fig. 6.24 Condition of dishcloth/wiping cloth

Beddows found that dishcloths were hung up to dry by 52% of respondents. Disposable cellulose wiping cloths were usually in a worse condition than cotton cloths. Although 71% of subjects had paper towels in the kitchens they were seldom used during food preparation.

6.11 Refrigerated Storage

The life style of many consumers, with weekly or less frequent purchasing and a heavy dependence on chilled and frozen foods means that greater reliance must be placed on the home refrigerator or freezer to keep food in good condition until it is required.

Many of the ingredients used in the preparation of the four recipes had insufficient intrinsic factors to control the growth of micro-organisms and required to be chilled or frozen to avoid spoilage and multiplication of pathogens during storage. All subjects stored the chilled and frozen foods in a refrigerator or freezer with the exception of eggs, which were stored at room temperature by 10% of the people. Board and Clay (1991) found that *Salmonella* inoculated into eggs began to multiply after a few days at 25°C, but not at 4°C or 10°C. Humphrey *et al.* (1989) showed that *Salmonella* inoculated into eggs held at room temperature reached 10^8/gram after two days. This suggest that those subjects who stored their eggs in the kitchen might be exposing themselves to a greater risk of food poisoning.

It was not possible in many cases to observe the position of the stored foods in the refrigerator. When questioned about the storage of raw poultry, 40% of respondents indicated that they would place it at the bottom of the refrigerator (Fig.

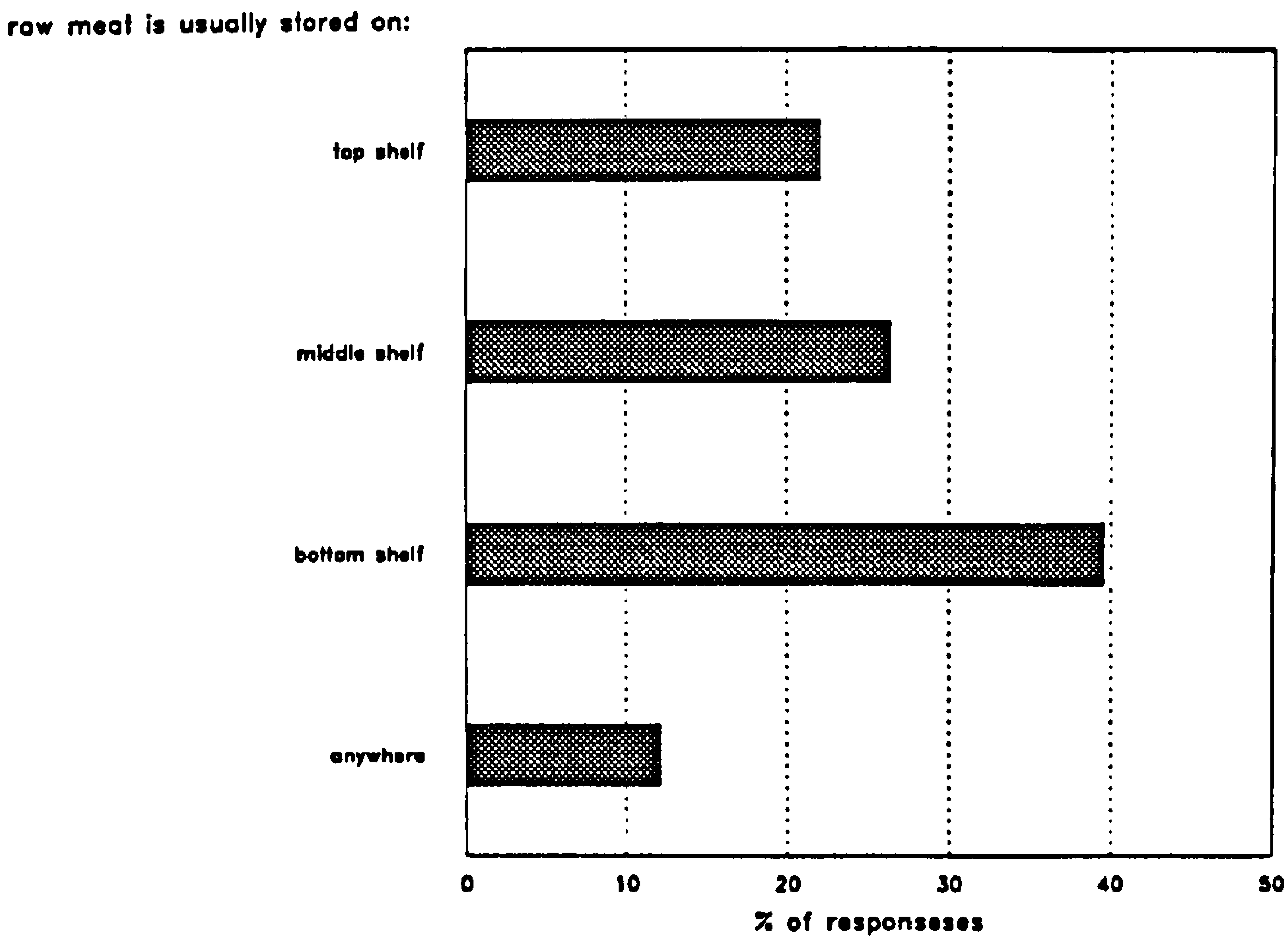


Fig. 6.25 Storage of raw meat in the refrigerator

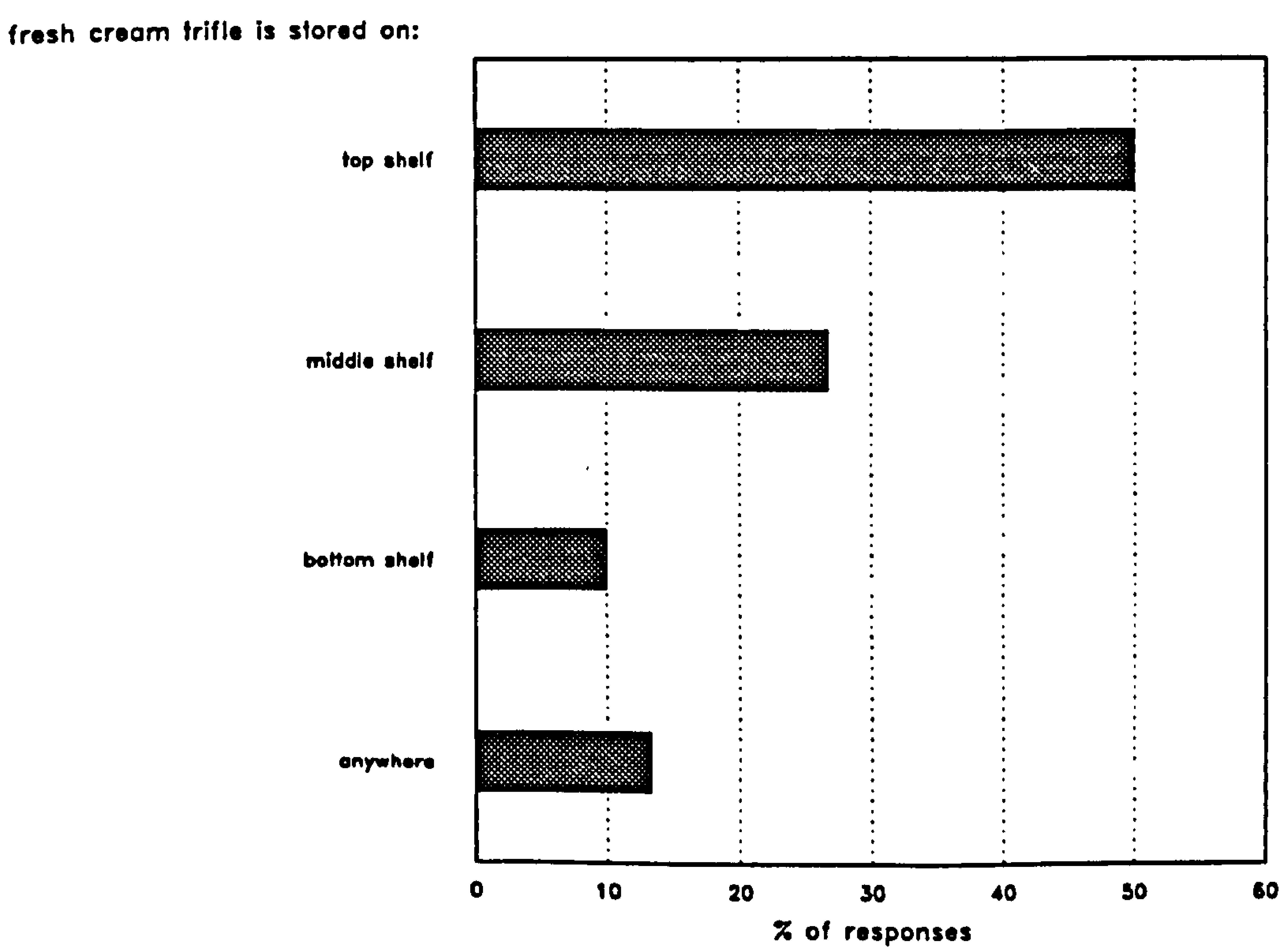


Fig. 6.26 Storage of fresh trifle in the refrigerator

6.25) and 50% would store a fresh cream trifle on the top shelf in the same refrigerator (Fig. 6.26). Some (22%) would use the top shelf for raw poultry and 12% would store food items anywhere there was a space. None of the subjects removed the pre-packed meat or poultry from its packaging before storage. This type of sealed packaging may reduce the opportunity for cross-contamination during storage.

Over half of the subjects stored the chilled ingredients in a refrigerator that operated above 5°C (Fig. 6.27). The mean air temperature of the refrigerators was 5.9°C, with a range from -2°C to 12°C (Fig. 6.28). The highest recorded temperature in the domestic refrigerators studied by Evans *et al.* (1991) was 11.37°C and the lowest -0.89°C, with a mean of 6.04°C.

Previous surveys of the public (Spriegel, 1991; FDF IEHO, 1993a) and the present study have revealed that knowledge of the correct storage temperature for chilled foods is not widespread. The lack of thermometers in domestic refrigerators and the consequent inability to measure the operating temperature is also well documented (FDF IEHO, 1993a; MAFF, 1988; West Glamorgan Public Health Promotion Group, 1990).

Only 7.5% of the subjects in the present study claimed to do main food shopping two or more times a week. If shopping is conducted on a weekly basis, or less frequently, it suggests that some chilled foods are being held for longer than recommended. It is possible that consumers freeze chilled products if they have to be held for several days and it is also likely that consumers visit the shops for small quantities of food during the week. 33.7% of respondents in

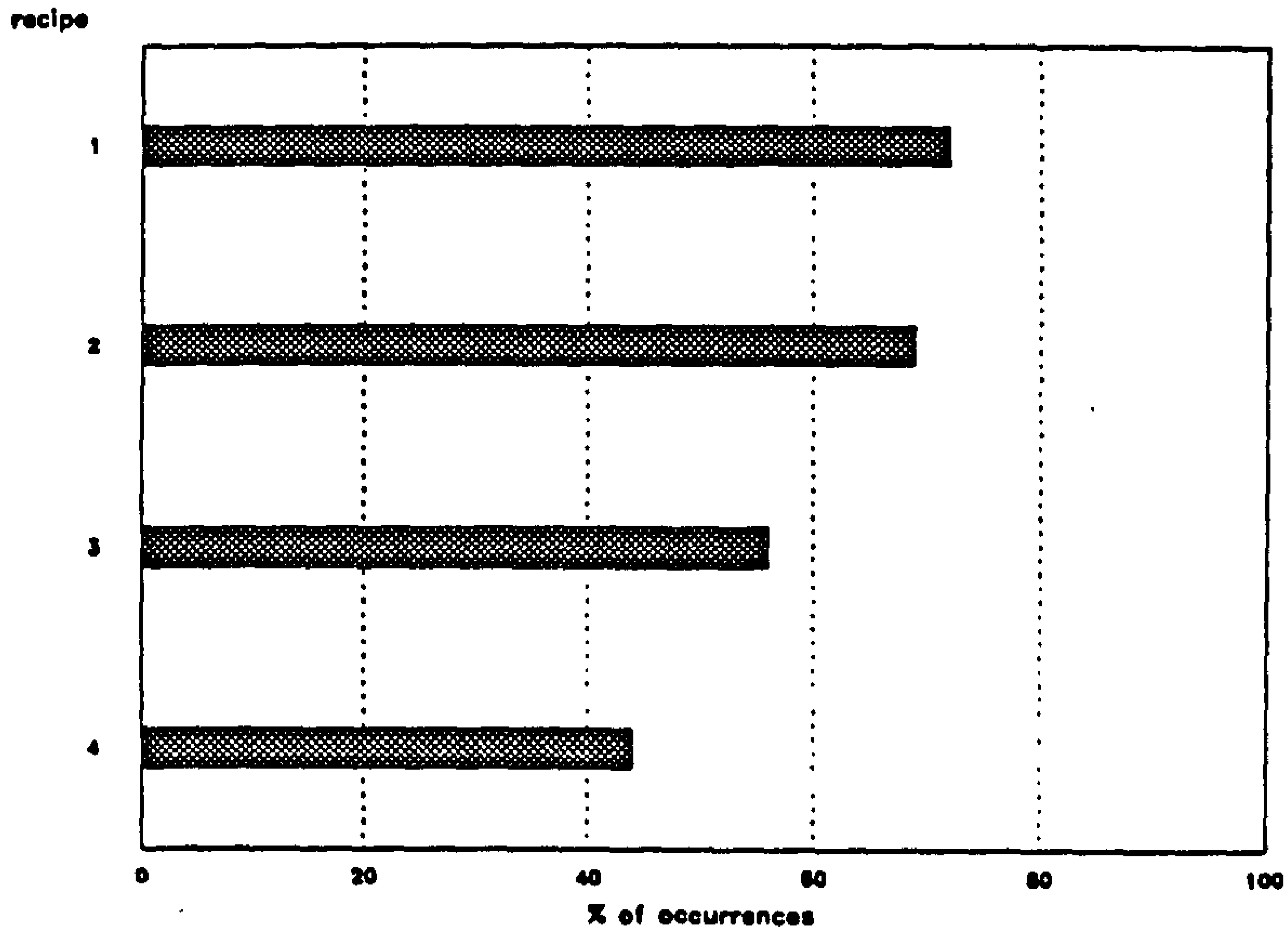


Fig. 6.27 Temperature abuse during storage

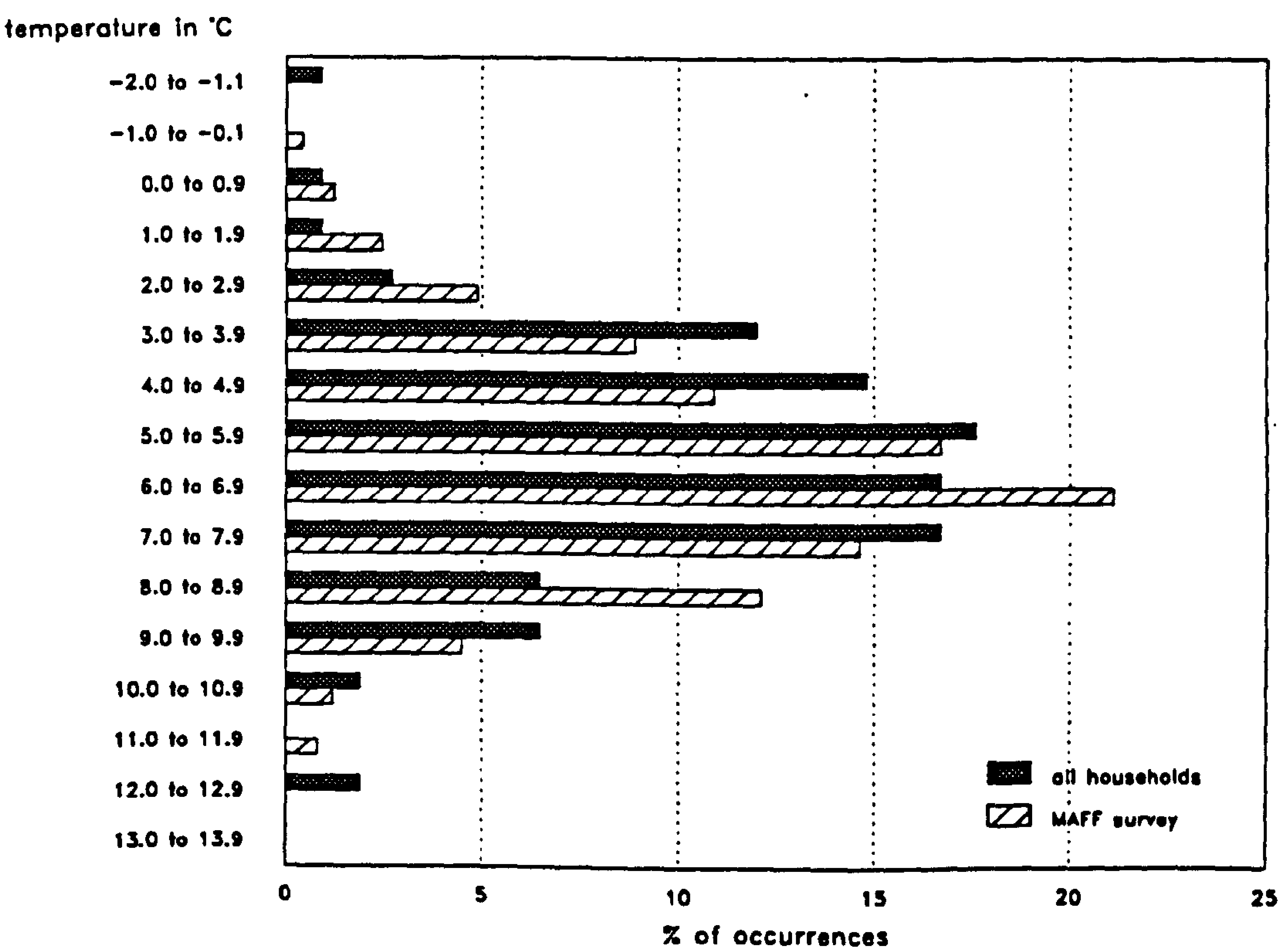


Fig. 6.28 % of refrigerators in each temperature range

Evans's survey shopped for food 3-4 days per week and 26.2% shopped 5-7 days per week.
She did, however, find that 17.1% of chilled products were already over their shelf life at the time of examination and 26% of food items would have been past the 'use by' date at the estimated time of consumption.

6.12 Food transport

The Food Hygiene (Amendment) Regulations 1990 requires suppliers of chilled foods with small delivery vehicles (less than 7.5 tonnes) to deliver all relevant food (including '5°C' food) below 8°C. Chilled or fresh foods make up 60% of the contents of the food basket of the average European consumer, yet several surveys (Evans *et al.*, 1991; FDF IEHO, 1993; West Glamorgan Health Promotion Group, 1991) have reported that the majority of people do not use a cool bag or cool box to transport chilled or frozen food from the shop to home.
In this study 45% of the subjects transported the chilled food without an insulated bag, at ambient temperatures that were sufficiently high to raise the food temperature above 8°C (Fig. 6.29). Home visits were undertaken in every month of the year (Fig. 6.30). The lowest transport air temperatures were recorded in February 1993 (7.5°C) and the highest (32°C) in July of the same year. Only 15/51 (29%) of the subjects who transported food during the warmest months of June, July, August and September used an insulated cool bag.
The temperature of the chilled foods could not be measured directly, since this would have involved the insertion of a

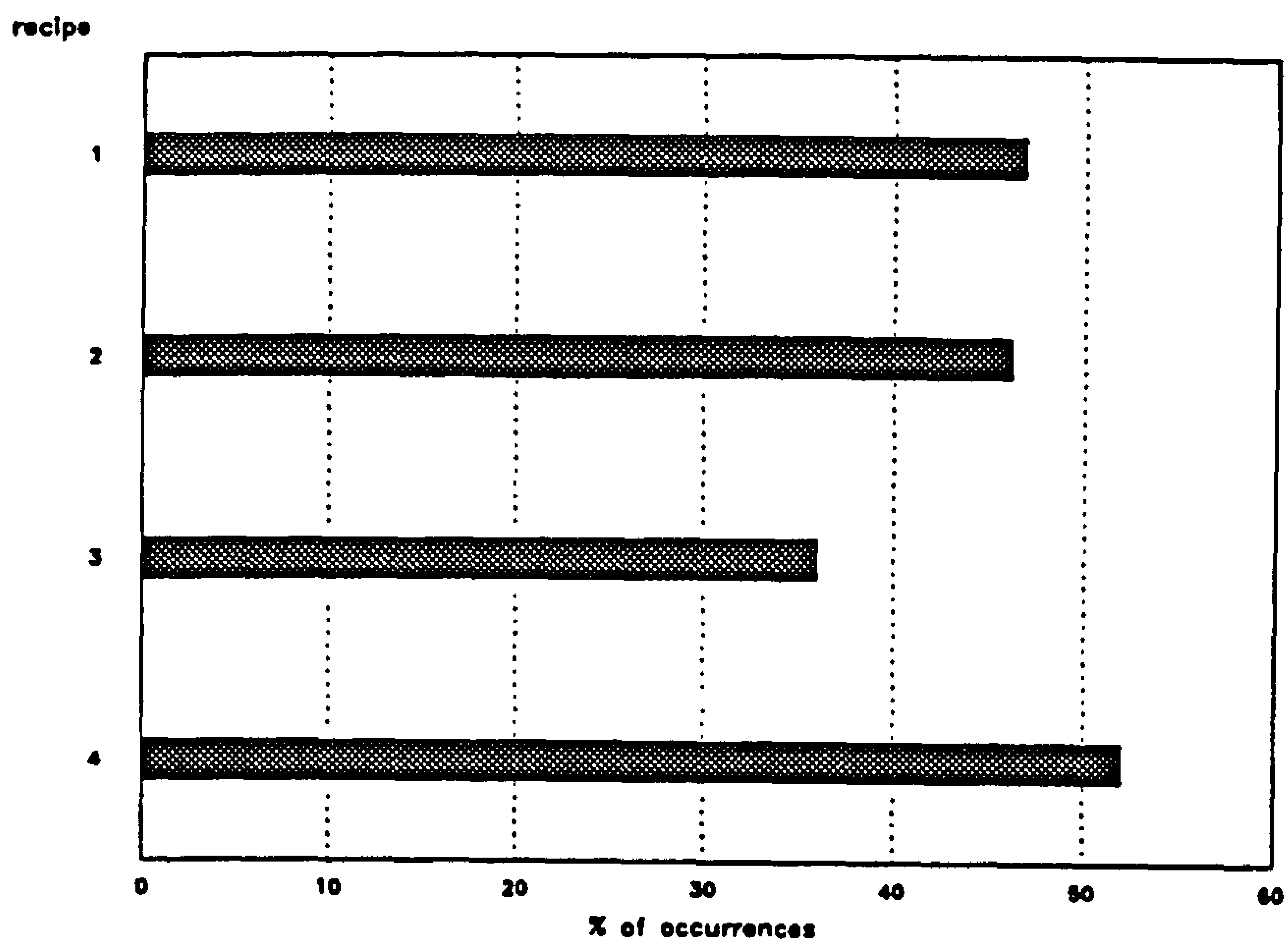


Fig. 6.29 Temperature abuse during transport

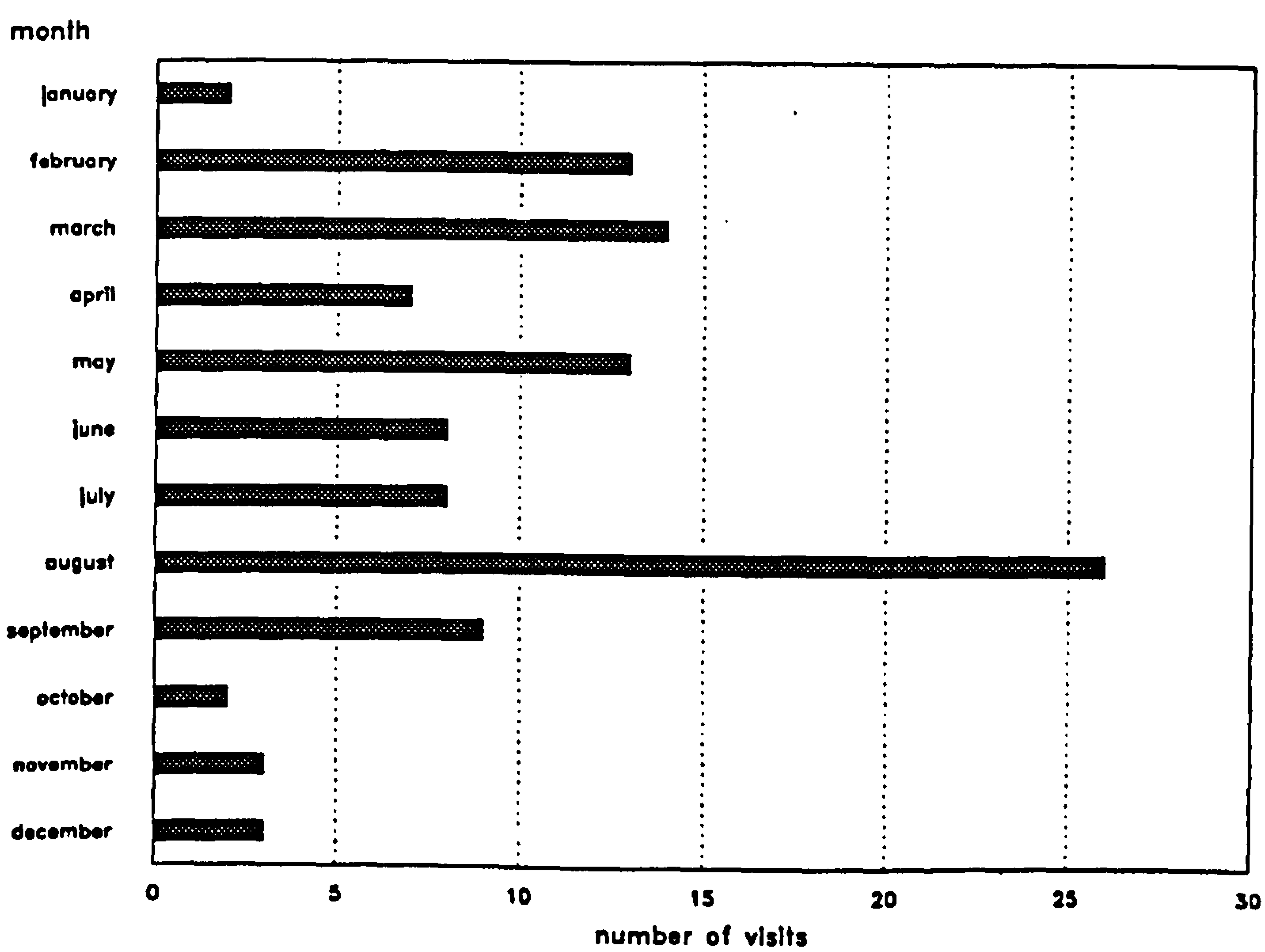


Fig. 6.30 Month of home visit

sensor into the product, a procedure which might have caused concern to the subjects who were required to use the ingredients and eat the end product. It was found that an accurate temperature profile of the product could not be obtained by the use of the integral sensors of the data loggers alone. The difference between the product temperature and air temperature could be as much as 20^{o}C. Laboratory temperature trials which simulated representative transport conditions, using sensors inserted into the products, indicated that chilled products transported without chilled insulated bags, for short periods (30 minutes or less) at temperatures below 17^{o}C, remained below 8^{o}C. Higher transport temperatures resulted in unsatisfactory product temperatures unless the products were transported in chilled insulated bags. These usually maintained the products under 8^{o}C (Table A3.3).

Evans *et al.* (1991) has reported that the internal temperature (recorded by means of sensors) of some chilled food products transported in the boot of a car increased to nearly 40^{o}C. during a one hour journey at an ambient temperature of 23 - 27^{o}C. It took five hours of cooling in a domestic refrigerator before the temperature of these products was reduced below 7^{o}C. In contrast most food samples that were transported in a chilled insulated cool box remained at their initial temperature. Predictions, based on a mathematical model that calculates bacterial growth from temperature/time relationships, indicate that increases of up to two generations in bacterial numbers could occur during this transport and domestic cooling phase. The model employed by Evans *et al.*, assumed that bacteria require a time to acclimatise to a change in temperature (the lag phase) and that no acclimatisation had occurred during display. Very small increases in bacterial numbers(< 0.4 generations) were predicted when the insulated box was used.

Transport times in the present study were short, with 90% completed in 30 minutes or less. Most (79%) made the journey home in a car, placing the shopping in the boot. These results accord with the findings of Evans's survey, where 85.3% of respondents claimed always or occasionally to use a car to transport main food shopping, and the vast majority (96.3%) reached home within 30 minutes of leaving the shops. The survey by Colwill (1990) revealed that the average time spent in the supermarket on a main food shopping trip was 42 minutes and that most people removed food from the chilled display within 15 minutes of arriving at the shop. Chilled foods which may be subjected to frictional heat from check-out conveyers, were found to remain out of refrigeration for a mean period of one hour with a range from 10 minutes to six hours.

6.13 Thawing

The process of thawing small frozen foods is not particularly hazardous. Foods thaw quicker at room temperature than in the refrigerator. Some (37%) of the respondents indicated that they would usually thaw frozen poultry overnight in the kitchen (Fig. 6.31). Frozen cooked foods can be particularly hazardous if thawed and held at room temperature because competitive flora (destroyed during cooking) is unavailable to limit the growth of pathogens. Most (18/25, 72%) subjects thawed the cooked frozen prawns at room temperature; the risk

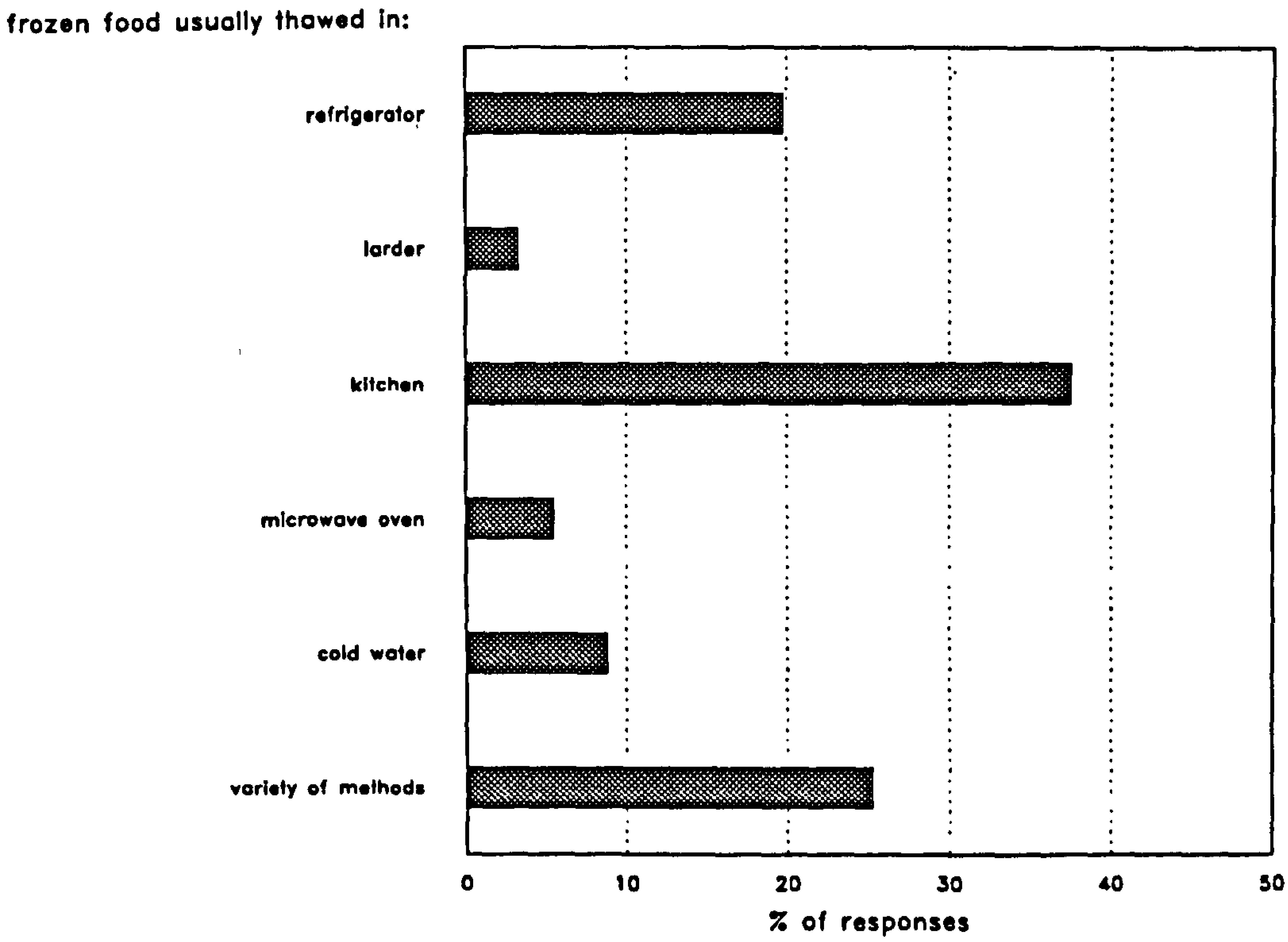


Fig. 6.31 Thawing frozen food

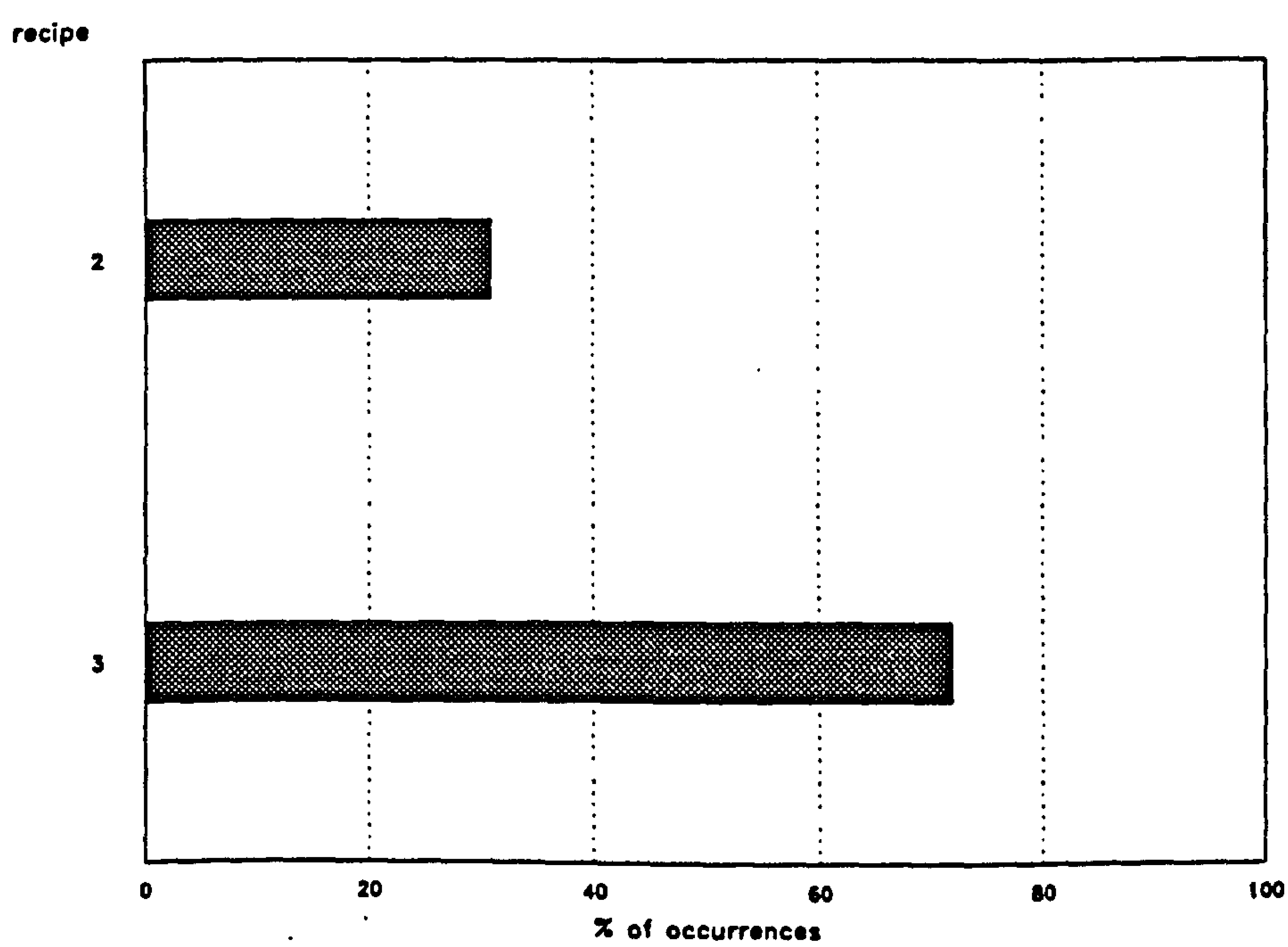


Fig. 6.32 Food thawed at room temperature

was not considered high, however, because the holding period was usually less than one hour and the prawns were subjected to a period of heating in the assembled product (Fig. 6.23). If thawed raw food remains for several hours at room temperature after thawing, psychotrophic bacteria could multiply. Thawed meat and poultry and the thaw water are important sources of salmonellae and other pathogens and can contaminate surfaces, equipment and the hands.

The refrigerator provides a controlled environment for the thawing of frozen food products. The rate of thawing is, however, slower because there is only a small difference between the refrigerator temperature and the surface of the food as it starts to defrost. A cool larder at 10^{o}C or 15^{o}C would provide a balance between defrosting food in a refrigerator (bacteriologically safe but slow and possibly uneconomical with space) and thawing at room temperatures (fast but carrying a higher risk of contamination). Unfortunately only 14% of subjects had a larder in their homes.

Few (6%) respondents said they would usually thaw frozen food in the microwave oven. This level of usage, which is similar to that found in the MAFF survey, is much lower than in the West Glamorgan study, in which 60% of respondents claimed to use the microwave oven for thawing frozen food. Thawing food by microwaves is faster than by conduction, but is best suited to small portions of food of uniform composition.

Most respondents (47%) said that they would ensure that poultry was thoroughly defrosted by calculating an adequate thawing period. Some (32%) indicated that they would observe that the flesh was pliable and that there was an absence of ice crystals in the body cavity. None of the interviewees indicated that they would test the temperature of the food with a thermometer. These results suggest that some of the subjects might expose themselves to a greater risk of food poisoning by using food that was inadequately thawed.

6.14 The use of the HACCP approach to assess the safety of domestic food handling practices.

The HACCP approach relies on epidemiological and microbiological data to determine the severity of hazards and the risk of their occurrence in the preparation of foods. This approach shows a specificity that is lacking in hygiene inspections based on guide-lines or mandatory documents. Where available, epidemiological data were used in the construction of the scoring system. This took into account the potential of the ingredients to be vehicles of food poisoning and allocated demerit ratings for each process step. The FSR score is a measure of the extent to which the subject has exercised the control measures appropriate to a sequence of food handling operations involved in the preparation of a specific food product. The higher the score, the greater the violation of control measures and the greater the risk of unsafe food being produced. The scores, expressed as a percentage, ranged from 0 to 65% with over half of the subjects (58%) scoring below 20% (Fig. 6.33). Five subjects scored zero indicating that the full implementation of control measures was an achievable goal. All of these people consumed the food they had prepared immediately or within 1 hour. The minority (10%) of subjects who scored over 40% of

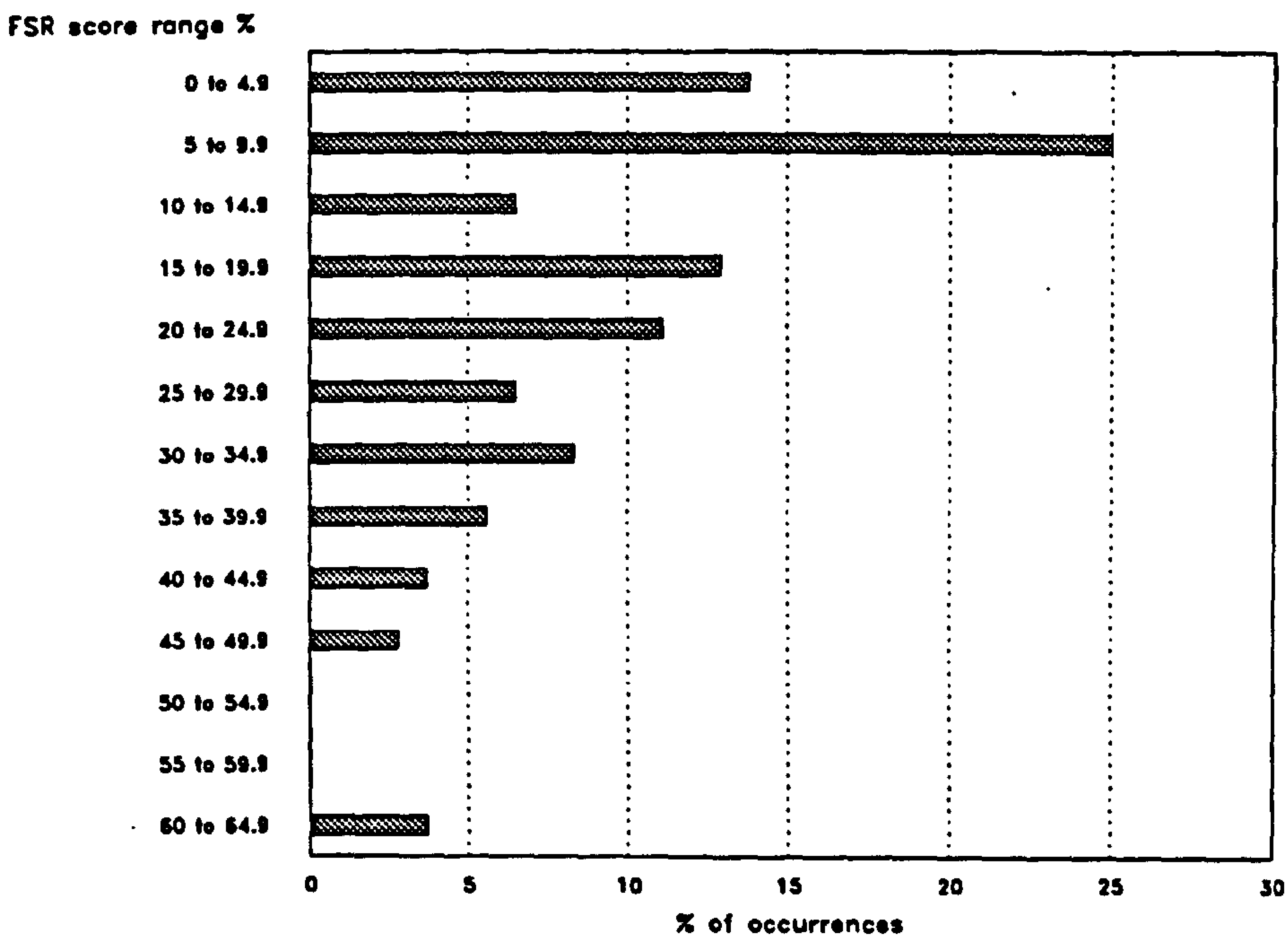


Fig. 6.33 Percentage of subjects in each FSR score range

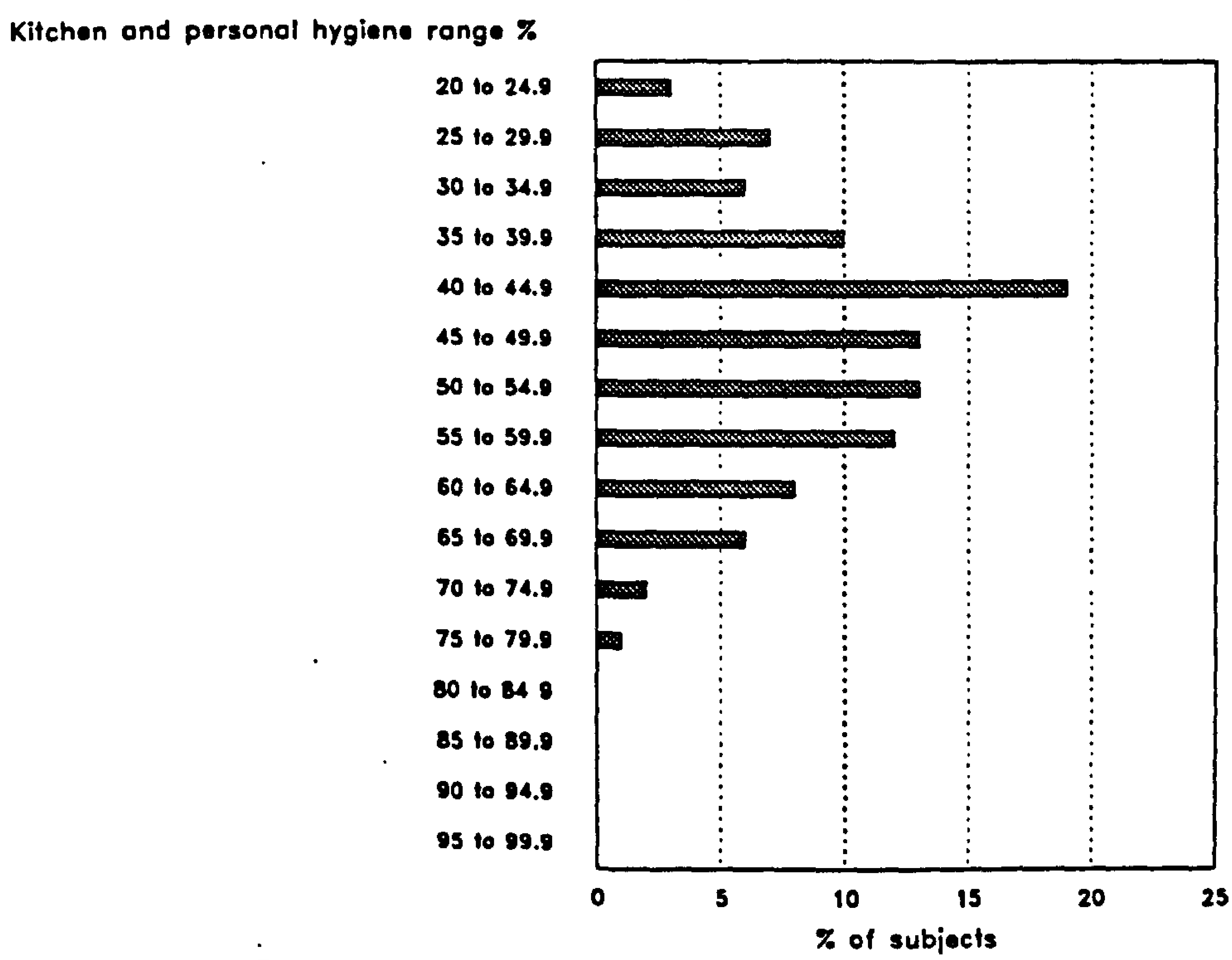


Fig. 6.34 Percentage of subjects in each kitchen score range

the maximum demerit marks violated critical control measures during cooking, cooling, holding and re-heating.

The mean FSR scores for the recipes ranged from 15.6% with Recipe 2 to 21.7% with Recipe 3 (Table 5.44). The lower mean score for Recipe 2 may reflect the fact that the cooking method was easier to carry out safely than the oven cooking technique used in Recipe 3.

The types of food that were selected for preparation by the participants were intended to be representative of popular home cooking using ingredients which have been commonly implicated in food poisoning. It is interesting to speculate whether similar Food Safety Risk scores would have been achieved by the same people if different recipes had been selected. It is recognised that one of the limitations of HACCP is that it is highly specific to the product and the process. Had the recipes provided more guidance on safe food handling, would the participants have utilised more control measures? If participants had prepared the recipe as part of a meal, would the standard of food handling have been similar or would more hazards have been identified? If the recipe had been one in regular use, would a similar pattern of food handling behaviour have been observed?

The scoring system which was designed for this study has not yet had the benefit of modification based on extensive experience; its demerit ratings and coefficients may not be universally applicable. However they are reliable within certain bounds and are adaptable to particular situations. The system could easily be modified for use with different foods, different preparation and cooking methods, with different groups and to measure the effect of food hygiene education intervention.

The difficulties which were encountered when using the HACCP approach in the domestic context relate to the lack of epidemiological data on the home, the general lack of monitoring equipment and the lack of standardised food preparation methods (Griffith and Worsfold, 1994).

6.15 Assessment of kitchen hygiene

The design, construction, cleanliness and the maintenance of food premises may affect the standard of food hygiene that can be achieved. ATP measurements were made in the preliminary study to determine the standards of kitchen cleanliness. This study indicated that there was a very wide range of ATP levels on selected surfaces. It became apparent that if the technique were to be adopted in the main study, it would be necessary to subject a wider range of relevant indicator or test surfaces to swabbing. Due account could be taken of the wide range of materials, their age and condition used in the domestic kitchen. This would allow the construction of a more comprehensive picture of cleanliness standards on representative and relevant surfaces. The time-scale of the study did not permit such an investigation, therefore the standard of cleanliness in the domestic kitchens in the main study was assessed visually. It is recognised that apparent cleanliness can be misleading and give a false sense of security. The equipment and surfaces in the kitchens in the main study did not look heavily soiled but observations of the food handling techniques revealed considerable potential for cross-contamination.

Kitchen hygiene check-lists attempt to assess those factors in the premises which might affect the standard of food hygiene. Since no inventories exist for the domestic kitchen, material for the catering industry was adapted for the use in the preliminary study. The time for completion was found to be excessive and there was a degree of overlap between items on the food preparation observation schedule and the kitchen check-list. The focus of the inventory was sharpened to concentrate on those factors which might contribute to contamination levels and might lead to cross-contamination during food preparation. The use of codes for ranking cleanliness and condition of boards greatly facilitated recording. Although kitchen hygiene check-lists were completed in over 50 homes before the main study was undertaken, the main audit revealed features that were unexpected and for which there was no specific record provision other than a general comment section on the inventory. These included a fitted shower unit in the kitchen, a lavatory that opened directly into the kitchen, a chipped butler sink, wooden draining racks, flag stone floor, no hot water, no working surface except for a small trolley, piles of bedding on the kitchen floor, a quantity of wet clothes drying on a ceiling-mounted rack, a plant propagator with trays of seedlings and a cardboard box of day-old chicks on the stove. It would be difficult to determine what contamination potential these items might represent without an appreciation of how the kitchen was used regularly by the food handler.

6.16 Kitchen and personal hygiene check-list scores

The kitchen and personal hygiene check-list score was a measure of the extent to which the opportunities for cross-contamination were controlled by the subjects. Scores expressed as a percentage ranged from 20 to 76% (Fig. 6.34) with over half of the subjects being awarded a score of less than 50%.

Results from the preliminary study and the main investigation indicate similarities in the layout, facilities and equipment of the kitchens. Whilst all homes had a refrigerator, there was a widespread lack of adequate temperature-controlled food storage facilities, such as cool larders for perishable fresh foods and for temporary storage of cooked foods. Most of the kitchens in both studies were centrally heated and over half had mechanical ventilation systems, which would have enabled some control to be made of kitchen humidity and temperature. More of the refrigerators in the preliminary study were found to be operating above the recommended temperature than in the main study. However, the difference may be accounted for by the errors inherent in making spot checks of temperature of appliances, as already discussed.

There was a higher ownership of microwave ovens in the preliminary study but this was to be expected as the subjects had been offered a free microwave oven safety check.

The ownership of dishwashers was higher in the main study and fewer of the subjects had a washing machine in the kitchen. Domestic pets were accommodated in a minority of kitchens in both studies.

There was a significant association between the kitchen/personal hygiene check-list score and the FSR score (Pearson's correlation r=0.2487, significance 0.0094, Fig. 5.5). The two scores were derived from an assessment of hazards which, in the cases of the kitchen/personal hygiene list were focused on factors likely to lead to cross-contamination and growth of pathogens, whilst the FSR score was derived from the assessment of all hazards, relating to the survival, growth and contamination of micro-organisms encountered in a specific food handling episode.
In the present study there was no significant correlation between the age (Fig. 5.1, 5.2) or socio-economic group of the subjects and their food safety risk score or kitchen/personal hygiene check-list score (Fig. 5.3, 5.4).

6.17 Food safety knowledge and practice

There were only two questions in the interview which tested knowledge of food safety principles, that could be directly related to practice. In the case of recommended refrigerator temperature, the majority were unaware of the correct temperature and did not operate their appliance in accordance with guide-lines. Most subjects cooked their food to a safe end-point temperature but only a few had any idea what this might be. It would have been instructive to have included more knowledge-based questions that could have been related to observed practices to find if any pattern emerged. The use of the interview does, however, have a number of limitations. There is the problem of interpreting and verifying the respondents' answers. People do not always tell the interviewer what he wants to know. This resistance to telling all may reveal insecurity in the interviewer's presence, may indicate a commitment to a sense of propriety unknown to the interviewer, may indicate misunderstanding of the question or may be a deliberate resistance. Goffman (1957) noted, 'I rarely believe what people say and in interview situations, I hardly believe them at all'. Most people can recall important or unusual events in their lives but they are usually unable to recall minor details. They forget or distort the details and may not be able to describe their activities accurately and to the level of detail required.

The International Commission on Microbiological Specifications (1988) has outlined the basic knowledge required by the public to avoid food poisoning in the home (Table 6.1).

Table 6.1 Basic knowledge required by the public (adapted from ICMSF, 1988)

The public should know:

1. that the food they buy may be contaminated with food poisoning bacteria
2. which foods represent a high risk for food poisoning, so that they can give food safety priority to these
3. how to transport and store foods safely
4. about cross-contamination, and the role contaminated preparation equipment, surfaces and cleaning materials play in spreading food poisoning microbes
5. how to cook food safely, to include information on the temperatures required to kill bacteria in food
6. the importance that a high standard of personal hygiene can play in the production of safe food handling
7. about the recommended methods of cleaning and sanitising food and hand contact surfaces.

There is an assumption that people's awareness or knowledge determine or is an important influence on their behaviour

(Sheppard, 1990). It is assumed that if awareness of food poisoning is increased, there is a greater likelihood of adoption of hygienic handling methods. There is, however, little support from the literature for a direct relationship between awareness and behaviour. Many are sceptical that more information by itself will lead to changes in behaviour. Ignorance may not be the major problem. People may fail to apply already well-known principles. The real challenge for hygiene education is to persuade people to translate what they know into practice. The problem of changing people's behaviour is complex. Unhygienic practices, often deeply in-grained habits, are not easily displaced, even by the most imaginative teaching programmes. Poor food hygiene is sometimes a perfectly rational response to home circumstances. If the circumstances remain unchanged so will the practices, despite the knowledge that they might not be hygienic.

The public seems to care little for the health impact of food-borne disease (Mossel & Drake 1990). Learning depends on motivation. People are quite likely to ignore much information except when the desire to know is present. It is very difficult to explain the risks of poor hygienic food handling to persons who do not want to know. Those who seek to raise the awareness of the public must compete for people's attention along with a vast amount of other information. Information is not scarce but the public's attention is. People screen out messages seen as not directly relevant to themselves. With more and more information available, people are forced to become more selective. Under such circumstances, material about a risk which many perceive as a low threat may scarcely be noticed. In addition, people are subjected to a continual stream of often well presented commercial and non-profit advertising. This competes for their attention but also the process of habituation may mean that messages on a particular medium are relatively ineffectual. The most common delivery mode for food safety communication is the mass media. A recent review by McGuire (1985) argues that there is little evidence that the mass media are effective persuaders.

CHAPTER 7. CONCLUSIONS AND RECOMMENDATIONS

'We may give advice,
but we cannot give conduct'

Proverb

7. Conclusions and recommendations

7.1 Conclusions

1. A HACCP approach, using direct observation, temperature measurement and a scoring system based on epidemiological data, can be used to evaluate the hygiene of domestic food preparation practices. The benefit of this approach is that it focuses attention on those practices which are critical to the safety of the product.

2. The detailed analysis of the preparation process which is required by the HACCP system is best achieved by direct observation rather than reported behaviour.

3. The variability of food preparation practices in the home has probably been under-estimated by this study since it required participants to use a limited range of ingredients and a standard recipe.

4. Many of the hazards observed in this study were identified by Bryan (1990) in observations of retail food and restaurant operations. The decision to base the scoring system on epidemiological data drawn from the catering industry, to supplement information from homes would appear to be justified.

5. The present study identified the same critical control points as earlier studies carried out in the homes of peasants in developing countries. However, food preparation in advanced western societies presents a greater variety of hazards. More care is required in handling and storing food, particularly in relation to foods produced by the newer technologies.

6. Most people cooked the food to a safe end-point temperature, even though they were ignorant of what this might be. Food was commonly cooked in advance and not infrequently held for prolonged periods at room temperature. Few people used any method to assist the cooling of cooked food. Re-heating was improperly executed by over half of those who heated a chilled product. This has raised the suspicion that the problem may be more wide-spread than revealed by the study.

7. The incidence of temperature abuse during food transport and storage was similar to that identified in the study by Evans *et al.* (1991).

8. The standard of food preparation that was set, based on the execution of all control measures, was not an unrealistic ideal since 4.6% of subjects achieved a Food Safety Risk score of zero and over half scored below 20% of the maximum score.

9. The microbial quality of food produced in accordance with the stipulated control measures satisfied the guide-lines of the PHLS and verified the HACCP system.

10. In the home, compared with the commercial food production unit, it is more challenging to identify critical control points using the decision tree approach. With the general lack of monitoring equipment in homes, it is difficult to formulate realistic control measures. It is therefore suggested that the domestic food handler exercises control measures at each process step.

10. In the commercial food sector the HACCP system is likely to be underpinned by good manufacturing or catering

practice. An assessment of the cleanliness of the domestic kitchen and the condition of equipment and surfaces used in food preparation, based on ATP measurements and the kitchen check-list, showed that there was a wide variation in the hygiene standards found in homes.

11. Observations conducted during food preparation and in the completion of the kitchen check-list have revealed the great potential for indirect and direct cross-contamination in the domestic kitchen. It is suggested that the importance of cross-contamination as a contributing factor to food poisoning has been substantially under-estimated.

12. The findings of this study indicate that some of the participants would benefit from a greater awareness of food hygiene. The opportunities for food poisoning to occur were evident and present a disturbing picture if projected to the public at large.

7.2 Recommendations for improving food hygiene in the home

The government and everyone in the food chain from the manufacturer, distributor and retailer to the consumer, has a part to play in minimising the risks of foodborne disease.

Manufacturers

Could usefully provide:

1. time-temperature indicators on chilled foods packs
2. 'wash hands' reminder labels on meat, poultry and egg packaging
3. commercial quality paper towels for domestic use
4. colour coded preparation boards

5. cheaper digital thermometers
6. compact rapid chillers suitable for domestic use
7. built-in thermometers in refrigerators
8. refrigerators with a -1^{o}C to +1^{o}C section for chilled products
9. a wider range of liquid soap with bactericidal properties
10. hygienically designed kitchen furniture.

Retailers

Could usefully:

1. encourage check-out staff to segregate chilled and frozen foods and assist with packing
2. stock insulated bags for chilled food transport all year
3. place 'wash first' reminder labels on packed vegetables
4. locate chilled display cabinets closer to the check-outs
5. encourage shoppers to use in-store coffee shops prior to shopping rather than after
6. display more food safety guidance on product packaging.

Publishers

Could usefully:

1. incorporate more food safety information in the recipes they produce for the public
2. carefully check the accuracy of the recipes they publish.

Consumers

Should be advised to:

1. always leave food shopping until last and go straight home afterwards
2. put food in the boot of the car, where it is less likely to be warmed by sunlight

3. unload perishable food immediately and store correctly
4. Check the temperature of the refrigerator with a refrigerator thermometer
5. disinfect work surfaces and chopping boards with a sanitiser before food preparation
6. wash and dry hands thoroughly before touching food using a clean, dry hand towel
7. reserve separate chopping boards for cooked and raw foods
8. change tea-towels, hand-towels and dishcloths regularly. Boil or treat with a sanitiser if they become soiled. Allow dishcloths to dry. Use paper towel where possible
9. empty covered rubbish bins daily. Use bin liners and clean regularly with disinfectant
10. cook and re-heat food thoroughly. Pre-heat ovens, use the recommended temperature and control the time. Check the temperature of meat and poultry with a meat thermometer
11. cool cooked food quickly and refrigerate within 90 minutes. Use ice or water-baths to speed cooling
12. thaw frozen food thoroughly in the refrigerator
13. keep pets out of the kitchen when preparing food.

The government

The government must raise the food safety awareness of domestic food handlers and persuade them to put food safety principles into practice. They must be educated on the safe handling and storage of the foods of the 1990s, on the hazards of consuming under-cooked products, the avoidance of cross-contamination between raw and cooked products and on

the need for a high standard of personal hygiene when handling foods.
An awareness of food hygiene should be developed early in childhood. It clearly fits into the National Curriculum for science in the infant school. At this age children should be:

'introduced to ideas about how they keep healthy'

and

'know about the need for personal hygiene, food and rest' (DoE, 1988).

The topic is suitable for the science course of older age-groups as it meets the science National Curriculum criteria for the 11-14 age range:

'They should extend their study of ways in which the healthy functioning of the human body may be promoted or disrupted by diet, lifestyle, lifestyle, bacteria and viruses' (DoE, 1988).

The difficulty of effective food safety communication has been acknowledged. The message timing, mode of delivery, source and content will all have a bearing on the success of the communication. The context of the message must be positive and say what to do as specifically and clearly as possible. Telling people not to do something is likely to be less effective. Food microbiologists need the assistance of behavioural scientists. It is a challenge but also a duty of the two disciplines together to present, clearly and honestly, sound food safety data to consumers.
In 1993 the Department of Health and the Ministry of Agriculture, Fisheries and Food supported the National Foodlink campaign developed by the Food and Drink Federation in association with the Institution of Environmental Health

Officers. An evaluation of the campaign, based on responses from participating Local Authorities, revealed the need for and desirability of a continuing campaign (FDF-IEHO, 1993b). The organisers of one of the largest campaigns undertaken to improve awareness of the importance of good hygiene practices in the home will promote a National Food Safety Week in 1994. The target audience will continue to be women aged 25-40 years, who typically prepare most food in the household. The key messages for 1994 will be:

1. the importance of temperature control in storage and cooking
2. avoidance of cross-contamination
3. the importance of cleanliness
4. avoidance of preparing food too far in advance of consumption.

7.3 Recommendations for further work

1. Repeat hazard analyses with a group of subjects using the same and different recipes to determine the consistency of their performance.
2. Conduct hazard analyses in homes which have suffered an outbreak of food poisoning.
3. Conduct direct observations of subjects using recipes with explicit hygiene precautions, with a view to determining whether there is a significant improvement in hygienic handling performance.
4. Attempt to recruit subjects that were either not represented or were under-represented in the present study. The food handling practices of men, ethnic minorities and single people would be of interest.

5. Identify the process hazards involved in the production of other popular foods such as packed meals and snacks.

6. Analyse the processing of complete meals in the home.

7. Investigate the re-heating practices used for convenience chilled and frozen products.

8. Conduct observations of routine cleaning and disinfection practices in domestic kitchens

9. Undertake a more comprehensive investigation of contamination levels on kitchen surfaces using bioluminescence techniques.

10. Undertake further investigations of the microbiological quality of foods prepared in the home under conditions where the critical control points had been violated.

11. Devise a cross-contamination index for use in the domestic kitchen.

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Appendix 1. Kitchen Hygiene Check-list

Circle the appropriate answer

		Yes/No
1	Is the refrigerator located close to a heat source?	Yes/No
2	Is the refrigerator seal in good condition?	Yes/No
3	Is the refrigerator interior clean?	Yes/No
4	Is the temperature of the refrigerator under 5°C?	Yes/No
5	Does the refrigerator need defrosting?	Yes/No
6	Is the refrigerator over-crowded?	Yes/No
7	Is the refrigerator more than five years old?	Yes/No
8	Is there a larder?	Yes/No
9	Are the dry foods stored in cupboards?	Yes/No
10	Are the storage cupboards clean?	Yes/No
11	Are fruit and vegetables stored openly in the kitchen?	Yes/No
12	Is there an adequate amount of work surface?	Yes/No
13	Is the work surface made from:	
	plastic laminate	Yes/No
	wood	Yes/No
	tiles	Yes/No
	other	Yes/No
14	Is the condition of the work surface good?	Yes/No
15	Are the work surfaces sealed to the wall?	Yes/No
16	Are there gaps between work surfaces?	Yes/No
17	Are the work surfaces clean?	Yes/No
18	Are the work surfaces cluttered?	Yes/No
19	Is the work surface separated into at least 2 distinct areas?	Yes/No

20	Are the walls tiled behind:	
	the sink	Yes/No
	work surface	Yes/No
21	Are the walls clean?	Yes/No
22	Is the kitchen centrally heated?	Yes/No
23	Is there a mechanical extract ventilation system or a cooker hood?	Yes/No
24	Is the ceiling smooth, non-flaking?	Yes/No
25	Is the ceiling clean?	Yes/No
26	Is the lighting level adequate?	Yes/No
27	Does the kitchen have an external door?	Yes/No
28	Is the kitchen carpeted?	Yes/No
29	Is the floor clean?	Yes/No
30	Is there a single general purpose sink?	Yes/No
31	Is the sink in good condition?	Yes/No
32	Is the surrounding area clean?	Yes/No
33	Are the draining areas clean?	Yes/No
34	Is there a dishwashing machine?	Yes/No
35	Is there a paper towel roll in the kitchen?	Yes/No
36	Are the dishcloths made from:	
	Cotton	Yes/No
	Cellulose	Yes/No
	Sponge	Yes/No
37	Is a drying cloth present?	Yes/No
38	Is the dishcloth in good condition?	Yes/No
39	Is the drying cloth clean?	Yes/No
40	Is the drying cloth hung up?	Yes/No
41	Are pots and pans put in covered storage?	Yes/No
42	Is the waste bins covered?	Yes/No
43	Is there a waste bin liner?	Yes/No

44	Is the lid hand operated?	Yes/No
45	Is there a waste disposal unit?	Yes/No
46	Is there a single general purpose cutting board?	Yes/No
47	Is the board made from	
	wood	Yes/No
	plastic laminate	Yes/No
	polypropylene	Yes/No
	other	Yes/No
48	Is the condition of the board good?	Yes/No
49	Is there a washing machine in the kitchen?	Yes/No
50	Is there a domestic pet in the kitchen?	Yes/No
51	Are animal feeding bowls in the kitchen?	Yes/No
52	Is the kitchen used as a dining room?	Yes/No

Appendix 2. Methods used to examine foods for various microbiological criteria

Aerobic Plate Count

1.	Medium:	Plate count Agar Oxoid CM 325
2.	Technique	Pour plate
3.	Incubation temperature	30°C, 37°C
4.	Incubation atmosphere	Air
5.	Incubation Time	48 hours
6.	Dilutions examined	10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} Count all colonies

Coliforms

1.	Medium:	Violet Red Bile Agar Oxoid CM 107
2.	Technique	Pour plate (15 ml of medium) with overlay of agar (10ml)
3.	Incubation temperature	37°C
4.	Incubation atmosphere	Air
5.	Incubation Time	18-24 hours
6.	Dilutions examined	10^{-1}, 10^{-2}, 10^{-3} Count all red colonies

Staphylococcus aureus

1.	Medium:	Baird Parker Medium + Egg Yolk Tellurite Emulsion
2.	Technique	Surface spread, maximum volume 0.5ml
3.	Incubation temperature	37°C
4.	Incubation atmosphere	Air
5.	Incubation Time	Examine at 24 and 48 hours
6.	Dilution examined	10^{-1} Count all colonies which are black, shiny, convex, 1-1.5 mm diameter narrow opaque margin surrounded by zone of clearing 2-5 mm wide

Clostridium perfringens

1.	Medium:	Perfringens agar (OPSP) plus supplements
2.	Technique	Pour plate, use 20-25 ml of medium
3.	Incubation temperature	37°C
4.	Incubation atmosphere	Anaerobic - use gas generating kit in aerobic jar
5.	Incubation Time	24 hours
6.	Dilution examined	10^{-1} Count large black colonies and record presumptive *C. perfringens* count

Appendix 3. Detailed results

Table A3.1. Analysis of Kitchen and Personal Hygiene Check-list

		% of occurrences
A.	**Equipment maintenance and sanitation**	
1.	Single general purpose cutting board	60
2.	Condition of cutting board:	
	* Smooth, not scored, clean and dry	12
	* Very lightly scored and/or stained	27
	* Some central scoring and staining	39
	* Heavier scoring and staining	19
	* Very heavily scored, chipped stained, dirty	3
3.	Method of cleaning the cutting board after use with raw ingredients:	
	* Immersed in hot detergent water, scrubbed with clean brush, rinsed, dried with paper towel. Sprayed with sanitiser, allowed to dry	9
	* Immersed in hot detergent water, wiped with cloth, allowed to drain	49
	* Held under running hot water, wiped with cloth	23
	* Wiped with damp cloth	19
4.	Condition/cleanliness of dishcloth/wiping cloths:	
	* No stains, not worn, not discoloured, no odour	4
	* Some wear, but not stained or discoloured	29
	* Some wear, some discolouration, screwed up	54
	* Stained or discoloured, wet	10
	* Worn, wet, soiled, smelly	4
5.	The same cloth is used for wiping surfaces and dishwashing	55
6.	No disposable cleaning, drying cloths	29
7.	No handwashing soap	37
8.	No hand towel	46
9.	No nailbrush	79
10.	No dishwasher	57
B	**Environmental maintenance and sanitation**	**% of occurrences**
11.	Work surface not segregated into areas for handling raw/cooked	17
12.	Work surface not clear	80

		% of occurrences
13.	Condition of the work surface in the area of food preparation:	
	* No sign of food particles, grease, dirt	6
	* Some food particles or food stains	32
	* Some food particles and dirt or grime	51
	* More food particles, dirt or grease	11
	* Heavily soiled	1
14.	Cleanliness of working area adjacent to sink:	
	* No sign of food particles, grease, dirt	7
	* Some food particles or food stains	28
	* Some food particles and dirt or grime	48
	* More food particles, dirt or grease	16
	* Heavily soiled	2
15.	Single general purpose sink	75
16.	Soiled vegetables stored openly in kitchen	19
17.	Kitchen heated	92
18.	Kitchen lacks ventilation system	33
19.	Washing machine located in kitchen	59
20.	Domestic pet in the kitchen	41
21.	Animal feeding bowls in the kitchen	27

Hygiene of handler

		% of occurrences
1.	Handle food with infected lesions	0
2.	Smokes whilst handling food	0
3.	Does not wear any protective clothing	62
4.	Hand-washing after handling raw animal produce:	
	* Holds under hot running water or immerses hands in a bowl of hot water, uses soap or detergent, generates lather, rinses and dries	7
	* Holds hands under hot running water, uses detergent or soap, generates lather, does not dry	16
	* Holds under hot running water, dries	14
	* Agitates fingers in water, dries	3
	* Agitates fingers, briefly in water, does not dry	2
	* Wipes fingers on a cloth	11
	* Neither wipes or washes hands	47

The mean score for the kitchen and personal hygiene check-list was 46.7% (sd=11.2)

Table A3.2 Analysis of Interview

		Percentage of responses
1.	How often is the main food shopping for this household carried out?	
	a. twice a week or more	8
	b. once a week	62
	c. once a fortnight	14
	d. less often	16
2.	How far away are the shops that you use for your main shopping?	
	a. under 1 mile	12
	b. less than 5 miles	34
	c. more than 5 miles	54
3.	How long does it take you to get your main shopping home?	
	a. less than 15 minutes	38
	b. less than 30 minutes	60
	c. less than one hour	1
	d. more than one hour	1
4.	Do you usually use an insulated cool bag or box to transport chilled or frozen food?	
	a. no	75
	b. yes	25
5.	Do you use the storage advice on packs of perishable foods?	
	a. usually	51
	b. sometimes	29
	c. rarely	15
	d. never	5
6.	When buying food how often do you look at the use by date?	
	a. usually	73
	b. sometimes	18
	c. rarely	9
	d. never	0
7.	When buying chilled food would you reject a damaged pack?	
	a. always	90
	b. sometimes	10
	c. never	0
8.	How often is raw meat/poultry prepared in the kitchen?	
	a. daily	62
	b. three times or more a week	30
	c. less than three times a week	8
	d. never	0
9.	How often are raw vegetables prepared in the kitchen?	
	a. daily	96
	b. three times or more a week	3
	c. less than three times a week	1
10.	Do you prepare raw and cooked foods in separate parts of the kitchen?	
	a. no	76
	b. yes	24
11.	Do you use more than one chopping board?	
	a. no	56
	b. yes	44

12.	Where do you store raw meat in the fridge?		
	a.	top shelf	22
	b.	middle shelf	26
	c.	bottom shelf	40
	d	anywhere there is a space	12
13.	Where in the same fridge would you put a fresh cream trifle:		
	a.	top shelf	50
	b.	middle shelf	27
	c.	bottom shelf	10
	d	anywhere	13
14.	Where is hot cooked food cooled?		
	a.	in the larder	7
	b.	in the kitchen	69
	c.	in the utility room	17
	d.	other	9
15.	Do you prepare meals to be eaten on another day or at a later time?		
	a.	regularly	23
	b.	occasionally	46
	c.	rarely	25
	d.	never	7
16.	How do you usually re-heat food?		
	a.	in a conventional oven	9
	b.	on the hob	15
	c.	in the microwave	48
	d.	more than 1 method	28
17.	Where do you thaw food?		
	a	in the fridge	20
	b.	in the larder	3
	c.	in the kitchen	37
	d.	in the microwave oven	6
	e.	under the tap/in the sink	9
	f.	use variety of places, a-e	25
	g.	other	0
18.	How do you know when a frozen chicken is thawed?		
	a.	by experience, based on the length of the thaw period	47
	b.	take the final temperature of the bird	0
	c.	by touch	19
	d.	more than 1 method	34
19.	How long would you thaw a 3lb (1.5 kg) chicken for?		
	a.	overnight, at room temperature	67
	b.	about 20 hours in the fridge	26
	c.	about 20 minutes in the microwave	3
	d.	other	3
20.	The temperature inside the fridge should be at or below?		
	a.	10°C	8
	b.	5°C	42
	c.	-18°C	8
	d.	-40°C	1
	e.	don't know	42
21.	Have you ever measured the temperature of your fridge?		
	a.	no	71
	b.	yes	29

22. Have you ever adjusted the temperature control on your fridge?

a.	no	26
b.	yes	74

23. How long would you allow a 3lb cooked chicken to cool before refrigerating it:

a.	less than one hour at room temperature	21
b.	up to two hours at room temperature	36
c.	more than two hours	41
d.	other	2

24. How do you calculate meat cooking temperatures and times?

a.	past experience	63
b.	instructions on the food	4
c.	recipe books	7
d.	with the help of a meat thermometer	2
e.	more than 1 method	24

25. What should the temperature be inside a piece of meat when it is well cooked?

a.	40°C.	0
b.	60°C.	5
c.	75°C.	11
d.	100°C.	3
e.	above 100°C.	1
f.	don't know	80

26. Do you know the power output of your microwave oven?

a.	no	12
b.	yes	88

27. Do you know how to adjust cooking times in the microwave oven according to the wattage?

a.	no	21
b.	yes	80

28. Do you allow for standing time when cooking food in the microwave oven?

a.	no	19
b.	yes	80

29. Which of these age groups do you belong to?

a. 16-34

b. 35-54

c. 55+

30. What is the occupation of the head of the household?

Number of subjects = 93

Table A3.3 Product temperature after 30 minutes transport

product	air temperature °C	chilled insulated cool bag	plastic bag
		product temperature °C	
single cream	8	0.7	2.0
	16	2.4	4.3
	25	3.4	14.1
minced beef	8	3.0	4.9
	16	5.3	7.9
	25	7.8	14.3
chicken breast	8	0.8	1.4
	16	1.9	2.4
	25	2.9	12.0