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PREFERRED LIVES – A MORE COMPLETE METHOD OF RISK ASSESSMENT

by

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CONTENTS

PREFACE

Traditional methods of underwriting life proposals still leave a wide variation in the 'standard' pool of mortality risk. There is, therefore, some cross-subsidy between policyholders. With a greater knowledge of the risk factors that can alter the mortality profile, insurers could charge policyholders more accurately for the cost of their cover. This paper outlines the issues that need to be considered and weighs up the evidence for a more comprehensive method of risk classification.

Fortunately, the philosophical debate surrounding Preferred Lives is outside the scope of this paper. The purpose of the paper is to report the facts, as far as they are known, and leave the reader and the profession to debate the merits of the concept.

The paper is divided into two parts. The first part of the paper examines the issues which need to be addressed in developing a Preferred Lives insurance product. This includes marketing and pricing issues, as well as methods of risk classification. This part of the paper also explores the experience from the US and other markets.

The second part of the paper reviews the evidence which links mortality to various risk factors, including smoking, cholesterol, blood pressure, weight, alcohol consumption, etc. The studies are almost always from a general population and not an insured population. Whilst the two sections of the paper can stand in isolation, the second section provides the statistical justification for use of the risk factors discussed in the first section.

One point which makes this subject of particular interest today is the Government's White Paper, "The Health of the Nation: A Strategy For Health In England", which was published in July 1992. The paper set out health targets which the Government, the NHS and the public must work together to achieve. The concept of Preferred Lives insurance is, possibly, another method of emphasising the advantages of a healthy lifestyle, as it introduces a financial incentive. This point was made by a quotation in the Times on 23 September 1994, where Professor McVie, Scientific Director of the Cancer Research Campaign said "I find it profoundly depressing that health education has failed us. We have got the information on how to prevent cancer, but we have not persuaded people to use the information to change their behaviour."

Finally, I would like to thank all the people who provided me with information and advice in researching this paper. In particular I should mention Professor Barry Lewis, who pointed me in the right direction, and Dr Leon Rozewicz, for all his useful comments. I must not forget my secretaries, Karen Spendlove and Mandy Harrison, who worked through endless drafts. My biggest thanks, however, must go to my wife and sons for their endless patience.

Despite of all the help, the opinions expressed in the paper are my own and do not necessarily reflect those of my company. I must also take full responsibility for any errors.

PART A - THE APPLICATION OF PREFERRED LIVES IN LIFE INSURANCE

1. INTRODUCTION

1.1 Most offices in the UK currently use age, sex and smoking habit as a means of risk classification. Within each cell over 90% of the lives will be accepted without an adjustment to the standard terms. However, within the group of standard lives there is a wide distribution of individuals who exhibit high and low mortality risk factors.

1.2 The concept of sub-dividing the ordinary non-smoker and smoker rates category into lower risk and higher risk applicants originated in the US and has now spread to the UK and Ireland. The generic term for this method of sub-division is called Preferred Lives. This is because the lowest risk category is known as the preferred group and the remainder as the non-preferred or standard group.

1.3 The name Preferred Lives has very negative connotations, because it has elitist over-tones and intimates discrimination. It may be advisable to change the name to enhance its acceptability. "Risk Classification" or "Risk Assessment" insurance may be more accurate terms.

1.4 A recognition of mortality differences should not automatically be classified as unfair. For example, the use of lower mortality rates for females is not considered controversial. In addition, without the use of some method of risk discrimination there is inequity, as one group of individuals must subsidise another. Some may argue that equality is more important than equity. In an insurance context, equality means charging the same premium to everybody, regardless of their risk classifications. In contrast, equity means charging a premium which is commensurate with the risk. Outside of social insurance, or regulations to control premiums, there is a danger that equality can lead to instability, where the level of cross-subsidy is significant. This is particularly important in a free and competitive insurance market, such as the UK's.

1.5 Offices set their rates and underwriting standard according to their target market, and this reduces the level of cross-subsidy within the office. However, many offices have multi-sales channels and use the same rates over a wide range of lives. This can lead to instability where the volume of new business through each sales channel is important to maintain the pricing assumptions.

1.6 The concept of Preferred Lives should therefore be considered as a means of fine tuning the ordinary risk group in order to eliminate some of the inherent heterogeneity.

1.7 The grading of risk is very common in non-life insurance, such as motor and household covers. The public accept that risk factors such as area, type of car or property, etc are indicative of the insurers' risk.

For group life and disability covers the rates are also determined based on other risk factors. These normally include occupation, location and previous claims experience.

1.8 Preferred Lives, with many risk classifications, is a complicated product and will need better staff training and more sophisticated quotation and administration systems. However, with the rapid advances in technology and the development of "point of sale" underwriting systems, there are now opportunities for more comprehensive rating methods.

1.9 There are many different ways of structuring a Preferred Lives product, including:-

- the use of an application form, paramedical information, or a full medical examination;
- lifestyle, demographic or medical risk factors;
- preferred and non-preferred categories, or individual risk pricing.

This part of the paper examines all these methods and highlights the factors that should be considered in weighing up alternative approaches.

1.10 The paper first considers the major issues that need to be discussed before implementing Preferred Lives project. It then reviews the alternative risk factors that could be applied and methods of obtaining and verifying the information. This leads into pricing considerations. The paper then examines some of the marketing issues that need to be discussed, including how many applicants should qualify for preferred terms and how the concept can be presented to the public. The paper then briefly reviews the UK and other markets with Preferred Lives products and finally considers applications in other lines of business.

2. ISSUES IN LAUNCHING A PREFERRED LIVES PRODUCT

2.1 Term assurance is a very simple product and it has few attributes which can distinguish one product from another. There has also been a move back to guaranteed premium rates, in spite of the general trend in other areas towards reviewable rates. As a result term assurance is a classic commodity product which competes squarely on the price line. Whilst a reputation for underwriting, administration and strength are important, these factors are insufficient to enable an office to deviate far from the price line.

2.2 The term assurance market has become increasingly competitive since 1993, in particular for the larger sums assured. Whilst this has certainly been noticeable for business generated from Independent Financial Advisers, it has also affected business produced through a direct sales force and tied agents. The escalating level of competition has partly been due to new more aggressive companies entering the market and partly due to existing companies reviewing their premium bases, in particular their AIDS assumptions. During 1994 these processes accelerated and established offices seeking to compete in this market have had to maintain a constant watch on their rates. It is now not uncommon for offices to change their term assurance rates regularly in order to maintain their competitive position. Competition has forced offices to review and reduce the margins in their rates and now they are arguably very thin. The increased intensity of competition is likely to continue into 1995.

The consequences of the more frequent rate reviews and the jostling for position results in an unpredictable flow of business, and can cause considerable administration problems.

2.3 In order to compete in the term assurance market, an office must understand and verify all elements of its pricing basis. It must also be aware of all elements of cross-subsidy, which may distort the flow and mix of business. Whilst it is common to offer large sum assured discounts to reflect the proportionately lower expenses, little has been done to analyse the inherent mortality variations within the portfolio.

2.4 About fifteen years ago the UK life industry took one major step to differentiate the mortality risk, by introducing separate rates for and smokers and non-smokers. For many years the pricing differential was very narrow, but recently this has widened as greater insurance evidence has built up on the mortality differential. With a few exceptions, the smoker and non-smoker rates are now an established part of life offices' standard terms.

2.5 Where the life office has obtained medical evidence on the applicant, this can provide valuable information for a more comprehensive system of risk rating. For almost all offices, the medical information has been used to look for peak risks and these applicants are either rated or declined. The remainder of the applicants, often between 90% and 95%, are accepted on the offices' standard terms. The system of underwriting is, therefore, used as a means of protecting the office from the worst risks.

2.6 The concept of Preferred Lives is to recognise that the pool of standard risks, differentiated by age, sex and smoking status, is very diverse and that other factors could be used to more effectively differentiate the mortality risk. Whilst there is strong evidence to support this argument, a move away from the well understood present approach is a major step. However, the competitive nature of the term assurance market may leave the life office little option, if it wishes to become a significant player or maintain its leading position.

2.7 The arguments for a new entrant are simpler than for an existing office. If there is a profitable niche of a reasonable size which can be tapped into, then this would be worth exploiting. The new player does not have to worry about maintaining a competitive position across the whole age and health spectrum. If the new company's business plan is sound, it may not have to worry about disturbing the relative stability of the existing market place.

2.8 The established company's position is considerably more complex as it has to consider the premium income it obtains across the whole term assurance market. It would be far more comfortable with the existing market, within which it has developed and would not wish to destabilise it without sound reasons. Whilst the introduction of a Preferred Lives product could enhance its competitive position in one area, it may weaken its competitive position elsewhere. As a result, this approach could reduce its total premium income. In addition, the established office has built up a reputation and a move into a new area could damage this. The consequences of all these factors could only be estimated and would not be known for some time. An established player may, therefore, not readily wish to embrace the concept of Preferred Lives. However, there are three significant reasons why the office may consider introducing a product.

2.9 Firstly, if it considers the arrival of Preferred Lives to be inevitable and just a matter of time, it may wish to establish sound market procedures at the outset and not let the product develop in a disorderly way. Whether this would work in practice is open to question. The concept of Preferred Lives could be applied in so many ways that the methodology adopted could itself be a source of competition. The development of the critical illness market highlighted the fact that offices were resourceful and saw the opportunity to compete on three fronts - price, diseases covered and definitions thereof.

2.10 Secondly, an established office may have to develop a product for defensive reasons. When the offices already offering the product have established a "beach head" and are writing a noticeable proportion of the new business, possibly 10% to 20%, the office may be losing too much low mortality business for its cross subsidy assumptions to be maintained. As a result, the terms on its conventional product would have to be worsened.

2.11 Thirdly, where an office has a range of distribution channels and one set of products, it may find its standard premium terms do not reflect its diverse market. The concept of Preferred Lives, as a means of price differentiation, may be more acceptable than separate products for each distribution channel. This approach could also be extended to affinity group pricing.

2.12 In addition to these strategic decisions, both the new player and the established office must consider a number of wider issues before it could introduce a Preferred Lives product.

These would include:-

2.12.1 Reaction of the press, consumer groups and the general public. This is a new and sensitive area and could be thought of as a discriminatory or "cherry picking" approach, limiting the affordability or the availability of insurance to the general public. It could also be construed as a prelude to genetic testing and therefore an unacceptable intrusion.

2.12.2 The attitude of the Independent Financial Advisers. The concept of Preferred Lives may not be enthusiastically welcomed by the IFAs. The current term plan is a commodity product and offices are forced to compete squarely on price. In contrast, the Preferred Lives product is more complicated than a conventional plan and will require more time to sell. The IFAs will also require far greater training to understand the different rating structures available. The consequence of all the additional sales and training effort and time will be that some applicants will obtain cheaper terms and, therefore, the IFA's commission will reduce.

Their relationship with their client may also be affected by more probing underwriting questions and the need for them to undertake a medical. In addition, there could be further strains if the IFA quotes assuming their client's health is preferred and then has to re-sell on non-preferred terms. As a result, the IFA may prefer to maintain the status quo.

The IFA may respond to this challenge by hawking business around the market. Without sharing of underwriting information, this will lead to unnecessarily increased industry expenses.

.3 The attitude of the direct salesforce. Where the target market is clearly defined and there is little direct competition, the mix of business will be relatively predictable. The life office is therefore in control and can allow a greater degree of cross-subsidy between applicants. As a result, the concept of Preferred Lives would have few, if any, advantages.

2.12.4 The attitude of the applicant. Where the applicant applies for a Preferred Lives product and fails the health check, this may cause considerable distress. The insurer will have to deal with this issue sensitively. It is likely that the applicant's doctor will seek further information and may question both the insurer's judgement in raising his patient's anxiety and its conclusions.

2.12.5 Effect on the existing portfolio. The introduction of Preferred Lives insurance may provide intermediaries with a legitimate reason to recommend that existing healthy policyholders of conventional term assurance products reapply for insurance. However, this problem will only be an issue for the first few years, after which the increase in age will out weigh the benefits of the lower rates. In addition, the problem has been faced before when non-smoker rates were introduced and is already being faced now, as term assurance rates have fallen.

2.12.6 The positioning of other protection products. The office would have to consider whether the same approach should be applied to other life products (eg whole life assurance) and disability products. This is not such a problem, because other products are not so transparent and often have a larger investment portion and are not written on guaranteed terms. In fact, long term disability insurance already differentiates the risk according to occupation.

2.13 In addition, an office would have to consider the implementation issues:-

2.13.1 The number of distribution channels. The product could either be restricted to the IFA channel or widened to the direct salesforce. If the office decides to restrict the sales channel, it would need two products. This would upset the direct salesforce as they will have to compete on less preferential terms. In addition, it could result in distortions as non-preferred applicants could be better off with the standard plan.

2.13.2 Quotation, underwriting, administration, valuation and claims monitoring systems. Each of these elements will be more complicated and would require more staff training. It may also lead to confusion, as staff would have to apply a unique set of rules for term assurance (eg underwriting methodology). In addition, more data would have to be input for claims monitoring. With advances in modern technology these issues may no longer be a problem.

2.13.3 Minimum application size. The additional costs of both selling and underwriting would necessitate a minimum cut-off point below which it would be uneconomic to offer the product.

2.13.4 Method of risk differentiation. There are a large number of alternative approaches and these are discussed in sections 3 and 5.

2.13.5 Response to policyholders who report a subsequent changes in lifestyle. The method of risk classification takes account of the policyholder's lifestyle at the time of application. However, to some extent, this is within the control of the policyholder and, therefore, subject to change. The life office may have to deal with non-preferred policyholders reporting improved lifestyle practices and, therefore, requests to be reclassified. Whilst this already happens with smoking status, the frequency of the requests may be much greater. Where a change for the worse takes place, a preferred life may not inform the office. As a result, the office would have to take care to avoid a gradual erosion of the non-preferred group.

An office may prefer to adopt a simpler approach and not to recognise any changes in lifestyle after the application. The risk of anti-selective lapses would be small, except in the few years immediately after the commencement date.

Whilst some of these issues are common to any new product launch, many are unique and the office should consider their ramifications carefully

3. METHODS OF RISK DIFFERENTIATION

3.1 The prime purpose of Preferred Lives insurance is to restructure the ordinary rates category, so that the degree of heterogeneity is reduced. There are many ways of doing this and the office must review how each method fits in with its business philosophy. The life office should consider its target market, method of selling, product positioning and systems limitations in developing its approach.

3.2 The following section reviews some of the factors that could be used to reclassify the risk. The factors considered are not meant to be exhaustive, but are indicative of the methods that could be used in practice.

3.3 The minimum criteria that need to be satisfied for a risk factor to be used in insurance are as follows:-

- non-technical and easy to explain;
- significant real effect on mortality;
- easy to measure;
- verifiable;
- simple to classify;
- effectively sub-divides the group;
- relatively stable over time.

3.4 Not all lifestyle factors are suitable as a means of risk classification for insurance purposes. Where there is a financial incentive, there will be a greater risk of non-disclosure or falsification. For example, a vegetarian diet has recently been associated with a lower risk of cancer and coronary heart disease. However, it is not a suitable method of risk classification for insurance, because there is no feasible method of verification and dietary habits frequently change. Another example, which may be considered inappropriate, would be a question on whether a women has reached menopause, although this could be easily measured.

However, for affinity group pricing, where all lives would exhibit the same risk factor (eg members of a vegetarian society) and, therefore, there is no element of choice, not all of the criteria listed above would have to be met.

3.5 The methods of risk differentiating described in paragraphs 3.6 to 3.56 are all measurable without a medical check-up, although some should be independently verified. In most cases these methods are simple to understand and the information is already available from a standard application form. The risk factors in paragraphs 3.57 to 3.76 are medical-risk factors and would require the intervention of a nurse of doctor.

Stricter Underwriting

3.6 The requirement to sub-divide the standard rates group into smaller sub-groups has arisen because life offices have attempted to accept over 90% of lives on ordinary terms.

3.7 The underwriting standards set by each office traditionally vary and would be set based on the office's target market; an industrial office would have a more liberal set of underwriting criteria than an IFA office. One office in the UK, which targets the professional sector, does not apply separate terms according to smoking status.

3.8 The significant variation in mortality experience can be seen from the Inter-Office Comparisons *(1)*, where the mortality in the heaviest office was double that of the lightest. Whilst the difference is partly due to underwriting standards, it is also partly due to the market the office is targeting.

3.9 An office could narrow its ordinary lives group by applying stricter underwriting criteria. Unlike other methods of applying the Preferred Lives concept, this method would not require a formal set of pricing and selling procedures, which have to be disclosed to the sales channel. As a result, the product may appear cheaper, but the application process would remain the same.

3.10 This method may have limited early success, but would lead to dissatisfaction amongst the sales channels as more applications, which would previously have been accepted on standard terms, would be rated. Given that the office has not disclosed its approach, the intermediary would be unclear about the new underwriting requirements and, therefore, the suitability of his clients.

3.11 In addition, this method would only reduce the standard group by a small amount. The increased use of sub-standard underwriting could not be applied to more than 20% to 25% of applicants. As a result, at least 75% of lives would still receive the same terms.

Large Sums Assured

3.12 Many life offices already offer lower terms for large sums assured (usually in excess of £250,000). This normally reflects the lower level of expenses as a proportion of the premiums, although some offices also recognise that the mortality experience of this group should be lighter.

3.13 The latter is generally true because the applicants have higher incomes and are, therefore, usually in the highest social class. In addition, the underwriting is more comprehensive and is, therefore, more likely to uncover any adverse medical conditions. However, there may be additional mortality risks without adequate financial underwriting.

3.14 Published data on large sums assured in available from the US *(2)*. The large sum assured experience showed lighter mortality, except in the early years, although there was also some evidence that term products exhibited higher mortality than permanent plans. In addition, term assurance mortality lightened with increasing sums assured until $500,000 and then deteriorated. This is indicative of anti-selection.

3.15 An office could not simply reduce its terms for large sums assured, without reviewing its total basis, as the original rates may have assumed some expense and mortality cross-subsidy.

Wider Non-Smoker/Smoker Differentials

3.16 Smoking is probably the most commonly recognised risk factor (see section 13). Most offices sub-divide their standard rates according to whether the applicant has smoked any cigarettes during the last twelve months. Where an applicant has given up smoking cigarettes for over a year, regardless of the quantity and duration smoked, or where an applicant smokes a pipe or cigar, he would be considered to be a non-smoker. There is evidence to show that it takes between ten and fifteen years for the additional mortality risk to fall to that of a non-smoker and that pipe and cigar smokers have a higher mortality than non-smokers. In addition, given that many smokers have now ceased, the ex-smokers represent a large separate group.

3.17 Those that have continued to smoke are now a distinct group and are unrepresentative of those who smoked 20 years ago. Their mortality will be affected by both the quantity of tobacco smoked and the duration they have smoked. In addition, there is evidence to suggest that the personality of smokers is different. Not only do they drink more heavily, but they may pursue a more hazardous lifestyle.

3.18 The size of the never smoked category has also increased and for the highest social class now exceeds 50% (see table 16). This group should exhibit significantly lower mortality than a traditional non-smoking category, as it would not contain a large proportion of ex-smokers.

3.19 This would suggest that a more comprehensive method of classifying smoking status could be employed, which would take account of any history of tobacco use. Possible risk categories would then be:-

- never smoked;
- given up over five years ago;
- given up more than one year, but less than five years ago;
- type and quantity of tobacco smoked.

3.20 There has always been some concern about verifying current smoking status, but this is now possible by using a cotinine test. This measures the quantity of nicotine in the body, without differentiating by the source. A category of "any tobacco" is, therefore, necessary. It is more difficult to verify whether the applicant has never smoked, or at what date he stopped. However, for a number of lives their GP may have a historic record, particularly for those who gave up more recently.

3.21 A more sophisticated method of classifying smoking status may be acceptable to the public, as they would consider it a good proxy for general health.

3.22 Insurers may also feel more comfortable with this approach as some insurance experience is available, particularly in the US (see table 15). A hardening of the smoking status is already taking place in the industry, as some offices are moving to an "any tobacco" question.

Occupation and Location

3.23 There is a wide variation in mortality experience according to occupation and location (see sections 21 and 22). Information on occupation and location is already available from most insurance application forms. Occupation is already used as a method of risk differentiation in Long Term Disability insurance and the combination of occupation and location is very common in Group insurance business. These factors are also used by general insurers in rating motor insurance. As a result, the general public and IFAs may consider them to be non-contentious risk factors.

3.24 However, individual life business is very different from Group insurance business, generally written by the large employee benefit consultants. The public and the salesmen may not readily accept that occupation and location are mortality risk factors. Whilst smoking, blood pressure, weight, etc, would be viewed as measures of health, occupation and location may be considered as too simplistic. In particular, IFAs and salesmen in the north would feel discriminated against.

3.25 In balancing these issues, it may be deemed more reasonable to only use occupation; one Preferred Lives office in the UK already does this. This would be an efficient way of sub-dividing the small and medium size applications. However, it may be less effective for the largest applications as these would generally be from those in the highest social classes. As a result, the mortality experience would already reflect the best occupations and the office would gain only a marginal pricing advantage.

3.26 Location may still be used as a risk factor, by limiting the cover to UK residents.

3.27 An office which uses occupation as well as smoking status would also have to consider the inter-relationship between them. Table 16 shows that only 16% of professionals smoke, compared with 43% of unskilled manual workers. As a result, the non-smoking discount for professionals would be much smaller than for the unskilled group.

Marital Status

3.28 Marital status is another lifestyle factor that has been shown to influence mortality rates (see section 23). Marital status information is usually asked in proposal forms. Insurers commonly apply different underwriting criteria for single males and this could be extended to rating structures.

3.29 Whilst this is a simple risk factor, it has severe limitations.

3.30 Firstly, since over three-quarters of men and women are married, the risk factor does not effectively divide the population. As a result, the discount that could be applied to married lives would be small.

3.31 Secondly, there is a considerable movement between the groups; in 1990, 5.5% of non-married males, aged 35-44, married and 1.3% of married couples divorced, in England and Wales *(3)*.

3.32 Marital status is also subject to secular trends. Between 1972 and 1989, there has been a dramatic change in the distribution by marital status, in particular the proportions of both divorced and single men have increased. For example, the percentage of married men, aged 25 to 34, has fallen from 80% to 55% *(4)*. This may also be due to an increased level of cohabitation.

3.33 As a result, whilst the evidence supporting the lighter mortality of married lives is strong and has been stable over time, the risk factor may be unsuitable for sub-dividing the population.

Family History

3.34 An effective tool for measuring the risk of early death is the health of the natural parents or siblings (see section 20). A question on family history was almost always included in an application for life cover, but has now been dropped by many offices.

3.35 The family history question can disclose deaths under the age of 60. In addition, it may be possible to obtain information on cancer, heart attacks and strokes.

3.36 The problems with family history however are:-

- In some cases this information may not be known, or may not be reliable.
- In most cases it would not be possible to verify answers.

3.37 Family history information may also be misleading. For example, female cancers would have far less relevance for male applicants. In addition, smoking related cancers may not be applicable to non-smoking applicants. It is also necessary to bear in mind changes in occupational conditions and in diet. Whilst the death of a parent may indicate a hereditary weakness, it could be confounded by environmental and lifestyle factors, which may no longer be relevant.

3.38 However, despite the limitations of family history, it is clear that where it is known that the parents have lived into old age, and there have been no deaths of siblings, then the applicant has a lower risk of premature death.

3.39 There are also wider issues in the use of family history as it has a strong association with genetic profiling. As a result, where greater reliance is placed on family history, in isolation, it may be viewed by the public and consumer groups as a precursor to genetic testing. Given this concern amongst consumer groups, insurers should be sensitive to its use.

3.40 It is worth noting, however, that a family history question is asked with all critical illness plans and this has not caused adverse publicity from consumer groups.

3.41 In view of the limited credibility of the family history question and because of its negative connotations, it may only be a suitable factor for Preferred Lives, where it is used in combination with other risk factors.

Physical Activity

3.42 Taking regular exercise reduces the risk of cardiovascular disease (see section 19). A life office could, in theory, incorporate a discount for applicants who regularly exercise. This risk factor would have general appeal to those who exercise, as they would see themselves as generally healthier than those who do no exercise.

3.43 However, the use of physical activity as a risk factor has limitations. Firstly, it is not possible to validate whether an applicant does exercise, say three times per week for at least twenty minutes. It is also not possible to ensure that the routine is maintained and the benefits of physical exercise cannot be stored up. This is particularly so for young lives who have a high probability of not maintaining their routine into middle age.

3.44 It is also necessary to consider methods of measuring physical activity. Some possible measures are:-

- Pulse Rate. With regular activity the heart rate is slower at a particular intensity of effort and, therefore, the normal pulse rate should be lower. The 1983 Medical Impairments Study suggested that this was a simple index of physical condition. However, it is first necessary to ascertain that there is no underlying illness. In addition, the normal pulse rate is subject to variation (eg anxiety, caffeine).

- Respiratory Function. Recent studies in the UK have shown an association between levels of physical activity and fitness, as measured by respiratory function. A simple test would be Peak Expiratory Flow Rate, which measures the air flow rate during a maximal forced expiration.

- Treadmill Test. This is far more involved and requires the individual to walk on a treadmill at increasing speed and gradient, whilst tests are performed.

3.45 To measure physical fitness objectively would require the applicant to take a treadmill test. However, this would be disruptive, time consuming and expensive, particularly, given the severe limitations of the risk factor.

Alcohol Consumption

3.46 Alcohol consumption can reduce coronary heart disease (CHD) mortality (see section 18). Abstainers have higher mortality than moderate drinkers and alcohol is only a problem for health when consumed in large quantities. The lowest level of mortality has been shown to be at about one to two units of alcohol per day (one unit of alcohol is roughly equivalent to half a pint of ordinary strength beer, a single pub measure of spirits, or a small glass of wine). However, this message is not in line with public health education and has some serious implications. Most people already under-estimate their alcohol consumption and should not be encouraged to consume more. There has also been a large increase in cirrhosis of the liver, suggesting more people are now drinking excessively. Alcoholism is also linked to an increased risk of suicide. In addition, alcohol is often the cause of accidental death, both on the road and at home.

3.47 The use of alcohol consumption as a positive risk factor is, therefore, inappropriate. However, it could be used as a negative risk factor, where consumption exceeds, say, 40 units per week. Given the fact that most people underestimate their consumption, the figure should be halved. At this level it would reinforce the Government's message of 21 units per week for men and 14 units per week for women.

3.48 A life office would not be able to validate the quantity of alcohol consumed. A liver enzyme test could be carried out to show whether there has been a recent history of heavy drinking, or whether there is any permanent liver damage. GPs will only have recorded information where the applicant has had treatment for a drink problem.

Accidental Death

3.49 Accidents account for a large proportion of deaths at young ages. Whilst it is not possible to identify lives who are accident prone, there are other risk factors that could be considered. In the US the following questions are asked:-

- Are you a private or student pilot?
- Do you participate in hazardous sports?
- Have you held a clean driving licence for the last three years?

3.50 The participation in hazardous pursuits may give an idea of the applicant's attitude to life; a play hard and, possibly, work hard philosophy. In addition, hazardous sports and private flying do carry an increased risk of accidental death.

3.51 However, some sports are indicators of physical fitness. In addition, private pilots have to meet rigorous medical standards. For young lives, the increased accidental risk may outweigh the positive health factor. This may change with advancing age as natural causes of death become more significant.

3.52 It is less clear whether a clean driving license is correlated with lower accidental deaths. Whilst speeding may be dangerous, this is probably more so for the pedestrians and other drivers. However, driving whilst intoxicated may be indicative of a more hazardous lifestyle.

3.53 Application forms already ask questions on hazardous pursuits and, therefore, it could be used as a risk factor. However, it does have limitations since the answers cannot normally be validated and the pursuit may be subject to change. Nevertheless, the question could be used to eliminate unsuitable applicants, without having to grade the risk.

Height and Weight

3.54 The inter-relationship between height and weight is an important risk factor (see section 17). Information on height and weight is almost always requested on application forms. Whilst underwriters normally apply wide height and weight limits, it would be possible to more effectively grade the risk. A height and weight table may, therefore, be considered a simple measure of mortality risk.

3.55 However, whilst height is easy to validate, weight can vary and applicants may hold an optimistic view. A small understatement of weight, plus rounding up of height may move an applicant to a lower risk group. A life office should, therefore, obtain an independent measure of height and weight.

3.56 Build may also be considered to be a proxy for blood pressure and cholesterol level. However, this is only correlated for obese lives, who are then prone to higher blood pressure and a higher cholesterol level.

Blood Pressure

3.57 CHD mortality increases exponentially with blood pressure (see section 15). It is also considered to be an important measure of health. Blood pressure is simple to measure and does not cause discomfort. In addition, most people will have had their blood pressure previously measured.

3.58 However, blood pressure is subject to natural variation, due to illness, anxiety and other factors. It is often necessary to determine the mean from several measurements. Blood pressure may also vary depending on the measurement technique and, therefore, this should be standardised.

3.59 It could be argued that these sources of variation make blood pressure an unsuitable method of grading risk. However, the blood pressure studies in Section 15 were based on one measurement and, with large numbers of individuals, blood pressure was shown to be an effective risk factor.

Cholesterol Level

3.60 CHD mortality increases exponentially with total cholesterol (see section 14). As for blood pressure, life offices should, therefore, consider cholesterol level to be an important risk factor.

3.61 In determining whether to use cholesterol level the life office would have to consider the ease and speed of measurement, the applicant's discomfort, the accuracy of the results and how the information will be used.

3.62 Most people in the UK have not had their cholesterol measured and, therefore, there may be a greater degree of apprehension than a blood pressure measurement.

3.63 The most common method of measurement is a laboratory blood test. This requires a doctor to draw a syringe of blood. The technique of drawing the blood sample must be standardised in order to minimise error.

3.64 It is also possible to measure total cholesterol in a few minutes with a simple finger prick, using a desk-top blood analyzer. However a UK study questioned the reliability of the results. Although the machines were accurate, errors arose due to operator techniques. This meant that it would not be possible to distinguish reliably between a cholesterol level of 5.2 mmol/l and 6.5 mmol/l.

3.65 Blood cholesterol is also subject to natural variations. For example, it is lowered following illness. Blood cholesterol is also lower in those with chronic illnesses. A clinician with the task of interpreting blood cholesterol measurements has to consider these sources of potential error. However, the studies in section 14 were based on one measurement and showed cholesterol to be an effective risk factor.

3.66 There is also evidence to support the measurement of HDLs and LDLs (see paragraph 14.3) and these are already used by life underwriters. However, these factors have not been considered for Preferred Lives, because total cholesterol is already complicated. Nevertheless, these additional factors may be helpful in borderline cases.

3.67 The desirable cholesterol level is 5.2 mmol/l or less. The life office may consider this as a suitable cut-off for the lowest mortality group. However, the median blood cholesterol level for men in England aged 35 to 54 is over 5.8(5). Therefore, unless the marketing or selling of the product encouraged healthier applicants, more than half would have an excess reading and would not qualify. This would place the life office under greater pressure to ensure their decision is not a false positive (ie genuine readings and not the result of natural variation, or measurement error).

3.68 In summary, the use of cholesterol level is open to debate. Whilst it is clear that the information is invaluable for mortality grading, the method of measurement and its interpretation are obstacles. The life office may, therefore, not consider cholesterol to be a suitable risk factor where it employs a weak to moderate selection process for the preferred category. However, where the selection process is tight and the mortality discount is large, then cholesterol level should be used as a risk factor.

HIV Test

3.69 Whilst the actual number of AIDS deaths has fallen well below those expected, particularly for the high sums assured, the disease is still of concern. It is, therefore, still necessary to include an AIDS loading in the pricing basis.

3.70 An office could adopt a more aggressive Preferred Lives pricing basis by requiring an HIV test for each applicant. This would ensure all new applicants were not carrying the virus and were only at risk of new infection. In addition, applicants who fall into the recognised high risk groups could be excluded from the preferred category. This could be extended to include those who work in, or regularly travel to Africa, Asia or the Far East. However, jobs are subject to change.

3.71 This two pronged approach would enable the AIDS loading to be reduced in the first few years. This approach would have greatest benefit for short term policies and would be less important for longer term policies. The additional cost of an HIV test may negate some of the pricing advantage, although the cost may be slightly lower by doing a double HIV/cotinine saliva test. As a result, the Preferred Lives concept may put downward pressure on HIV testing limits.

Other Medical Factors

3.72 It is possible to test for the presence of variety of conditions following a medical examination and blood test. This may include a full blood biochemistry analysis, resting and exercising ECG, etc.

3.73 However, medical tests only provide a snap-shot of the applicant's health, they generally have little prognostic value. For example, many tests will provide no information and usually are only worthwhile where there are other symptoms. In fact, there may be a greater risk of a false positive.

In addition, where almost all people will have a negative result, it is not possible to grade the risks.

3.74 In evaluating the effectiveness of tests, the life office should examine their routine underwriting requirements to see which investigations are regularly obtained and which are rarely used. If a test is rarely required, then it would not be worthwhile using it as a risk factor for the Preferred Lives concept.

3.75 As a result, general tests and investigations should not be used as risk factors for grading mortality, they should only be a method of determining whether an individual should be rated.

3.76 Where an office is already carrying out a blood test, it would, nevertheless, be worth testing for other factors to validate answers and to look for other raised risk factors.

Combination of Risk Factors

3.77 The previous paragraphs have outlined risk factors that could be used to determine a Preferred Lives underwriting basis. It is the combination of risk factors that is particularly important in assessing the overall risk, rather than individual risk factors in isolation. Important causal risk factors (eg smoking, cholesterol and blood pressure) are multiplicative rather than simply additive (see section 16). For example, a smoker with a high cholesterol level would have a significantly greater mortality risk than a smoker with a low cholesterol level. In addition, high blood pressure combined with smoking and raised cholesterol level may be a very serious combination.

3.78 However, in some cases a combination of risk factors can lead to double counting. This is particularly so where indicative or proxy factors are used together with the underlying causal risk factors. For example, the lower mortality risk of the highest social classes is due, in part, to a smaller proportion of smokers.

3.79 As a result, where more than one risk factor is used, it is necessary to consider the inter-relationship of the chosen risk factors.

4. SOURCES OF INFORMATION

4.1 The concept of Preferred Lives could be applied for sums assured exceeding the office's normal medical examination limits. The medical information obtained could then be used to its full advantage and no, or limited, additional costs are incurred. However, the concept of Preferred Lives could also be extended to the lower sums assured by making use of other sources of medical information.

Application Form

4.2 General lifestyle and demographic information could be obtained from an application form. This is a cheap and relatively unobtrusive method of eliciting information. The application form could cover current smoking status and smoking history, occupation and location, physical exercise, build, marital status and family history. This information alone would be sufficient to categorise applicants into smaller more homogeneous groups. In fact, in paragraph 3.25 it was stated that occupation may be a more effective means of risk differentiation for the lower sums assured.

4.3 The use of the application form would be limited by the accuracy of the answers provided. Within a year of completing the application form it would be very difficult to refute a claim based on the lifestyle information given, unless other evidence clearly contradicts the information.

4.4 In particular, where the answers may result in a large reduction in the premium payable, the applicant could be more restrictive with the truth. In some cases, the answers may be totally false. This has already been seen with smoking status and is a reason why some offices have resisted widening their smoking differential.

4.5 A limited form of Preferred Lives may, nevertheless, be considered worthwhile, as an additional pricing tool. This may be necessary so that offices who have adopted a Preferred Lives approach for the high sums assured have a consistent pricing philosophy. However, given there are limits in the credibility of the available information and no medical-risk factors have been considered, the method should be limited to moderate sized sums assured, say up to £75,000 (reducing with age). In addition, the rate differential should not be too wide.

Telephone Underwriting

4.6 The approach using an application form, outlined above, could also be applied over the telephone. In general insurance, telephone selling is now very common for motor and household covers. These products rate by a large number of risk factors and require this information to be fully and accurately relayed. Telephone underwriting is also used in the US for a number of life insurance products.

4.7 Where applicants are asked direct questions over the telephone, it is likely that the answers will be more comprehensive and honest. The operator would also be able to seek confirmation to some of the more important questions and pick up on any hesitations. In addition, since the calls could be recorded, the full underwriting interview would be available to refute a claim.

4.8 The problems outlined in paragraph 4.4 would also be reduced where the premium rates are held on computer and are not generally published. The telephone applicant would, therefore, be unaware of the size of any premium differential and may be more complete with his answers.

4.9 However, as with an application form, the risk factors used would have to be non-medical. As a result, the method should be limited to medium sized sums assured, say up to £100,000 (reducing with age).

Private Medical Attendant's Report

4.10 A life office may consider obtaining a Private Medical Attendant's Report (PMAR) to supplement the application form. Whilst this provides additional medical information for underwriting a traditional product, it has limited use as a means of risk differentiation for Preferred Lives.

4.11 A PMAR provides a useful history of medical related conditions, but it is unlikely to provide any credible lifestyle data. Any details on weight, blood pressure, etc may be very out of date and, therefore, could not be relied on.

In particular, the PMAR is less likely to give much useful general information on younger lives.

4.12 As a result, whilst the PMAR may provide additional peace of mind to the underwriter, it would be unsuitable for determining a Preferred Lives structure.

Paramedic

4.13 This is a relatively new method of obtaining information. Paramedics are normally qualified nurses who can obtain general medical information. The paramedic would be able to verify information on height and weight and measure other risk factors, such as blood pressure and pulse, or peak flow rate (see paragraph 3.44). The paramedic could also obtain urine and saliva samples, to enable cotinine, HIV and other tests to be carried out. In addition, the paramedic could determine the consistency of the answers given in the application form. This would help validate the information, in particular smoking status.

4.14 A paramedic could also be used to provide a visual report on the applicant's general well being, for example, whether the applicant is over-weight due to fat or muscle. It may also be possible to use a paramedic to obtain a total cholesterol count, using a desk top analyzer. Where the paramedic is a doctor a blood test could also be taken.

4.15 As a result, it would be possible to extend the Preferred Lives concept to large sums assured, say up to between £150,000 and £200,000 (reducing with age). In addition, it would be possible to apply a stricter Preferred Lives underwriting basis, using medical and non-medical risk factors.

4.16 Given the size of these cases, normal good underwriting practices would also recommend obtaining a PMAR, to ensure that there are no adverse factors in the applicant's medical history.

Health Screening

4.17 This is another new method of obtaining medical information. The use of a health screening has a positive image and fits well with the concept of Preferred Lives.

4.18 The health screening could include a full blood analysis, resting and exercising ECGs, as well as basic medical and non-medical data. It could also provide advice on maintaining and improving health.

4.19 The cost of a health screening would be in excess of a medical examination and this may limit its use. However, one Preferred Lives office in the UK charges a nominal fee for the health screening, which is refunded when the policy is accepted.

4.20 This approach could be used for sums assured exceeding the office's normal medical limits. At this level it would also be good practice to obtain a PMAR.

5. UNDERWRITING STRUCTURES

5.1 Having outlined some of the risk factors that could be considered and their justification, it is necessary to consider how to apply the Preferred Lives concept in practice. It is essential that the approach is simple and non-technical to explain and that it takes account of the method of selling, the target market and the proposed minimum sum assured.

5.2 There are basically three different approaches that could be applied and these are:-

- All underwriting conditions must be satisfied. Under this method an applicant who fails one of the criteria, regardless of the other factors would be rejected. This is the approach generally used in the US and will be referred to as the "all or nothing" method.

- A minimum underwriting threshold must be met. Under this approach an applicant would have to reach a minimum underwriting standard. Where the applicant just fails to meet one of the criteria, but more than satisfies some of the others, the case would be accepted. This approach will be referred to as the "minimum threshold" method.

- The individual underwriting profile would directly determine the rates. Under this approach each underwriting condition would be individually assessed and the total credits or debits would be used to calculate the premium. This approach is similar to general insurance rating techniques and will be referred to as the "individual assessment" method.

5.3 It would also be possible to apply a combination of these factors. For example, it may be necessary to satisfy some core risk factors, plus a "minimum threshold" for the remaining factors.

5.4 All these approaches can then be applied using just non-medical factors (eg occupation, location, build, smoking status), or medical factors, or a combination of both.

5.5 With all of these methods, an office should carry out a retrospective analysis of previously underwritten cases to determine the percentage of lives who would qualify. If too many or too few lives qualify, it should alter the criteria.

5.6 The following paragraphs give examples of each of these methods. With such an extensive range of possible risk factors and qualifying conditions, the examples given are meant just to illustrate the alternative techniques and they should not be viewed as workable solutions.

All or Nothing

5.7 The "All or Nothing" method is the most straightforward of the preferred lives concepts and is a natural extension of the non-smoker and smoker differential. However, instead of two ordinary rates categories, this approach extends the number to four. These would be categorised as follows:-

- non-smoker preferred;
- non-smoker standard;
- smoker preferred;
- smoker standard.

Some offices in the US only differentiate for non-smokers and have one category of smokers.

5.8 The life office would then apply some underwriting rules. The applicant would have to satisfy each and every requirement to qualify as a Preferred Life. One such approach which is used in the US *(6)* is as follows:-

(a) Tobacco Use

Non-smoker preferred	- no tobacco use in the past 5 years.
Non-smoker standard	- no tobacco use in the past 12 months.
Smoker preferred	- less than 20 cigarettes per day.
smoker standard	- 20 or more cigarettes per day.

(b) Build

For the preferred class the weight in indoor clothes must be within the following range:-

Table 1 - Acceptable build for males and females.

Height	Male (Weight in Pounds)		Female (Weight in Pounds)	
	Minimum	Maximum	Minimum	Maximum
4'9"	95	120	100	120
5'0"	105	135	105	125
5'3"	115	150	110	135
5'6"	135	160	120	145
5'9"	135	180	130	160
6'0"	140	195	140	170
6'3"	150	210	150	175
6'6"	160	225		

(c) Occupation

No hazardous occupations would be accepted as preferred.

(d) Habits

For the preferred class there must be no history of alcohol abuse or drug dependency.

(e) Family History

For the preferred class there must be no parent or sibling with a history of, or death from stroke or heart disease prior to age 60.

(f) Hobbies

For the preferred class the applicant must not have been a student pilot or held a pilots licence in the last two years and must not have participated in any hazardous sports within the last three years.

(g) Driving Record

For the preferred class the applicant must not have had his licence revoked or suspended and must not have committed a repeated major driving offence within three years.

(h) Blood Pressure

For the preferred class blood pressure must be below 140/90 mmHg.

(i) Total Cholesterol Level

For the preferred class cholesterol level must be below 6.2 mmol/l

(j) Urine or Blood Analysis

For the preferred class the applicant must not test positive for cocaine, sugar, protein or have abnormal blood liver enzymes.

In addition, if the applicant is rateable for any reason then preferred terms would not be granted.

5.9 The requirement for the applicant to satisfy all the conditions may tilt the life office to adopt more liberal individual underwriting rules. For example, based on the Health Survey for England, the following percentages of the population would satisfy the medical rules outlined above:-

Table 2 - Qualifying percentages by risk factor.

Male Age	Blood Pressure	Build	Cholesterol
35 - 44	73%	65%	62%
45 - 54	60%	57%	53%
55 - 64	36%	57%	52%

Source: Health Survey for England 1991 and 1992 Combined

5.10 This would suggest that the model rules used in the US are not individually severe. However, in combination the risk factors can be much more restrictive. In particular, blood pressure and cholesterol are relatively independent. The stricter smoking requirement is also important. As a result, it would not be unreasonable to expect about 25% of non-smoker applicants to qualify for preferred terms, in line with the results of the Bragg report in the US (see paragraph 6.18).

5.11 In addition, given that the required blood pressure and cholesterol levels do not reduce with age, fewer lives would qualify with advancing age. The converse of this may be that the blood pressure and cholesterol levels are insufficiently restrictive at young ages.

5.12 The "all or nothing" method is very simple to apply and does not need any complex formulae. The underwriter would simply verify whether all the conditions are satisfied and if so the applicant qualifies and otherwise he does not. The salesman would also be trained to target clients who would meet all the non-medical requirements.

5.13 From a pricing point of view, this method would also be simpler because it could be based on the studies of individual risk factors and would not require an analysis of various combinations of risk factors.

5.14 However, the necessity to satisfy each and every category may be considered unduly harsh. For example, where the applicant marginally fails one test, but more than satisfies the others, the rigid approach could be questioned. This argument should be balanced against the fact that the individual rules may already be more liberal.

Minimum Threshold

5.15 This method would also divide the standard non-smoker and smoker categories into four groups, as shown above. However, instead of applying a rigid pass or fail approach a credit scoring system would be used. Each risk category would be allocated a number of points, depending on their relative importance and the applicant's total points would be calculated. Where these exceed a pre-determined threshold the applicant would qualify as a preferred life.

5.16 Given the increased complexity of this approach it may be necessary to limit the number of risk factors considered. In the example in Table 3, the underwriting programme has been limited to eight risk factors, excluding smoking status. In addition, the risk factors (except Hazardous Pursuits) have each been given an equal maximum weighting of 20 points.

5.17 To determine whether an applicant qualifies, the points would be added together. The maximum points would be 140. The preferred lives cut off point would be set by the marketing, underwriting and actuarial departments.

Table 3 - Example minimum threshold.

1. Occupations	Points
Class 1	20
Class 2	10
Class 3	5

2. Family History (Before Age 60)	Points
No Adverse Family History	20
One Heart or One Cancer Event	5

3. Build - Body Mass Index weight (kgs)/height(m)^2	Points
20 - 25	20
Within 10%	10
Within 20%	5

Note: Offices may prefer to use the equivalent values from traditional height/weight tables.

4. Alcohol Consumption	Points
Less than 21 Units Per Week	20
Between 21 and 30 Units Per Week	10

5. Blood Pressure		Points
Up to Age 45	120/85 mmHg	20
	125/90 mmHg	10
Up to Age 55	135/90 mmHg	20
	140/95 mmHg	10
Up to Age 65	140/90 mmHg	20
	150/95 mmHg	10

6. Pulse - Resting Heart Rate Without Treatment	Points
Between 45 and 70 Beats Per Minute	20
70 and 80 Beats Per Minute	10

7. Cholesterol	Points
Under 5.5 mmol/l	20
Under 6.0 mmol/l	10

8. Hazardous Pursuits
The applicant should be rejected if he undertakes any pursuits which are considered hazardous.

In addition, if the applicant is rateable for any reason then preferred terms would not be granted.

5.18 This approach is more complex and would, therefore, be difficult to explain to the sales channels. However, it may be considered more balanced in that one adverse condition would not automatically disqualify the applicant.

5.19 The example has assumed that the risk factors are additive. In practice, causal risk factors are multiplicative (eg smoking, blood pressure and cholesterol).

5.20 A scoring system has also been developed by Shaper, et al *(7)*, based on the data from the British Regional Heart Study. The purpose of the system was to identify men at high risk of a heart attack, for use in general practice. Three scoring methods were developed, of which the "intermediate" appears more appropriate for insurance. The scoring systems are shown in table 4.

Table 4 - Three systems for scoring the risk of a heart attack. The two electrocardiac criteria are mutually exclusive.

Risk Factors	Full	Intermediate	Basic (GP)
Age (yrs)	x 4.0	-	-
Smoking (yrs)	x 3.5	x 5.0	x 7.5
Systolic BP (mmHg)	x 2.5	x 3.0	x 4.5
Cholesterol (mmol/l)	x 38	x 51	-
ECG-Definite MI	+ 110	-	-
ECG-Ischaemia	+ 45	-	-
Diagnosis of Heart Disease	+ 100	+ 170	+ 265
Current Angina	+ 75	+ 100	+ 150
Diagnosis of Diabetes	+ 75	+ 95	+ 150
Parental Death from 'Heart Trouble'	+ 40	+ 50	+ 80

Source: A G Shaper, et al - Health Trends 1987

5.21 The intermediate scoring system omits age and the electrocardiogram, but retains the blood cholesterol measurement. The intermediate scoring identified 58% of heart attacks in the top fifth of scores and provided virtually the same success rate as the full score. Table 5 shows the distribution of scores from the data.

Table 5 - Percentiles of risk score for the intermediate scoring system for all men 40 to 59 years of age.

Percentiles (%)	Intermediate
10	725
20	770
30	815
40	850
50	885
60	920
70	955
80	1,000
90	1,070

Source: A G Shaper, et al - Health Trends 1987

5.22 For example, a respondent who had smoked for 25 years, had blood pressure of 145/95 mmHg, cholesterol of 7.0 mmol/l and a family history of heart trouble would score 967. This individual's health status would fall above the 70th percentile. Therefore, more than seventy percent of lives would have a lower risk of a heart attack.

5.23 This information could be adapted to develop a Preferred Lives credit scoring system. However, the approach may be too complex without modification. In addition, there is no data to suggest a system for scoring heart attacks can be applied to total mortality.

Individual Assessment

5.24 The "individual assessment" approach is an alternative interpretation of the Preferred Lives method. Instead of four categories of ordinary lives, this method is extended to hundreds of risk combinations. Each applicant would have a discount or loading depending on his individual risk factors. The approach could use both medical and non-medical risk factors to categorise applicants into small homogeneous groups.

5.25 For simplicity, the example outlined is limited to demographic and lifestyle information. This approach has similarities to a motor insurance application, where information is sought on occupation and location, as well as driving history and type of car.

Table 6 - Example individual assessment.

Factor	Category	Percentage Adjustment to Standard
1. Smoking	Never	- 20.0%
	Not in last 5 years	- 10.0%
	Not in last 2 years	0%
	0 - 10 per day	+ 20.0%
	10 + per day	+ 30.0%
2. Social Class	I - Professional	- 7.5%
	II - Employers/Managers	- 2.5%
	IIIN/IIIM - Skilled	0%
	IV - Semi-skilled	+ 2.5%
	V - Unskilled	+ 7.5%
3. Geography	South	- 5.0%
	Midlands	0%
	North	+ 5.0%
4. Family History	No events and both parents > 60	- 2.5%
	No events	0%
	One or more events	+ 20.0%
5. Height/Weight	BMI 20 - 25	- 5.0%
	0 - 10% Variance	0%
	10 - 20% Variance	+ 2.5%
	20% + Variance	+ 5.0%

Note:

i) The figures are cumulative. The total adjustment is the sum of the five factors.

ii) The final adjustments is the loading or discount on the pure mortality rate

The adjustments within each risk factor should be determined so that when they are weighted by the insured population, they equal zero. Once again, for simplicity, it has been assumed that the risk factors are additive. In practice, the risks will be multiplicative.

5.26 Using these illustrative adjustments, we would obtain the following results:-

Table 7 - Example individual assessment results.

	Percentage Adjustment to Standard	
	Non-smoker	Smoker
All Best	60.0	110.0
All Worst	117.5	167.5
Neutral	80.0	130.0
Standard	100.0	100.0

Note: The non-smoker is assumed to have never smoked and the smoker is assumed to smoke more than 10 cigarettes per day.

Thus, the overall extremes would be from 60.0% to 167.5% of the standard rates.

5.27 The "individual assessment" approach produces a wide range of premium rates, dependent on the applicants' risk factors. It, therefore, more finely grades the risk than the "all or nothing" and the "minimum threshold" methods. However, the large number of sub-groups has some disadvantages. Firstly, the quotation system has to be more complex and only illustrative rates can be published. Secondly, claims analysis will be more difficult, and thirdly, there is no insurance data to justify the more complex approach. Nevertheless, this approach may be more acceptable to the public.

6. PRICING ISSUES

6.1 The overriding pricing message is that their is very little relevant insurance data. The pricing actuary must, therefore, put together a basis that is logical and consistent, based on general population studies and limited insurance data. The pricing basis must reflect the Preferred Lives structure agreed between the marketing team and the underwriting team.

The Standard Mortality Distribution

6.2 The pricing actuary must start with his standard mortality basis. In the following paragraphs it is assumed that the standard mortality separately refers to the non-smoker and smoker groups. His first principle will be that the total mortality of the non-preferred and preferred categories should equal the standard mortality basis. Any move away from this principle can only be justified where:-

- The standard mortality basis is out of date.
- The preferred lives basis will enable the office to attract a better group of applicants, who previously would have gone elsewhere.
- The preferred lives basis will mean that some of the worse risks will no longer apply to the office.
- The office's underwriting stance will be changed so that more applicants will be rated.

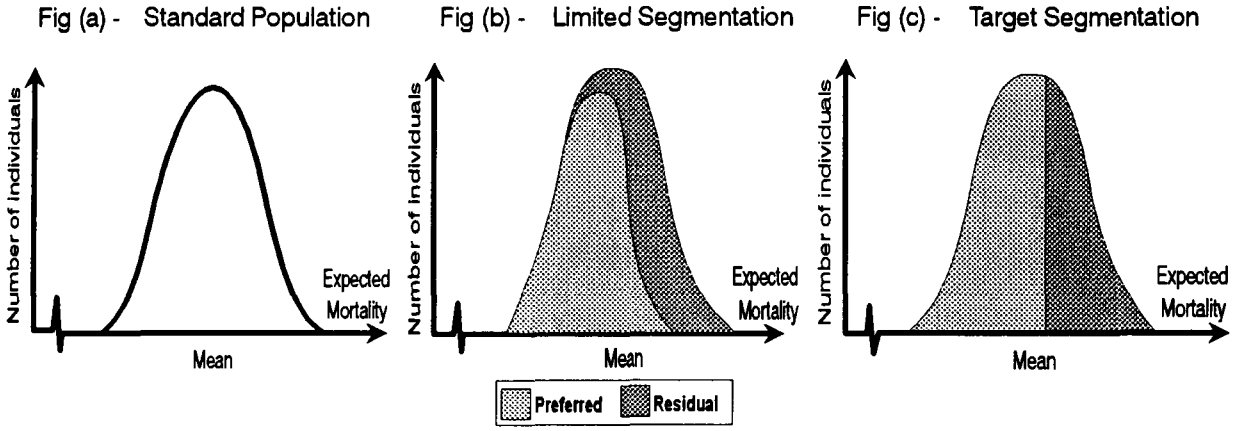
6.3 The mortality distribution of the standard category can be represented by a normal distribution, with a mean of $q^{standard}$. Lives who fall below the mean are better risks and over-pay for their cover. This group cross subsidises those who fall above the mean and under-pay for their cover. This is illustrated in Figure 8(a).

6.4 Traditional underwriting would cut off the extreme right tail of the population distribution, because the applicants have a significantly increased mortality risk. However, this is the result of a progressively increasing mortality risk and the cut off point for "high risk" is arbitrary.

6.5 The application of a Preferred Lives basis will sub-divide the standard population into a number of distinct groups. Where one risk factor (eg blood pressure) is used to divide the population into two groups, it does not account for all the mortality differences, and therefore, some preferred lives will demonstrate a higher mortality risk than some non-preferred lives. As a result, the standard mortality distribution has not been segmented perfectly (see figure 8(b)). The use of additional risk factors (e.g. blood pressure and cholesterol) would narrow the overlap. However, there would still be some non-preferred lives who would exhibit lower mortality than preferred lives. Ideally, every individual in the preferred category (see Figure 8 (c)) should have lower mortality risk than every individual in the non-preferred category. The more risk factors that are taken into account in determining the cut-off point, the closer one would come to this position.

6.6 However, there is some trade off between product simplicity and pure mortality segmentation. This must be determined by discussions between the marketing, underwriting and actuarial teams.

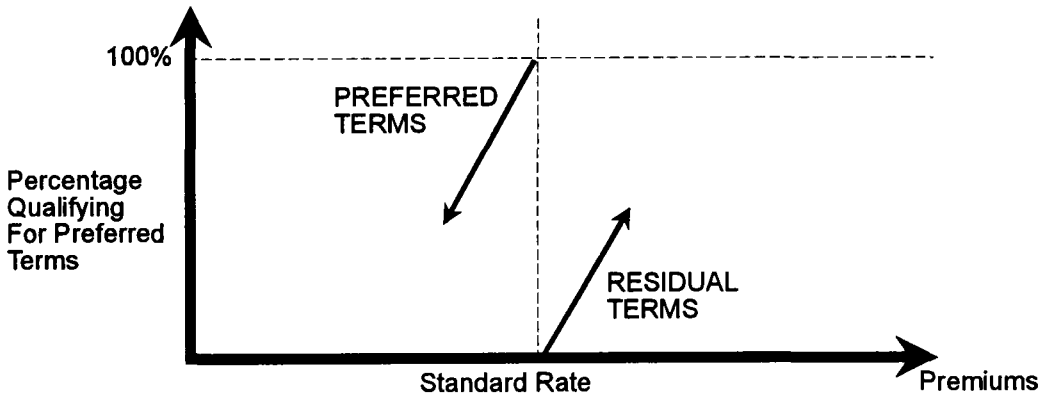
Figure 8 - Segmentation of a normal population.



The Preferred and Non-Preferred Lives Mortality Basis

6.7 The position of the cut-off point for the preferred category will determine the expected mortality from this group and, as a result, the mortality from the non-preferred group. Where this is on the far left of the standard mean, $q^{standard}$, and only cuts off the extreme tail, the mean preferred mortality risk , $q^{preferred}$, will be considerably lower than the standard mean. However, the new mean for the non-preferred group, $q^{residual}$ will only increase marginally. Conversely, if the cut-off point was on the extreme right of the standard population, the new preferred lives mean would fall marginally, but the non-preferred mean would substantially increase. This is illustrated in Figure 9.

Figure 9 - Qualifying Percentage and Expected Mortality



6.8 The diagram shows the percentage of lives who qualify as preferred. As the percentage increases, the $q^{preferred}$ moves towards the $q^{standard}$. At the same time the $q^{residual}$ moves away from $q^{standard}$. This can also be seen from the following formula:-

$$q^{standard} = pref \times q^{preferred} + (1\text{-}pref) \times q^{residual}$$

where pref is the proportion of lives falling into the preferred category.

6.9 Where there are more than two groups, the same principle applies:-

$$q^{standard} = pref_1 \times q^{pref1} + pref_2 \times q^{pref2} + pref_3 \times q^{pref3} + \ldots$$
where $pref_1 + pref_2 + pref_3 + \ldots = 1$

6.10 The values of $pref_1$, $pref_2$, etc are variable and depend on the structure of the particular group.

6.11 Where an office applies preferred and non-preferred terms to its smokers, as well as its non-smokers, the proportion of non-smokers who fall into their preferred group will not necessarily be the same as the proportion of smokers who fall into their preferred group. This would equally apply when analysed by gender and age.

6.12 The data to determine the relevant proportion of applicants who fall into each category may be available from a random sample of standard applications to the life office. Alternatively, it would be necessary to use population data, weighted towards the appropriate target market, where available.

6.13 There is no unique mathematical solution to these equations and the pricing actuary will need to determine separately $q^{preferred}$ as a percentage of $q^{standard}$. This will depend on the underwriting criteria used to select the preferred category. This percentage would also vary by age, gender and smoking status.

6.14 In particular, special consideration may be required for lives below age 35, where the major risks are accidental deaths and suicide. For example, if cardiovascular risk factors are used in the selection process, then the older ages would exhibit a larger discount than the younger ages. Conversely, if the criteria discriminates more on accidents and suicide, the discount will be larger at the younger ages.

6.15 In addition, the relationship between $q^{preferred}$ and $q^{standard}$ may not be stable over time and may alter with insured duration as well as advancing age. This instability reflects the fact that lifestyles change and that they cannot be determined by a single snap-shot. This effect may be more significant for younger lives, who may not have settled into their adult lifestyle (eg single lives may marry and young lives may cease exercising).

6.16 However, given the paucity of data, the pricing actuary will not have the luxury of a complex pricing model and will have to make broad brush assumptions.

6.17 The pricing actuary should, therefore, establish some working parameters. Without the use of Preferred Lives, the insurance data, split by smoking status, provided relatively credible and stable experience. Whilst the healthier lives may have cross subsidised the less healthy lives, this did not impact on the pricing basis. The move towards Preferred Lives reduces the degree of cross subsidy and, for the utopian product, would eliminate the cross subsidy. As we do not have the relevant pricing experience, the basis adopted should be conservative and, therefore, err on the side of retaining some of the unquantifiable cross subsidy. A move which steps over the, at present unknown and invisible boundary, so that the healthier lives no longer cross subsidise the less healthy, but, in fact require cross subsidy, would be unsound. Given that the non-preferred terms would then be expensive, the required mortality contribution may not come through and the office would make a loss.

Available Mortality Experience

6.18 There is some US insurance mortality experience that is worth drawing on to set the parameters. Bragg Associates produced a study into the mortality difference between preferred lives and residual lives during the years 1970 to 1991 *(6)*. The underwriting bases adopted by the companies who provided the data were relatively homogeneous and quite strict. The general approach used was as outlined in paragraph 5.8 and enabled 25% of applicants to qualify as preferred. The results showed that the non-smoker preferred lives exhibited more than 25% lighter mortality than all the non-smokers combined. Conversely, the residual group exhibited 10% heavier mortality.

6.19 The Bragg mortality study also showed that the AIDS deaths that were seen in the overall experience all occurred within the residual category and the preferred group appeared AIDS free. This was probably a by-product of the vigorous underwriting.

6.20 Care should be taken in interpreting these results. Although the underwriting rules are consistent, other policy requirements (eg minimum sum assured) which qualify applicants for preferred terms may be different. The data is also from the US and both the prevalence and distribution of mortality risk factors will be different. For example, CHD mortality is 40% higher in England and Wales than the US (see paragraph 12.6).

6.21 The MRFIT data described in section 16 also provides some useful parameters. This analysed CHD mortality by blood pressure, cholesterol and smoking status. If we assumed that the preferred risk category was limited to the lowest two quintiles and the residual was equivalent to the third and fourth quintiles, then, for non-smokers, the preferred group exhibited 35% lower CHD mortality. Whether measured by cholesterol or blood pressure. *However, care should be taken applying such broad and basic assumptions.* In addition, they only apply for CHD mortality which accounts for 30% of male premature deaths.

6.22 The only UK data which could be used comes from the British Regional Heart Study *(7)*. The data was used to identify men at high risk of acute myocardial infarction or sudden ischaemic death. This showed that the 20% of lives with the lowest scores had only 2% of the major CHD events in the five years of follow-up. This compared with 5%, 13%, 21% and 59% of the events for the remaining quintiles by increasing combined risk score. Whilst this would indicate a very steep gradient for major CHD event and quintile risk group, care should be taken in interpreting the data. Firstly, it only considers major CHD, not all of which was fatal. Secondly, the were only 270 events and, therefore, the data has limited credibility. Thirdly, this was not insurance data.

6.23 The three data sources provide some bench mark information for the pricing actuary in determining the discount for preferred lives. For some offices, additional information may be available by conducting some in-house mortality investigations. These should try to evaluate whether sub-groups of the standard population exhibit significantly lighter or heavier mortality than the total insured population.

Other Pricing Issues

6.24 When the actuary has developed a pricing model, he must then consider its practical application. As a result, other factors should also be taken into account. These include:-

- the mis-classification of applicants. This would arise from providing incorrect application details or the natural variability in the risk factors measured. As for smoking status, we could expect some lives to misinterpret the question and some to non-disclose;

- IFA and marketing pressure. This may lead to special individual applicants, or a higher percentage of all applicants, being forced into the preferred group;

- general underwriting slippage. This may occur over time and would gradually erode the qualifying criteria.

6.25 In addition, given the lack of UK insurance, the discount should also depend on whether the terms are to be reviewable or guaranteed. A reviewable product is a much more *suitable vehicle for developing a new pricing basis. However, in the current environment,* there will be strong pressure to guarantee the rates. As a result, the pricing actuary should adopt a more conservative basis whilst the office develops its expertise and builds up its own mortality experience.

6.26 The previous paragraphs have provided information in determining the pure mortality rates for preferred lives. In calculating the office rates, the pricing differential compared to a traditional approach will narrow for the following reasons:-

- Flat monetary expenses will represent a higher percentage of the lower risk premiums. As a result, the discount on the office rates will be lower than the pure risk differential.

- The underwriting expenses of establishing a preferred life will generally be higher. This may be significant where there is a high percentage of applications not taken up.

- The initial mortality reduction should gradually reduce over time, to allow for the possibility that some preferred lives will adopt less healthy lifestyles in the future and some non-preferred lives will adopt healthier lifestyles.

- The valuation basis for a preferred life may have to have a greater margin that traditional life business to reflect the pricing uncertainty, given the lack of insurance data. Where rates are guaranteed, the margin would have to be even larger. As a result, there would be a greater new business strain for Preferred Lives products.

6.27 Finally, having established a basis, the pricing actuary should ensure that a monitoring system is put into place to enable all the elements of the basis to be analysed. This should also include the number of applicants that qualify for the preferred terms. If this exceeds the pricing assumption this could be due to underwriting problems or because the type of applicants have changed, to reflect the office's new position in the market.

6.28 This should be part of a control cycle, which analyses all the elements of the pricing basis so that, where necessary, the basis can be adjusted and, in particular, early corrective action can be taken.

7. OTHER MARKETING ISSUES

7.1 Before the life office is able to finalise the structure of its Preferred Lives programme, it must weigh up the key reasons for developing the product (see section 2). General management, marketing, actuarial and underwriting must then consider the following issues.

Percentage Qualifying

7.2 Where the primary goal is a competitive price, the office would have to calculate how much lower the product must be priced in order to meet its target. Obviously, the greater the discount for the preferred category, the more conservative the underwriting stance and the fewer applicants would qualify.

7.3 A very restrictive Preferred Lives basis, where few applicants qualify, has severe disadvantages. One US life office developed a Preferred Lives classification basis that was so restrictive, that only extremely active, athletic applicants qualified and, therefore, the salesmen ended up ignoring the product.

7.4 For marketing and pricing reasons, it would be necessary to ensure that at least 25% of applicants qualify for the preferred category. The consequences of a smaller number qualifying would be IFA dissatisfaction, bad publicity and a general loss of interest. In summary, the programme would have failed.

7.5 On the other hand, if more than 70% of applicants qualify for preferred terms, then the discount from the standard premiums would be relatively small. In these circumstances, the better risks would be attracted to another life office, with a more select preferred group and, as a result, the office may obtain insufficient low mortality business from those remaining with it. This would put its pricing basis in jeopardy, unless the office had already allowed for it.

7.6 Given that the main purpose of Preferred Lives is tap into a profitable niche in a price sensitive market, the life office may decide to aim for between 25% and 50% qualifying. Where an office is outside of the IFA market it would not have to be constrained by these limits.

Market Positioning

7.7 The Preferred Lives product could be sold to all applicants, who would then undergo an underwriting assessment to determine whether they obtain preferred or non-preferred terms.

7.8 Where applicants are sold a policy as if they are a preferred life and are subsequently told that they would not qualify and are placed in the non-preferred group, there would be a greater risk of them not taking up the policy. If a large number of applicants are mis-sold a preferred plan and then do not take the non-preferred plan, considerable medical and underwriting costs incurred would be wasted. These would have to be absorbed by the small preferred group and this would increase the per policy expenses.

7.9 These problems could be limited by making the non-preferred terms the new standard product. The underwriting approach would then follow the office's established practice. However, where the applicant considers his health to be well above average, he could specially request the preferred terms and the more comprehensive underwriting programme. It may be possible to charge a special underwriting fee for this opportunity, which would be refundable on acceptance. This would give the preferred category a select feel. As a result, those who do not reach the required health status would just receive the standard terms. This approach may be viewed as less discriminatory, as the applicant self-selects and the insurer then verifies his status.

7.10 However, the disadvantage of this approach would be that the non-preferred terms would be the standard terms and these rates may not be competitive. To maintain these terms amongst competitors, who have one set of terms, it would be necessary to reduce the expense or profit margins to compensate for the heavier mortality costs.

7.11 The larger the percentage who apply and qualify for the special terms, the greater the reduction in the margins necessary for the non-preferred terms to compete as standard rates.

7.12 The concept of Preferred Lives may, however, have marketing appeal even without a rate discount. In the US, some companies simply define preferred lives as non-rated, non-smokers.

Minimum and Maximum Age

7.13 The minimum age should be set so that the Preferred Lives selection criteria are applicable. If the age is too low, then the medical risk factors are likely to be normal and they will be of little predictive value. In addition, other adult lifestyle factors may not have been established. As a result, the minimum age may be between 25 and 30.

7.14 The maximum age should also be set allowing for the Preferred Lives selection criteria. If the age is too high and the selection method is not age related, then the number of lives qualifying may be very small. For conventional term assurance business (not Inheritance Tax Planning), the number of applicants above age 70 will be low.

Minimum and Maximum Sum Assured

7.15 The minimum sum assured will depend on the method of underwriting. Where this is done without an automatic medical, the sum assured could be considerably lower than where a medical is required. The minimum sum assured will also depend on the method of selling. Where the policy is sold through the IFA the commission must be commensurate with the additional time required in selling and possibly having to resell, where the applicant is reclassified.

7.16 Where a medical is automatically required, the minimum sum assured should be set allowing for the increased expenses incurred in underwriting.

7.17 Another consideration in setting a minimum sum assured is how the rate should be structured just below and just above this cut-off. Whilst the premium for the preferred terms would fall, it may not be considered reasonable for the non-preferred terms to increase. Otherwise, this may result in IFAs dividing large non-preferred applications into smaller units.

7.18 The life office should also consider setting a maximum application size. This would depend on its maximum capacity and the terms available from the reinsurer. Where the reinsurer has been involved in designing the programme, the upper limit may be immaterial. However, a maximum size may still be necessary as the financial risk may exceed the medical risk.

Minimum and Maximum Term

7.19 A minimum term should be set so that the additional cost of obtaining medical evidence is not a disproportionately large expense. The minimum term should be set in light of the minimum sum assured. It is clear that, a short term plan combined with low sums assured will provide little incentive for the salesman to sell a complicated product.

One way of avoiding the problems of a minimum age, term and sum assured, would be to set a minimum premium.

7.20 The term of the policy also determines the importance of the mortality risk factors. The longer the term, the greater the dampening of the mortality adjustment. This is due to the build up of larger reserves. However, this would only be significant for older lives or whole life plans.

8. APPLICATION IN OTHER MARKETS

UK and Ireland

8.1 The first Preferred Lives products were introduced into the UK in 1993. By the end of October 1994 there were four offices in this market. In Ireland the first product was introduced in 1993 and there have been no subsequent entries.

8.2 The first three companies were new term assurance players who were keen to establish themselves in the IFA market. The last entrant was a significant IFA office, who already had an established reputation.

8.3 In Section 2 it was stated that once between 10% and 20% of the new business is written on preferred terms, then the major offices would have to react for defensive reasons. It is the recent entry of an established office who may now tip the balance and force other established offices into the market.

8.4 In Ireland the preferred life entrant was a new company into the term assurance market. The established offices have reacted by reviewing their pricing basis. For large sums assured the competition amongst a few players is now intense. As a result, the next downward price move may have to be as a result of another Preferred Lives approach.

8.5 The methods of sub-dividing applicants varies amongst all the UK offices. One uses occupation only, another a "minimum threshold", another an "all or nothing" approach, and the other uses a combination of core requirements and then minimum additional conditions.

8.6 For the IFA, these different approaches may lead to considerable confusion. Except for the office using occupation only, the IFA would not be able to determine whether his client would qualify for preferred terms. The decision would also vary for each office.

8.7 IFAs may put pressure on life offices to standardise underwriting approaches as they did with critical illness definitions. This would also enable homogenous industry-wide data to be captured.

United States

8.8 As for the UK and Ireland, the US has moved from a relatively price insensitive and unsophisticated market into a more competitive and sophisticated environment.

8.9 In 1968 the risk classification underwriting process was simply standard or rated, only two companies offered non-smoker discounts. At that time the insurance industry obtained high profits from a conservative underwriting programme. Over the next decade competition dramatically increased and more complex products were introduced and underwriting standards became more liberal. By 1978 non-smoking discounts were firmly established.

8.10 In the early 1980's, as a consequence of increased competition the concept of differentiating standard risks according to smoking status was extended to include other risk factors. At first the risk factors were very general and it was left to the underwriter to determine what was normal. However, as statistics were gathered and experience was gained, the analysis of what constituted a preferred life became more refined. In addition, the lowering of medical limits, primarily due to AIDS, yielded more information to differentiate the risks. Most companies now obtain a blood test at or near $100,000.

8.11 The number of offices offering Preferred Lives products have gradually increased after its introduction. However, the early predictions that it will be as common as the smoker/non-smoker division within ten years have been proven wrong. It is estimated that less than 50% of offices have Preferred Lives programmes.

8.12 The early companies that introduced Preferred Lives products tended to be brokerage companies, where price competitiveness was paramount. Later on companies with broader sales channels started introducing this concept. These companies did it more for marketing reasons and had a high percentage of applicants qualifying. It is now estimated that most approaches target 60% to 70% acceptance and few offices have strict qualifying requirements with 25% acceptance.

8.13 The initial Preferred Lives products were only available to non-smokers and were just a further sub-division into four risk groups - preferred non-smoker, non-smoker, smoker and rated. Subsequently the Preferred Lives concept was extended to smokers.

8.14 Although the Preferred Lives programme in the US is now over ten years old, there has been no convergence to one single approach. On the contrary, innovative design has led to a wide spread of different methods.

8.15 Of the preferred underwriting methods surveyed, most appeared to be of the "all or nothing" method, although the "minimum threshold" was also used. The minimum sum assured varied according to the Preferred Lives method adopted, but was generally between $50,000 and $100,000.

8.16 Competition has also led to increasing pressure on offices to weaken their underwriting standards. Where an applicant does not qualify, they often ask for reconsideration. This extends the underwriting process and increases the costs.

8.17 A number of offices have weakened their approaches by allowing a "grace period" for applicants who almost qualify. This would allow applicants to qualify for the preferred terms after a two or three year period, if there has been some lifestyle change. Provided adequate evidence was given, the policy would not have to be re-underwritten.

8.18 With such a diversity of preferred risk programmes, capturing homogeneous industry wide data is next to impossible and may remain so for many more years.

Other Countries

8.19 In Australia a few companies have previously marketed Preferred Lives products, but they are no longer sold. This primarily was due to the fact that the product was sold by niche companies and not a major office. However, there is some suggestion that the concept is not completely dead.

8.20 In Canada the concept of Preferred Lives has also surfaced, but, at present, only one company offers this product.

8.21 In South Africa, the concept of preferred lives is more common and it is marketed by the large life offices. However, the reasons for introducing the product may be very different from the US. In South Africa the product differentiates by social class, income and education and it may, therefore, be an indirect method of allowing for the AIDS risk and reflecting racial mortality differences.

9. APPLICATION IN OTHER LINES OF BUSINESS

9.1 The concept of Preferred Lives does not need to be restricted to life products. In fact the concept already applies in other lines of business. For example, Long Term Disability insurance already differentiates the risk by occupation class and in many cases smoking status. Group insurance products also differentiate by location and occupation.

9.2 Preferred Lives pricing would have an immediate affinity with critical illness, where the risk is highly correlated to lifestyle factors. In fact, many of the studies were directly targeted at CHD mortality. In addition, the scoring system developed by Shaper and colleagues, was to identify men at risk of a heart attack.

9.3 The system could also be applied to Long Term Care insurance. Many of the studies have also shown that lifestyle factors continue to apply into old age, in particular, regular exercise can reduce the risk of osteoporosis.

9.4 The converse of the Preferred Lives approach is to apply better annuity terms to less healthy lives. This approach already exists for Structured Settlements and Immediate Long Term Care products, which meet the care fees of disabled applicants. In addition, there are some companies who buy second hand policies from terminally ill policyholders.

9.5 There may also be a niche market for higher risk term assurance applicants. In motor insurance, the company who led the field in developing a computer based rating system targeting lower risk drivers, has just launched a company offering cover to high risk or non-standard drivers. For term assurance non-standard applicants could include those with impaired health or those pursuing hazardous sports or occupations. However, for this market to exist, the current underwriting practices would have to be viewed as conservative and therefore excessively profitable. There is no evidence to suggest that this is the case

10. CONCLUSION

10.1 This part of the paper has provided an overview of the issues that should be considered in developing a Preferred Lives programme. The length of the paper is indicative of the diversity of approaches that could be applied and, the fact that, this is a new method of risk classification.

10.2 Competition in all industries, not just life insurance, forces companies to strive to more accurately charge their clients for the actual services used. As customers become more sophisticated and competition intensifies, this process accelerates.

10.3 Traditional life insurers are faced with increased competition for savings business and greater regulation and disclosure requirements. This will restrict growth opportunities in these markets and may encourage offices to sell more protection business. As a result, competition for protection business may intensify.

10.4 At the same time, some offices are attempting to widen their target market, by developing new distribution methods. This will lead to greater mortality risk variation within the office.

10.5 An office without a captive market of potential customers may have to develop more sophisticated rating systems, in order to compete and still make a profit. As the technology to do this is now available, it will be used.

10.6 A more comprehensive method of risk classification is, perhaps, inevitable. Its structure is far less clear. Lifestyle and demographic methods of risk classification are relatively easy and cheap to apply. Medical factors are more complex and more expensive, but provide more comprehensive information.

10.7 IFAs may respond to a diverse range of qualifying methods by submitting multiple applications, in particular for large cases. This would not be good for the industry as costs would rise, without a policy of sharing medical information.

10.8 In summary, over the next five years the market is likely to move to some form of Preferred Lives approach. For medium sized sums assured, the risk rating is likely to be based on lifestyle and demographic factors. For large sums assured, where medical evidence is collected automatically, this evidence and other risk factors will become an automatic part of the rating basis.

PART B - POPULATION MORTALITY

11. POPULATION RISK FACTORS

11.1 The following sections provide a review of the major risk factors linked with mortality. This part of the paper concentrates on population studies, with few exceptions. The purpose of the review is to highlight the truly heterogeneous structure of the population. In addition, it shows how much data is available to the actuarial profession. This part of the paper stands in isolation from the first part and may be used for reference only.

11.2 In the search for risk factors which can be used to sub-divide the population, it is not necessary to identify the precise causal agents, or to understand the mechanism by which they work. A risk factor is important if it is consistently correlated to mortality.

11.3 There are three types of risk factors:-

- modifiable lifestyle risk factors, such as smoking, cholesterol, blood pressure, weight, exercise and alcohol consumption;
- fixed risk factors, such as age, family history and gender;
- demographic risk factors such as social class, geography and marital status.

11.4 Epidemiologists are more interested in causal risk factors. These not only demonstrate a relationship with an event, but action taken to reduce or modify these factors leads to a decrease in the incidence of the event.

11.5 The studies shown in this part of the paper, generally analyse one risk factors. However, it is important to understand the inter-relationship between all the risk factors.

11.6 The studies that have been selected are all cohort studies of reasonable credibility. However, the reader should view them critically and recognise any design limitations in interpreting the results.

11.7 This part of the paper is not an underwriting manual and, therefore, only considers the major population risk factors, not individual medical conditions.

12. MORTALITY BY CAUSE OF DEATH

12.1 In order to identify which risk factors are important, it is necessary to review the main causes of death. Table 10 shows the main causes of death in the general population and in ten year age bands between ages 25 and 64.

Table 10 - Death rate and causes of death (percentage) for men and women, England and Wales (1991).

	Male Age				
	25 - 34	35 - 44	45 - 54	55 - 64	25 - 64
Death Rate Per 1,000	0.92	1.75	4.55	13.85	5.27
Cause of Death (%)					
Suicides	27.3	15.0	5.3	1.3	4.4
Other Injuries	26.2	12.6	4.8	1.6	4.3
Lung Cancer	0.7	3.3	9.3	12.2	10.3
Other Cancers	12.2	18.1	23.5	23.8	22.8
CHD	3.4	19.1	32.2	35.9	32.3
Stroke	2.3	3.8	4.8	5.6	5.2
Other Circulatory	3.5	4.4	4.7	5.3	5.0
Other	24.4	23.7	15.4	14.3	15.7

	Female Age				
	25 - 34	35 - 44	45 - 54	55 - 64	25 - 64
Death Rate Per 1,000	0.44	1.05	2.87	8.14	3.12
Cause of Death (%)					
Suicides	13.2	6.8	2.9	1.0	2.4
Other Injuries	12.9	6.0	3.1	1.4	2.6
Lung Cancer	0.7	3.4	7.2	9.3	8.0
Breast Cancer	6.8	19.4	20.0	11.8	14.1
Other Cancers	25.0	28.9	31.0	27.9	28.6
CHD	1.8	5.2	9.6	19.4	15.3
Stroke	3.4	5.8	5.8	6.6	6.3
Other Circulatory	4.8	3.9	3.8	4.9	4.5
Other	31.4	20.6	16.6	17.7	18.2

Note: Suicides include self-inflicted and undetermined causes of death.

Source: 1991 Mortality Statistics, OPCS Series DHI No. 26

12.2 The three major causes of death for men and women are Cancers, Coronary Heart Disease (CHD) and suicides and other injuries. Whilst stroke is a significant cause of death, it is of far less importance than CHD in this age group.

Cancer

12.3 Cancers are a major cause of death for both sexes. For females, they account for one third of the deaths in the age group 25 to 34 and half the deaths in the age group 35 to 44. For males, cancers account for over 20% of deaths in the age band 35 to 44, increasing to over 35% in the age band 55 to 64. Two particularly stand-out:-

- breast cancer is the major cause of death for females and accounts for about one third of female cancers;
- lung cancer is a major cause of death for both sexes and accounts for about 10% of all deaths for ages 45 to 64.

12.4 Deaths from breast cancer has steadily risen since 1970 and may have peaked in 1989 *(3)*. For lung cancer the trend is sex dependent; for males the rate of lung cancer has fallen and for females it has steadily risen and may still be rising *(8)*.

Coronary Heart Disease

12.5 Coronary Heart Disease (CHD) is the leading cause of death in the UK and the developed world. CHD mortality rates are over twice as high in men as in women accounting for 32% of premature deaths among adult men and 15% among women.

12.6 Deaths due to CHD have declined in the UK, but some other countries have had more success in reducing CHD mortality. In the USA, for lives aged 35 to 74, there was a 57.7% reduction in CHD mortality for men (from 743 to 322 per 100,000) and a 57.6% reduction in women (from 311 to 132 per 100,000), between 1970 and 1989. This compared with a 22.6% reduction for men (from 588 to 461 per 100,000) and a 13.6% reduction for women (from 198 to 173 per 100,000) in England and Wales. As a result, CHD mortality in men is over 40% higher in England and Wales than in the USA *(9)*.

12.7 The CHD death rates in England and Wales have fallen much more rapidly at the younger age groups, than the older age groups. However, CHD in the younger age groups is of far less significance than in the older age groups.

12.8 The death rates from CHD in Scotland and Northern Ireland are even higher than in England and Wales and are now the highest in the world.

12.9 It is this relatively poor international comparison that led to the Health Of The Nation strategy. Epidemiological studies have shown that the premature onset of CHD could be reduced significantly if people adopted healthier lifestyles *(10)*.

Suicides and Other Injuries

12.10 For males up to age 44, suicides and other injuries are of primary interest. Half of all these deaths are either suicides, self-inflicted or of undetermined cause. The other half are due to accidents either in a motor vehicle or at home.

It is noteworthy that, for males, deaths from suicides are rising amongst those aged 25 to 44 *(8)*.

The Health of the Nation

12.11 Whilst the major causes of death are of obvious interest, the more important goal is to understand how the risk of death from these causes can be influenced by genetic, lifestyle and demographic risk factors. For cancers, coronary heart disease and strokes it is clear that the risk can be influenced by behavioural factors. For example, smoking accounts for between 80% and 90% of lung cancers and, in total, one third of all cancer deaths *(11)* and is a major risk factor for coronary heart disease and stroke.

12.12 The Government has set some targets in its Health of the Nation White Paper for the reduction in death rates from selected causes *(8)*. Of particular interest are those related to cancers, coronary heart disease, strokes and suicides and other injuries.

The Health of the Nation targets are as follows:-

- To reduce the death rate from breast cancer for women aged 50 to 64 by 25% between 1990 and 2000.
- To reduce the death rate from lung cancer for males by 30% and for females by 15%. These targets apply to men and women under age 75 and they will be measured between the years 1990 and 2010.
- To reduce the death rate from both coronary heart disease and stroke in people under 65 by 40% between 1990 and 2000.
- To reduce the overall suicide rate by at least 15% between 1990 and the year 2000. It has also set some targets for a reduction in death rates from accidents, but these apply to lives under 25 and over 64.

12.13 The Health of the Nation targets would directly impact on the mortality rates of the general population. If all the targets are achieved, the mortality rate would fall by about 18% for males and 13% for females. This assumes that there is no increase in other causes of mortality. However, this overall reduction in mortality may not simply translate to the insured population as they are not a representative sample of the general population.

13. SMOKING

31.1 The first and probably the most commonly recognised and significant behavioural risk factor is smoking. This is the most important cause of avoidable premature death in the UK *(12)*. The relationship between smoking and death from lung cancer, other malignancies, vascular disease and non-malignant respiratory disease has been recognised since the 1950s.

13.2 Lung cancer is the most common cause of cancer deaths in men. In women it is second to breast cancer. In Scotland and parts of Northern England, female deaths from lung cancer have recently exceeded breast cancer deaths *(11)*.

13.3 CHD is the most common cause of death in men and it has been shown that smoking significantly increases the risk of premature death from CHD.

31.4 Whilst it has been recognised that smoking is such an important risk factor, it is necessary to evaluate the additional mortality between the following groups:-

- non-smokers who have never smoked;
- smokers who have quit, measured by duration and previous quantity smoked;
- smokers measured by type of tobacco, duration and quantity smoked
- passive smokers.

13.5 Men began to smoke cigarettes in significant numbers at the turn of the century and their consumption rose steadily until 1945. Smoking was not a common habit among women until after 1945 after which the consumption of cigarettes by women has grown, reaching a peak in 1974. Table 11 shows how smoking patterns have changed since 1950, by percentage of adults smoking and the average number of cigarettes per smoker.

Table 11 - Percentage of men and women aged 16 and over who smoke manufactured cigarettes and the daily consumption per smoker, Great Britain.

Year	Men		Women	
	% Smoke	Daily Consumption	% Smoke	Daily Consumption
1950	62	15.2	38	7.9
1955	58	18.6	36	10.0
1960	61	18.6	42	10.5
1965	54	18.4	42	12.1
1970	55	18.9	44	13.6
1975	47	21.6	43	15.8
1980	42	21.2	39	16.4
1985	35	19.0	34	15.6
1987	34	19.2	34	15.4

Source: Tobacco Advisory Council

13.6 From the table it can be seen that the percentage of men who smoke cigarettes has fallen from 62% to 34%. However, in contrast, the percentage of women smoking remained fairly constant from 1950 until 1977 and still remains level. As a result, the percentage of men smoking has fallen to approximately the same level as women, but males continue to smoke over 25% more cigarettes per day than females.

13.7 This pattern is important in understanding the additional mortality risk from cigarettes. For many of the diseases caused by tobacco the adverse effects of smoking usually becomes substantial only after several decades of exposure *(13)*. As a result, conclusions drawn before the smoking habit has been sufficiently established may greatly under-estimate the potential hazards.

13.8 Doll and Hill were amongst the first to recognise the association between smoking and lung cancer in 1949 after investigating the large increase in lung cancer which occurred between the two world wars, particularly among men. Doll initiated a study of 34,439 male doctors resident in the UK. This study has now been running for forty years and provides the longest follow up of the effects of prolonged smoking on males *(14)*.

13.9 This study is of particular relevance for insurers, as they represent a relatively homogeneous sector within the highest socio-economic group. In addition, the use of doctors should reduce the risk of inaccurate reporting of information on smoking habits.

Table 12 - Mortality ratio by age at death for cigarette smokers in The Doctors' Study (1951-1971) and (1971-1991) compared with those who have never smoked

Age At Death	1951-1971	1971-1991
45 - 49	2.96	2.63
50 - 54	1.59	3.10
55 - 59	1.86	3.06
60 - 64	1.86	2.82
65 - 69	2.21	2.37

Source: Doll, et al (1994)

13.10 In summary, the results of the 40 year study are as follows:-

- The mortality ratio of cigarette smokers has widened between the first and second half of the study. During 1951-1971 the death rates in cigarette smokers were about double those of non-smokers in middle age, but between 1971-1991 they were nearly treble. This is due to the "maturity" of the epidemic of deaths from smoking, with those in the second half of the study having had a longer history of regular consumption of cigarettes, than men of the same age would have had during the 1950s and 1960s.

- The proportion of 35 year old males who survive to age 70 is dependent on smoking habit. Whilst 80% of non-smokers survive, only 59% of cigarette smokers survive; two-thirds of light smokers, 60% of moderate smokers and 50% of heavy smokers survive.

- Comparing the first and second 20 year periods, non-smoker mortality has fallen, but smoker mortality has remained constant. Even though national mortality rates rapidly improved and cigarette smokers shared in some of the mortality improvements affecting non-smokers, this was counter balanced by the "maturing" of the smoker epidemic.

13.11 The "maturity" of the smoking epidemic is of particular interest. Whilst this is due to the increased duration of smoking, it is also due to a change in the mix of smokers. The minority of doctors who continued to smoke cigarettes may have had different smoking habits compared with those who have stopped smoking. These results show the importance of using recent epidemiological evidence.

13.12 The effect of both the quantity of cigarettes smoked and other types of smoking (ie pipes and cigars) on mortality can be seen from table 13.

Table 13 - Mortality by smoking habit (1951-1991).

Cigarettes	**Relative Risk**
Never Smoked	1.00
Ex-Smoker	1.24
All Current	1.78
1 - 14	1.49
15 - 24	1.76
≥ 25	2.30
Other Smokers	**Relative Risk**
Ex-Smoker	1.22
Current	1.25

Source: Doll, et al (1994)

13.13 The table shows how mortality increases with the quantity of cigarettes smoked. It also shows that the mortality of pipe and cigar smokers is less than that of cigarette smokers.

13.14 A study has recently been published which evaluated the effects of smoking on 117,001 registered female nurses aged 30 to 55 in the US *(15)*. This study ran for 12 years and the results are summarised in table 14.

Table 14 - Female mortality by daily number of cigarettes smoked.

Cigarettes Smoked Per Day	Relative Risk
Never Smoked	1.00
Ex-Smoker	1.29
1 - 14	1.51
15 - 24	2 02
25 - 34	2.09
Over 34	2.63

Source: I Kawachi, et al (1993)

13.15 The results of this study are remarkably similar to those for male British doctors. As with Doll's latest findings, this report also noted that the relative risk from smoking was higher than had been seen in earlier studies and also concluded that this was to do with the "maturing" of the smoking epidemic.

The results may also suggest that the mortality experience of female smokers will deteriorate further, as the female smoking habit is more recent than males and, therefore, not as mature.

13.16 The mortality ratio of smokers to non-smokers of the insured population reflects those of the general population. This is shown in table 15.

Table 15 - Insured mortality experience by smoking status and age.

Ratios of Smoker to Non-Smoker Mortality						
		Ages				
USA		20 - 29	30 - 39	40 - 49	50 - 59	60 - 69
Intercompany 1982-87	Male	1.82	1.94	2.34	2.47	2.26
	Female	1.50	1.86	1.93	2.28	2.27
1980 CSO Assumption	Male	1.75	2.25	2.50	2.30	1.88
	Female	1.45	1.75	1.90	1.78	1.53
		Ages				
UK		- 30	31 - 45	46 - 60	61 - 75	
CMI 1988-1989	Male	1.40	1.97	1.88	1.73	
	Female	0.91	1.31	2.11	2.27	

Note:

i) Non-smokers generally include cigar and pipe smokers, and those who have ceased cigarette smoking for over 12 months.

ii) 1980 CSO Assumptions are based on mortality between 1970 and 1975.

Source: Record, Volume 17, Number 2, Society of Actuaries, New York Meeting; Transactions, Society of Actuaries, 1982 Reports; CMI Report No. 13.

13.17 The insured experience is likely to understate the mortality difference due to non-disclosure, ex-smokers are underwritten as non-smokers and smoking habits may change since policy issue.

13.18 Passive smoking is also a risk factor. This covers a very large number of people, including those exposed within families and at work. In 1986 the US Surgeon General's report concluded that passive smoking causes lung cancer. Studies have shown that there was about a 30% increased risk of developing lung cancer and coronary heart disease among passive smokers *(12)(16)*. In addition, studies have shown that children of a parent who smokes have an increased risk of respiratory illness, which can also extend into adulthood *(12)*.

13.19 Table 11 showed how the percentage of people who smoke was changing over time. The changes in smoking habits vary significantly by socio-economic group. These differences may be a major cause of the mortality variation. Table 16 shows how the percentage of smokers has changed for each socio-economic group between 1972 and 1988.

Table 16 - Percentage of men and women aged 16 and over[1] who smoke compared with those who have never smoked by socio-economic group between 1972 and 1988, Great Britain.

Year	Socio-Economic Group											
	Professional		Employers and Managers		Intermediate and Junior Non-Manual		Skilled Manual and Own-Account Non-Professionals		Semi-Skilled Manual and Personal Service		Unskilled Manual	
Men	Never	Current	Never	Current	Never	Current	Never	Current	Never	Current	Never	Current
1972	39	33	26	44	30	45	21	57	23	57	19	64
1974	43	29	25	46	30	45	22	56	22	56	18	61
1976	46	25	28	38	32	40	23	51	21	53	18	58
1978	49	25	29	37	34	38	25	49	22	53	22	60
1980	48	21	32	35	36	35	25	48	26	49	23	57
1982	46	20	32	29	41	30	28	42	25	47	26	49
1984	49	17	34	29	41	30	29	40	28	45	30	49
1986	50	18	34	28	42	28	27	40	29	43	32	43
1988	49	16	35	26	45	25	30	39	30	40	33	43
Women	Never	Current	Never	Current	Never	Current	Never	Current	Never	Current	Never	Current
1972	53	33	51	38	52	38	43	47	49	42	51	42
1974	59	25	49	38	51	38	44	46	48	43	47	43
1976	57	28	51	35	51	36	45	42	49	41	50	38
1978	56	23	48	33	52	33	46	42	48	41	47	41
1980	61	21	50	33	52	34	43	43	48	39	44	41
1982	58	21	52	29	55	30	45	39	50	36	44	41
1984	64	16	50	29	55	28	45	37	47	37	48	36
1986	62	19	50	27	55	27	45	36	49	35	49	33
1988	60	17	51	26	57	27	45	35	47	37	43	39

[1] Aged 15 and over in 1972

Source: General Household Survey

13.20 Whilst the percentage of smokers has fallen by 37% for males and 29% for females, those in the highest socio-economic group has fallen by 50% (for both sexes) and those in the lowest by 33% and 7% for males and females respectively. What is now clear for the top three socio-economic groups is that the majority of lives do not smoke. In particular, 49% of professional men and 60% of professional women have never smoked.

13.21 With such a large number of people giving up smoking it is necessary to consider the effects on mortality of smoking cessation. The US Surgeon General's 1988 report "The health benefits of smoking cessation" indicates that anyone who stops smoking gains major and immediate health benefits. Prospective studies have shown that by stopping smoking, many of the risks can be brought close to the non-smoking levels within 15 to 20 years *(12)*. However, in some studies *(15)(17)*, the mortality of ex-smokers increased in the first two years before falling. This may depend on whether the ex-smoker quit on doctor's orders or for any other reasons.

13.22 The excess mortality of smokers is not all directly due to smoking related diseases. Excess deaths are also due to the association of smoking with other risk factors, in particular, as they now form a distinct minority. From the study of British doctors, it was seen that cirrhosis of the liver was five times greater in smokers than in non-smokers, and suicide and poisoning was almost twice as high.

This is, in part, as a result of the close association between smoking and drinking. From the study of British doctors, heavy drinking increased progressively from 2% in those who have never smoked to 20% in those smoking 25 cigarettes or more a day.

13.23 Smoking status may, therefore, intuitively be considered a good measure of one's general well being and attitude to health. However, in the Health Survey for England *(5)* there was no clear relationship between smokers and high blood pressure, physical activity (except vigorous exercise and for those over age 45), obesity (in fact smoking suppresses appetite and, therefore, smokers are generally less obese and weight gain is a by-product of ceasing smoking). The Survey did show a weak positive link between smoking habit and total cholesterol level (but see paragraph 14.10).

13.24 The Health of the Nation targets for smoking are:-

- to reduce the prevalence of cigarette smoking to no more than 20% by the year 2000 for men and women;
- to reduce the consumption of cigarettes by at least 40% by the year 2000;
- to reduce smoking prevalence of 11-15 year olds to less than 6% by 1994.

14. SERUM CHOLESTEROL LEVEL

14.1 In analysing the risk factors for CHD Shaper states "The evidence that the serum total cholesterol level is the most important single factor in determining the risk of CHD in individuals is considerable, if not overwhelming" *(18)*.

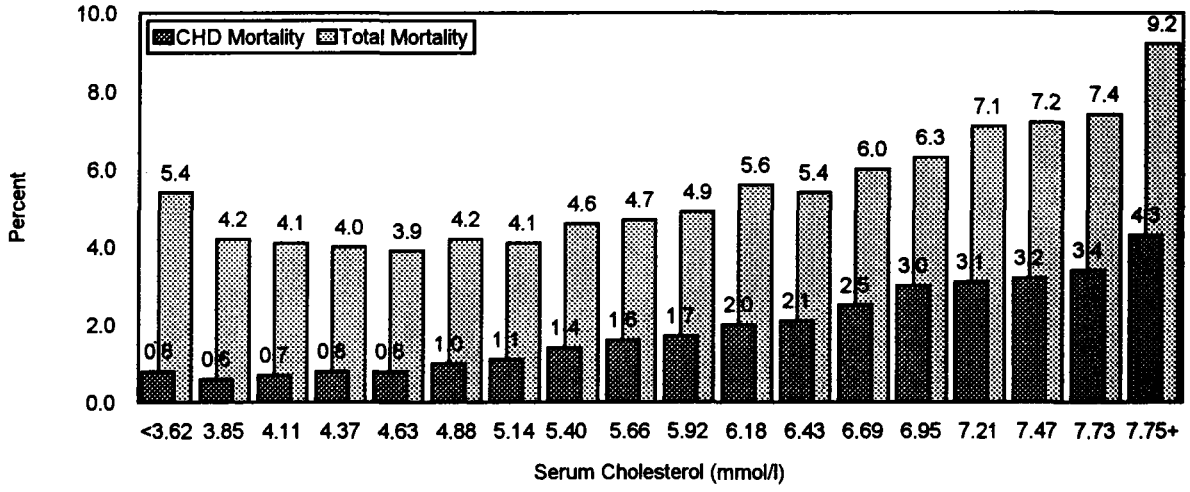
14.2 An important distinction should be drawn between plasma (or serum) cholesterol and dietary cholesterol. Both are independent risk factors for CHD. Whilst dietary cholesterol is not considered in this paper (as it is not measurable for insurance purposes) it should not be ignored. The risk of death for middle aged men who habitually consume dietary cholesterol at a level of 100mg/1000 kcal is 37% lower than that of men consuming 300mg/1000kcal *(19)*. Dietary cholesterol also influences serum cholesterol.

14.3 Serum cholesterol is transported in blood combined with specific proteins (lipoproteins). CHD is mainly linked with low density lipoproteins (LDL) which carry 60% to 70% of plasma cholesterol. LDL levels are affected by the dietary intake of saturated fat. A further 20% to 30% of plasma cholesterol is transported as high density lipoproteins (HDL). Although the exact mechanism is still not well understood, there is evidence that HDL is a protective factor for CHD which is independent from other risk factors. HDL levels may be reduced and the 'clearing' of cholesterol impaired, due to smoking, obesity and lack of exercise *(20)*.

14.4 One of the largest studies on the relationship between total blood cholesterol and CHD (and total mortality) was the Multiple Risk Factor Intervention Trial (MRFIT). This was a US study which involved screening 361,662 men aged 35 to 57 between November 1973 and November 1975. The group were followed up after ten years and the numbers of deaths caused by CHD and in total were recorded. Given the size of the sample, this study provides the most credible evidence of the blood cholesterol and CHD relationship.

The results of this study are shown in figure 17.

Figure 17 - Percentage of MRFIT Screenees (361,662) who died from CHD and all causes by serum cholesterol level after 10 years of follow up.



Source: L H Kuller - Assessing the Evidence: Risks and Benefits, Coronary Heart Disease Epidemiology 1992

14.5 Table 18 provides a more detailed age analysis of this data followed over six years. The results have been restricted to 325,348 white men *(21)*.

Table 18 - Six year, age specific total mortality rate (per 1,000 person years) by serum cholesterol quintile.

Age	6 Year Rates					
	< 4.7	4.7 - 5.2	5.2 - 5.7	5.7 - 6.3	> 6.3	Ratio Q5/Q2
35 - 39	6.6	5.4	6.3	7.8	10.2	1.9
40 - 44	9.7	9.2	12.6	13.2	19.3	2.1
45 - 49	18.5	18.1	19.6	20.7	27.7	1.5
50 - 54	30.3	25.4	27.1	31.8	39.0	1.5
55 - 57	45.8	43.3	42.0	44.8	52.1	1.2

Note:

i) The approximate quintiles are determined from the entire population

ii) Q5/Q2 is the ratio of quintile 5 to quintile 2. Quintile 2 was chosen as the lower limit, because those with very low cholesterol may be suffering from chronic illnesses and this confounds the results.

Source: Kannel, et al (1986)

14.6 From both these results there is a positive exponential association between blood cholesterol and CHD mortality and total mortality. It is likely that the MRFIT Study under-estimated the relationship between blood cholesterol and CHD mortality as blood cholesterol was only measured at the beginning of the trial. This is due to two factors:-

- Blood cholesterol levels fluctuate over time, which means a single measure can be higher or lower than the long term average value for the individual. Therefore, groups with the higher cholesterol concentrations also include those whose single measurement was higher than their long term average and vice versa. As a consequence, the results are narrowed and the effects are under-estimated. This is referred to as "regression dilution bias".

- During the follow-up period CHD mortality rates fell in the US. This may have also been due to a fall in blood cholesterol levels.

14.7 The MRFIT results suggest that the relationship between blood cholesterol and total mortality is J shaped. Whilst this effect is seen in shorter studies, such as MRFIT, it is not seen in longer studies such as the 30 year Framingham Study. Further research has shown that there is no evidence that low or reduced serum cholesterol in healthy lives increases mortality. However, cholesterol is lowered in preclinical cancer. There is also an association between depression and low cholesterol. This has led to a false association between low cholesterol and suicide *(22)*.

14.8 Serum cholesterol is a causal risk factor. Studies have shown that a reduction in serum cholesterol reduces the level of CHD mortality.

Peto has suggested that the true impact of a 10% reduction in cholesterol may be a 30% reduction in CHD *(23)*. In an Oslo study *(24)* diet and other risk factors, such as smoking were modified. This showed that a 10% reduction in cholesterol led to a 50% decline in CHD. There was also a reduction in total mortality on further follow up. The authors attributed most of the beneficial effect to diet, as anti-smoking measures were not very successful.

14.9 Whilst total cholesterol is a good predictor of CHD, the importance of HDL as a protective CHD factor and LDL as a bad CHD factor would suggest that ratios such as LDL/HDL or total cholesterol/HDL may further improve the risk assessment.

14.10 HDL tends to be low in overweight subjects, cigarette smokers and sedentary subjects *(25)*. Whilst cigarette smoking lowers HDL it is not associated with low total cholesterol. The Health Survey for England showed an increase in total cholesterol amongst smokers. This is because the LDL fraction is increased as smokers usually eat more saturated fat *(26)*.

14.11 Another consideration in the measuring of blood cholesterol level is familial hypercholesterolaemia (see paragraph 20.5). This is a genetic disorder of the lipoproteins. Heterozygous familial hypercholesterolaemia has been estimated to affect about one in 500 of the British population. Most affected subjects remain undiagnosed.

14.12 The MRFIT study also showed that drug treated diabetes increased the CHD mortality risk by more than three times, compared with non-diabetic men *(27)*.

14.13 Most blood cholesterol studies have concentrated on men, due to the much higher level of CHD mortality. However, elevated blood cholesterol is also a risk factor for CHD in women, although there is some evidence that it is only a weak risk factor, particularly in pre-menopausal women (see section 25).

14.14 A report from the World Health Organisation *(28)* set the desirable mean cholesterol level at less than 5.2 mmol/l. A US conference *(29)* considered desirable levels to be age related, with 5.2 mmol/l for those over age 30 and 4.7 mmol/l for younger adults. However, there are no fixed cut off points as the risk is exponential. The British Hyperlipidaemia Association recommends dietary counselling above 5.2 mmol/l and drug therapy above 6.5 mmol/l.

14.15 Table 19 shows the level of blood cholesterol in England by age and sex.

Table 19 - Mean and percentage distribution of serum total cholesterol by age and sex.

Adults Aged 18 and Over					
	Age				
Total Cholesterol (mmol/l)	18 - 24 %	25 - 34 %	35 - 44 %	45 - 44 %	55 - 64 %
Men					
Less than 5.2	67	44	27	18	17
5.2, Less than 6.5	28	40	46	46	45
6.5, Less than 7.8	4	13	22	31	32
7.8 or More	2	3	5	6	6
Mean	4.80	5.40	5.82	6.15	6.16
Women					
Less than 5.2	62	53	42	18	8
5.2, Less than 6.5	34	39	43	51	35
6.5, Less than 7.8	4	7	12	24	42
7.8 or more	-	1	2	7	15
Mean	4.87	5.14	5.43	6.05	6.71

Note:

i) The table only includes informants not taking lipid lowering drugs.
ii) Due to individual rounding, the figures do not always add up to 100.

Source: Health Survey for England 1991 and 1992 combined.

14.16 The table shows that the average serum total cholesterol level in England is much higher than the desirable level of 5.2 mmol/l or less; only in the youngest age band was this level achieved. Social class had very little effect on the mean serum total cholesterol.

14.17 For both men and women, apart from age, only the Body Mass Index was significantly associated with cholesterol after allowing for the effect of the other variables. For example, whilst there is an underlying association with physical activity, this virtually disappeared when age was taken into account. Analysis of the standard risk factors (age, smoking, alcohol, BMI, physical activity) accounted for 17.7% of the total variation in men and 34.3% of the total variation in women *(5)*. The remaining variation cannot be put down to any individual lifestyle factor. Where the analysis included education, marital status, social class, tenure and region, none of these factors were shown to be independent. This conclusion may indicate that there is not a sufficiently good proxy for cholesterol level and individuals need to be directly tested.

14.18 The Health of the Nation target for lowering cholesterol is directed at reducing the dietary intake of total and saturated fatty acids by 12% and 35% respectively by 2005.

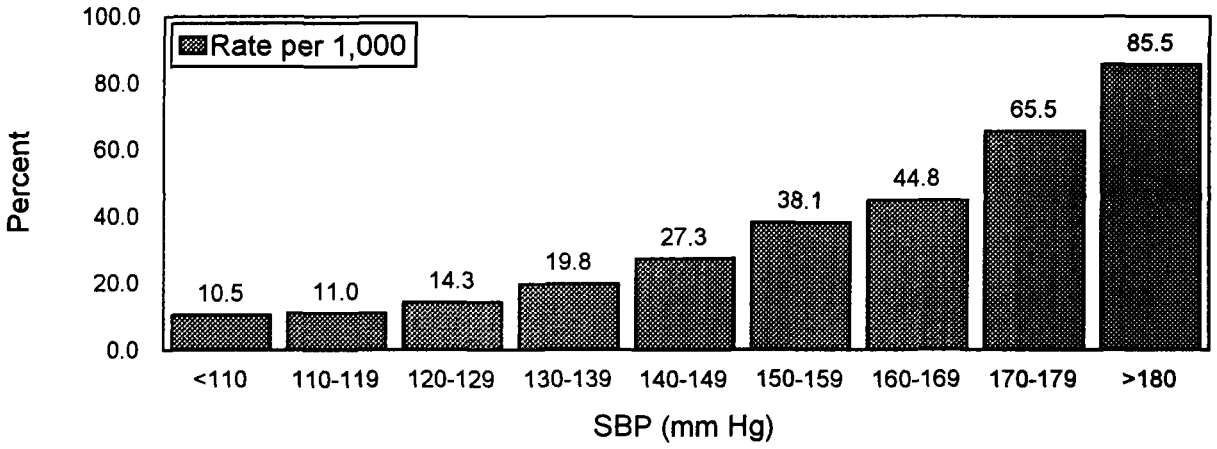
15. BLOOD PRESSURE

15.1 Raised blood pressure levels are associated with a wide range of disorders, including hypertensive heart disease, stroke, CHD and renal failure. Apart from smoking and blood cholesterol, blood pressure is considered to be the other major modifiable risk factor associated with CHD. It has also been shown that there is a largely unexplained association between levels of blood pressure and cancer (even after adjusting for smoking habit, alcohol and other possible cancer predictors) *(30)*. In one study there was also a direct relationship between blood pressure and violent death, even after repeated analyses at different lengths of follow up *(30)*.

Factors such as excess alcohol consumption, obesity and salt intake contribute to raised blood pressure.

15.2 The MRFIT trial provided the largest sample of data to analyse blood pressure. Once again the results have been restricted to men who identified themselves as white *(31)*. The results of the study are shown in figure 20.

Figure 20 - Baseline Systolic Blood Pressure and Age Adjusted 10 Year Cardiovascular Mortality for 347,978 MRFIT Primary Screenees.



Note: Men free of myocardial infarction history at baseline.

Source: R Stamler (1992)

15.3 The figure shows that the mortality risk increases exponentially at every level of systolic blood pressure above < 110 mmHg. Another study on the MRFIT data shows that systolic blood pressure was a stronger predictor of CHD mortality than diastolic blood pressure *(32)*.

15.4 In addition, increasing systolic blood pressure was more strongly associated with increasing age. This rise in blood pressure is not an inevitable human ageing condition, but reflects a Western lifestyle. This was shown by the INTERSALT study, which examined 10,079 men and women aged 20 to 59 in 52 centres in 32 countries *(31)*. In four remote populations the increase in blood pressure with age was negligible.

15.5 Blood pressure is a causal risk factor and, therefore, mortality would reduce with a reduction in blood pressure. Table 21 shows how mortality would fall with lower systolic blood pressure levels. The results are based on data from a number of prospective studies.

Table 21 - Potential for lower mortality with lower average population Systolic blood pressure.

Reduction in Mortality (%)			
Average SBP (mmHg) Lower By:	Coronary Deaths	Stroke Deaths	All Deaths
2	4	6	3
3	5	8	4
5	9	14	7
Based on combined multiple regression coefficients from five population studies: 360,000 male screenees from MRFIT, men in the Whitehall Civil Servants Study, men in the Western Electric Company Study, 40,000 men and women in the Chicago Heart Association Detection Project in Industry, and men and women in the Framingham Study.			

Source: R Stamler (1992)

15.6 The Framingham Study 30 - year follow up provides an analysis of how systolic blood pressure is linked with all cause mortality. This is shown in table 22.

Table 22 - Average annual mortality rate per 1000 lives from the Framingham 30 year follow up.

Average Annual Mortality Rate Per 1,000 Persons for Males						
Systolic Blood Pressure (mmHg)	Age 35 - 44		Age 45 - 54		Age 55 - 64	
	Males	Females	Males	Females	Males	Females
74 - 119	2	2	7	5	12	7
120 - 139	2	1	7	3	15	6
140 - 159	2	3	9	6	16	7
160 - 179	10	3	15	6	19	12
180 - 300	9	20	20	10	36	16
Ratio Bottom/Top	4.5	10.0	2.9	2.0	3.0	2.3

Source: Framingham Study, 30 Year Follow Up

15.7 The table shows a strong correlation between systolic blood pressure and mortality. Across all ages, the mortality ratio between the groups with the highest and lowest systolic blood pressure readings is 3:1. This applies to both males and females.

15.8 It is necessary to set some guidelines over what is considered to be acceptable blood pressure levels. It is generally assumed that blood pressure of up to 120/80 mmHg is desirable and blood pressure over 160/95 mmHg is hypertensive.

15.9 Table 23 shows the systolic blood pressure in England by sex and age.

Table 23 - Systolic blood pressure by age and sex.

Systolic Blood Pressure (mmHg)	25- 34 %	35 - 44 %	45 - 54 %	55 - 64 %
Men				
Less than 120	15	11	10	4
120 - 129	28	25	23	12
130 - 139	32	35	30	20
140 - 149	19	19	19	23
150 - 159	6	7	12	18
160 - 169	1	2	5	9
170 or over	-	1	1	14
Mean	132	134	137	147
Women				
Less than 120	37	35	17	6
120 - 129	36	29	25	15
130 - 139	17	20	24	19
140 - 149	7	10	16	21
150 - 159	1	3	10	15
160 - 169	1	2	3	9
170 or over	1	2	5	16
Mean	124	126	135	147

Source: Health Survey for England 1991 and 1992 Combined

15.10 The table shows that over 80% of adult males 25 to 54 have higher than desirable blood pressure, although they are not hypertensive. These individuals still have an increased cardiovascular risk.

15.11 The survey also confirms that in England mean systolic blood pressure increases with age. In addition, the survey showed a link between increasing blood pressure and lower social class, a strong male association between alcohol consumption and blood pressure, and a strong association between Body Mass Index and blood pressure. There was no clear association between smoking and blood pressure.

15.12 The Health of the Nation target is to reduce mean systolic blood pressure in the adult population by at least 5 mmHg by 2005.

16. THE INTER-RELATIONSHIP BETWEEN SMOKING, CHOLESTEROL LEVEL AND BLOOD PRESSURE

16.1 The previous sections considered the evidence that smoking, blood cholesterol and blood pressure are major independent risk factors in the incidence of CHD mortality and total mortality. Whilst the analysis of individual risk factors is extremely important, it is vital to also understand how different combinations of risk factors influence CHD mortality. Is this additive or multiplicative?

16.2 The MRFIT study provides sufficient data to carry out a multivariate analysis. Table 24 shows the results of the MRFIT twelve year follow up study of 342,815 men free of heart attack and diabetes *(27)*.

Table 24 - MRFIT Study of the interrelation of smoking, serum cholesterol and systolic blood pressure in age-adjusted CHD mortality per 10,000 person years, by serum cholesterol and systolic blood pressure quintiles.

Serum cholesterol (mmol/l)	Systolic pressure (mmHg)					
	< 118	118 - 124	125 - 131	132 - 141	142 +	Q5/Q1
Non Smokers						
< 4.7	3.09	3.72	5.13	5.35	13.66	4.42
4.7 - 5.2	4.39	5.79	8.35	7.66	15.80	3.60
5.2 - 5.7	5.20	6.08	8.56	10.72	17.75	3.41
5.7 - 6.3	6.34	9.37	8.66	12.21	22.69	3.58
6.3 +	12.36	12.68	16.31	20.68	33.40	2.70
Q5/Q1	4.00	3.41	3.18	3.87	2.45	-
Smokers						
< 4.7	10.37	10.69	13.21	13.99	27.04	2.61
4.7 - 5.2	10.03	11.76	19.05	20.67	33.69	3.36
5.2 - 5.7	14.90	16.09	21.07	28.87	42.91	2.88
5.7 - 6.3	19.83	22.69	23.61	31.98	55.50	2.80
6.3 +	25.24	30.50	35.26	41.47	62.11	2.46
Q5/Q1	2.43	2.85	2.67	2.96	2.30	-

Note:

i) The approximate quintiles are determined from the entire population.
ii) Q5 is quintile 5; Q1 is quintile 1.

Source: J Stamler (1992)

16.3 The table shows the following results:-

- At every level of systolic blood pressure, the risk of CHD death rises with higher serum cholesterol, for both non-smokers and smokers.

- For non-smokers in the highest serum cholesterol group, compared with the lowest group, the relative risk ranges from 2.45 to 4.00, depending on systolic blood pressure.

- For smokers, the relative risk for serum cholesterol, as described above, is less than for smokers, varying between 2.3 and 2.96.

- The same analysis by systolic blood pressure, varying with serum cholesterol, produces relative risks of between 2.70 and 4.42 for non-smokers and between 2.46 and 3.36 for smokers.

- Other studies have shown that the relative risk factors are even stronger at younger ages and slightly weaker at older ages.

16.4 These results are based on measurements from a single visit and, therefore, as explained earlier are subject to "regression dilution bias". The results clearly show that these principal risk factors are multiplicative in nature. This serves to underline the importance of assessing overall CHD risk rather than individual risk factors in isolation.

- For non-smokers the absolute CHD mortality risk varies from 3.09 to 33.40 per 10,000 person-years. The risk depending on serum cholesterol and systolic blood pressure can, therefore, vary by a factor of almost 11.

- For smokers the absolute CHD mortality risk varies from 10.37 to 62.11 per 10,000 person-years. The problem is, therefore, qualitatively similar to non-smokers, but quantitatively much worse.

- Given that these risk factors are modifiable, it can be seen that the relative risk of CHD death is 20 times higher amongst a smoker in both the highest systolic blood pressure and serum cholesterol groups, compared with a non-smoker in the lowest groups for both systolic blood pressure and serum cholesterol.

17. WEIGHT

17.1 Obesity is another risk factor associated with CHD. In addition, it can increase the risk of stroke, certain cancers and non-insulin dependent diabetes. Obesity is closely associated with increased levels of blood pressure, serum total cholesterol and blood glucose and decreased levels of both physical activity and the protective HDL cholesterol *(33)*.

17.2 The most common and recognised measure of obesity is the body mass index, which is also known as Quetelet's index. This is calculated by applying the following formula:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height(m)}^2}$$

17.3 Body Mass Index is graded to indicate the degree of risk to health. This is as follows:

- BMI <20 is underweight
- BMI 20-24.9 is desirable
- BMI 25-29.9 is overweight
- BMI 30-40 is obese
- BMI >40 is severely obese

17.4 The BMI does have faults, as it does not take account of the relative distribution of fat, nor does it distinguish between fat and muscle. People's shape as well as their weight is important. A high waist:hip ratio (an "apple" shape) is more strongly associated with cardiovascular disease and non-insulin dependent diabetes, than a low waist:hip ratio (a "pear" shape). The cut off ratios associated with increased health risks are 1.00 for men and 0.85 for women *(34)*.

17.5 Life insurance companies have always recognised that over-weight applicants have a higher mortality risk. Studies of BMI and mortality have shown that as BMI increases so does total mortality. Although this is distorted by the fact that smokers tend to weigh less than non-smokers.

17.6 Traditionally, this relationship has been viewed as the result of changes in the associated risk factors (i.e. elevated blood pressure, cholesterol and blood glucose), however, it is now recognised that obesity is itself an independent risk factor. In the 26 year follow up of participants in the Framingham Heart Study, Hubert and colleagues reported that, even allowing for the associated risk factors, weight was a significant predictor of cardiovascular disease *(35)*.

17.7 Table 25 shows the results of a study of 750,000 men and women by the American Cancer Society over the period 1959 to 1972 *(36)*.

Table 25 - Mortality ratios for all ages combined according to smoking habits in relation to those 90% to 109% of average weight.

	Percentage of Average Weight						
	85%	80% - 89%	90% - 109%	110% - 119%	120% - 129%	130% - 139%	140% +
Males							
Never Smoked	0.88	0.75	0.75	0.91	0.98	1.16	1.69
20 + Cigarettes	1.68	1.40	1.34	1.53	1.76	2.00	2.21
Other	1.22	1.01	0.93	1.04	1.15	1.29	1.66
Total	1.25	1.05	1.00	1.15	1.27	1.46	1.87
Females							
Never Smoked	1.10	0.88	0.93	1.08	1.20	1.37	1.74
20 + Cigarettes	1.98	1.59	1.64	1.82	2.22	2.30	2.73
Other	1.53	1.13	1.12	1.40	1.42	1.62	2.04
Total	1.19	0.96	1.00	1.17	1.29	1.46	1.89

Source: E Law and L Garfinkel (1978)

17.8 The table shows that for both smokers and non-smokers the mortality by weight is U-shaped. For non-smokers more than 140% overweight their mortality ratio compared to 90-109% was over 2.20. The Framingham Study showed an even greater association *(37)*. Their 30 year mortality ratio (of greater than 110% of desirable weight to 100-109% of desirable weight) was 3.9 for non-smokers. For overweight smokers, compared with desirable weight non-smokers, the mortality ratio was 9.8.

17.9 Another study concluded that severe obesity (BMI greater than 40) is associated with a 12 fold increase in mortality in persons aged 25 to 35 years and a 6 fold excess in the age group 35 to 44 years *(38)*.

17.10 The high mortality amongst underweight lives may be as a result of some underlying disease process, as most chronic illnesses tend to cause loss of weight.

17.11 Table 26 shows how BMI varies according to age, social class and sex in England.

Table 26 - BMI by social class of head of household, age and sex.

BMI	Men					Women				
	Social Class of Head of Household				Total %	Social Class of Head of Household				Total %
	I and II %	III Non-Manual %	III Manual %	IV and V %		I and II %	III Non-Manual %	III Manual %	IV and V %	
Age 16 - 44										
20 or less	9	7	7	7	8	13	9	12	12	12
Over 20 - 25	49	42	45	52	48	57	58	49	53	55
Over 25 - 30	33	44	38	29	35	21	22	26	21	22
Over 30	10	7	10	12	10	8	11	13	14	11
Age 45 - 64										
20 or less	1	2	4	3	3	5	2	3	2	4
Over 20 - 25	30	34	28	29	29	60	31	31	33	39
Over 25 - 30	49	42	54	54	51	29	47	36	33	34
Over 30	20	22	14	14	18	16	20	29	32	24

Source: Health Survey for England 1991 and 1992 combined

17.12 The table shows that for males there is no clear relationship with social class. However, for females obesity increases in the lower social classes.

17.13 The results of the survey also showed that smokers tend to be thinner than non-smokers and that stopping smoking led to an increase in BMI. In addition, the survey showed that BMI was inversely related to physical activity.

17.14 In the UK there has been a substantial increase in BMI over the past decade and now over half the male adult population and just under half the female population are overweight.

17.15 In the Health of the Nation White Paper a target has been set to reduce the percentage of men and women aged 16 to 64 who are obese from 8% and 12% (measured in 1986/87), to 6% and 8%, respectively. However, there has actually been an increase in obesity to 13% and 15% for men and women respectively.

18. ALCOHOL CONSUMPTION

18.1 Alcohol is a feature of many people's lives in the UK and is felt to be socially acceptable, in moderation. However, excess alcohol consumption can result in increased risks of morbidity and mortality, as well as social problems.

18.2 Alcohol intake increases the blood concentration of HDL-cholesterol (by about 15% to 20% in heavy drinkers) *(18)* and this has led to the conclusion that alcohol can reduce the risk of CHD. In addition, alcohol reduces the tendency for the blood to clot.

18.3 Nevertheless, Marmot and Brunner concluded that "...the balance of harm and benefit does not weigh in favour of making recommendations to the public to drink in order to prevent coronary heart disease" *(39)*.

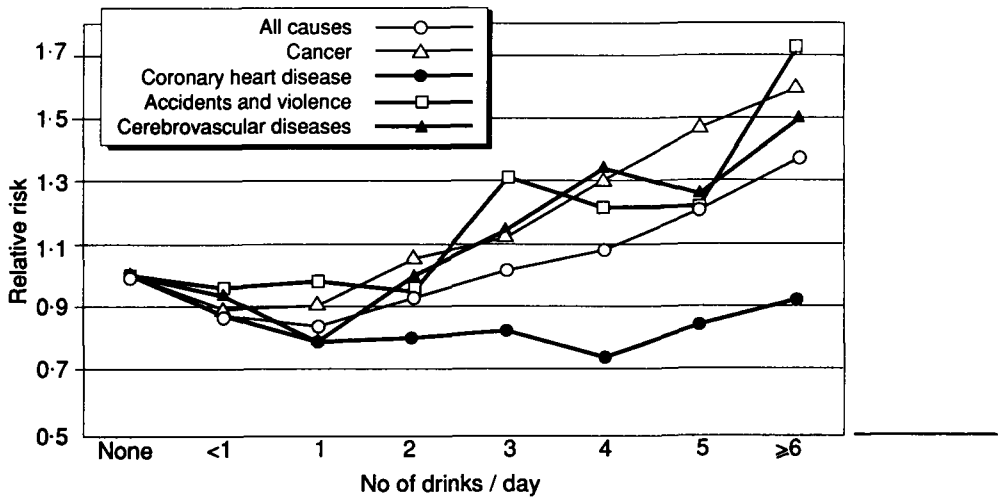
18.4 However, there is a linear relationship between alcohol intake and blood pressure, which is independent of age, weight and cigarette smoking *(40)*. This was accentuated where daily alcohol consumption was more variable (ie binge drinkers). This leads to an increased risk of stroke. In addition, alcohol causes chronic liver damage; mortality from cirrhosis of the liver has increased 224% in men aged 35 to 44, between 1974 and 1991. It is also the single most common factor in many accidents and accounts for about 15% of deaths from road traffic accidents *(41)*.

Alcohol has also been linked to some cancers, and suicide.

18.5 The relationship between alcohol consumption and the risk of mortality from all causes is U-shaped. Heavy drinkers have an increased risk of death compared with moderate drinkers, but moderate drinkers have a lower risk than abstainers. This is due largely to the lower death rate from CHD of moderate drinkers.

18.6 The following graph shows the relationship between alcohol consumption and relative risk of death. The results come from a 12 year American Cancer Study of 276,802 men aged 40 to 59 *(39)*.

Figure 27 - Mortality Ratios by major cause of death adjusted for age and smoking habit.



Source: Marmot and Brunner (1991)

18.7 The lowest all cause mortality was at about one drink per day. The most recent study of British doctors reported that those who drank between one and two units of alcohol per day had the lowest mortality *(42)*. A recent study in Denmark showed the lowest risk to be one to six drinks per week *(43)*.

18.8 It is interesting that non-drinkers have a higher death rate than light and moderate drinkers. Whilst this may be slightly confounded by those who have given up because they are unwell, this does not explain the effect, which has been seen in many studies and has not diminished with time.

18.9 The Danish study *(43)* also examined the relationship between sex, age, BMI and smoking on alcohol intake and mortality. This concluded that the lowest risk was observed at one to six drinks per week. Abstainers had a 37% increased risk and those drinking more than 70 drinks per week had a 129% increased risk. The U-shaped curve was not affected by sex, age, BMI or smoking. However, if the relative risk for a lean (BMI of 20 to 25) non-smoker who consumes one to six drinks per week was 1.0, then the lowest relative risk for an obese non-smoker increased to 1.5. For lean and obese smokers (>20g tobacco per day), the lowest relative risks were 3.5 and 5.0 respectively. A heavy drinker (>69 drinks per week) who also smoked had the greatest relative risk of more than 9.0.

18.10 There is some evidence to support the theory that wine, in particular red, is better than other forms of alcohol. This may be due a natural fungicide found on grape skins, which appears to raise the levels of HDLs.

18.11 The UK medical profession advises that sustained alcohol consumption in excess of 21 units per week for men and 14 units per week for women is likely to lead to increased health risks. Over 50 units per week for men and 35 for women is definitely dangerous.

18.12 Whilst there may be some debate about optimum number of drinks per week, it is clear that most people do not know what constitutes a unit of alcohol and under-estimate their consumption, possibly by more than 50%.

18.13 The Health Survey for England showed that the younger age groups tended to drink slightly more than the older groups and that the highest socio-economic groups drank slightly more than the lowest. It is also noteworthy that 15% of men and 17% of women drank nothing, or less than one unit per week. This was slightly lower at the youngest ages and the highest socio-economic groups.

18.14 The Health of the Nation target is to reduce the proportion of men drinking more than 21 units of alcohol per week from 28% in 1990 to 18% by 2005 and to reduce the proportion of women drinking more than 14 units of alcohol per week from 11% in 1990 to 7% by 2005.

19. PHYSICAL ACTIVITY

19.1 The observation that physical activity can protect against CHD was first made in the early 1950's. In 1953 a report was published on CHD among London Transport Workers. This showed that physically active conductors on double decker buses experienced under half the incidence of CHD than less active bus drivers *(44)*. However, whilst the study has been subsequently challenged, on the basis of self selection (drivers tended to be more over weight, had higher blood pressure, etc even at hiring), this landmark study stimulated interest in the relationship between physical activity level and CHD.

19.2 The scientific evidence that physical activity benefits health accumulated over the next forty years, such that physical inactivity has become a recognised risk factor for CHD in men. Studies have shown that the inverse relationship between physical activity and CHD is independent of other CHD risk factors and is of the same order of magnitude as that due to smoking, blood cholesterol and blood pressure *(45)*.

19.3 The health benefits of regular aerobic exercise are that individuals have both a lower heart rate and lower blood pressure, even at rest. This means that the cardiovascular system needs to work less hard, particularly when called upon to increase effort. This, therefore, reduces the risk of acute episodes, such as heart attack or stroke. In addition, physical activity may also modify other risk factors. For example, an increase in regular aerobic activity increases HDL cholesterol, which protects against CHD. It also helps control non-insulin-dependent diabetes mellitus and helps maintain bone density, thus reducing the risk of osteoporosis. However, some of these effects may have been an indirect consequence of a reduction in body fat as a result of the exercise routine *(46)*.

19.4 The general lack of physical activity in the population is possibly greater than the prevalence of any of the other risk factors. A US study , the 1988 Behavioral Risk Factor Surveillance System, showed that the most prevalent risk factor was a sedentary lifestyle (58%), followed by serum cholesterol greater than 5.2 mmol/l (31%), cigarette smoking (25%), obesity measured by Body Mass Index greater or equal to 27.8 -men and 27.3 - women (22%), hypertension (17%) and diabetes (5%).

19.5 A US study, the Aerobics Centre Longitudinal Study (1970 to 1985) of 10,224 men and 3,120 women, with no pre-existing disease, followed up over eight years reported that age adjusted all cause mortality decreased with increasing physical activity *(47)*. This is shown in table 28.

Table 28 - Age-adjusted all-cause mortality rates per 10,000 person years of follow up (1970 to 1985) by physical fitness groups.

Fitness Group	Age-Adjusted Rates per 10,000 Person-Years	Relative Risk
Male		
1 (low)	64.0	3.44
2	25.5	1.37
3	27.1	1.46
4	21.7	1.17
5 (high)	18.6	1.00
Women		
1 (low)	39.5	4.65
2	20.5	2.42
3	12.2	1.43
4	6.5	0.76
5 (high)	8.5	1.00

Source: Blair, et al (1989)

Note:

i) Participants who did not achieve 85% of their age-predicted maximal heart rate were excluded as they were more likely to have a pre-existing disease or be receiving medication.

ii) The physical fitness categories were determined based on age and sex norms of treadmill performance, rather than by an absolute fitness standard.

19.6 These trends remained, even after statistical adjustment for age, smoking habit, cholesterol level, systolic blood pressure, fasting blood glucose level, family history and follow-up period.

19.7 In order to obtain health benefits, the exercise must be current. This was shown by a cohort study of 19,1936 Harvard alumni who had entered Harvard between 1916 and 1950. Those free of apparent heart attack were followed until the earlier of heart attack, death, age 75, or 1972. A physical activity index in kcal per week was derived from a questionnaire. This showed a sharp reduction in non-fatal and fatal heart attack rates up to an activity level of 2000 to 2999 kcal per week; beyond this level no further significant change was apparent. More importantly, previous physical activity did not confer a lower risk. In fact, there may be some evidence to indicate that intensive previous physical activity, followed by none is a worse combination. This can be seen from table 29.

Table 29 - First heart attack rate (per 10,000 person years) among Harvard male graduates in a six to ten year follow up.

University Athlete	Physical Activity in Adult Life		
	Low	Medium	High
No	71	53	35
Yes	93	45	35
low = < 500 kcal/week; medium = 500 - 1,999 kcal/week; high = > 2,000 kcal/week			

Note: Examples of energy expenditure are:-

squash, jogging	*7.5 kcal/min*
social dancing	*5.0 kcal/min*
golf, light gardening	*2.0 kcal/min*

Source: Paffenberger, et al (1978)

19.8 This study is interesting because it was carried out among individuals from the highest social class. In addition, university athletes would be considered a self-select group and, this alone, should have conferred a lower risk.

19.9 Guidelines which are now widely accepted in the UK are that moderate or vigorous exercise should be taken on at least three occasions per week and each should last at least twenty minutes. Table 30 shows the level of physical activity in England.

Table 30 - Physical activity level by age and sex.

Activity Level	25-34 %	35-44 %	45-54 %	55-64 %
Men				
Level 5	17	9	6	1
Level 4	16	15	7	4
Level 3	26	29	40	35
Level 2	17	16	20	13
Level 1	15	17	15	18
Level 0	8	15	12	28
Women				
Level 5	6	4	2	1
Level 4	14	7	10	3
Level 3	31	34	46	38
Level 2	21	25	17	19
Level 1	17	23	14	18
Level 0	12	8	12	20

Note: Activity level is based on the total number of occasions of moderate or vigorous intensity activity, of at least 20 minutes duration, during the previous four weeks:

Level 5 *12 or more occasions of vigorous activity*
Level 4 *12 or more occasions of a mix of moderate and vigorous activity*
Level 3 *12 or more occasions of moderate activity*
Level 2 *5 - 11 occasions of a mix of moderate and vigorous activity*
Level 1 *1 - 4 occasions of a mix of moderate vigorous activity*
Level 0 *none*

Source: Health Survey for England 1991

19.10 This table shows that activity level falls with age and, in the oldest age group, where CHD is the highest, only one in twenty males exercise sufficiently. Women also exercise far less frequently than men. For all age groups over 75% of men and women fell below an acceptable activity level. This is, therefore, an enormous population risk.

19.11 The survey also showed that individuals from social classes I and II were more likely to reach levels 4 and 5 and less likely to fall into level 0.

20. FAMILY HISTORY

20.1 Family history is another risk factor, but unlike smoking, cholesterol, exercise, build and alcohol intake, it is not modifiable. It, therefore, falls into the same categories as age and gender, which are fixed risk factors. The use of family history has strong undertones of identifying genetic weaknesses. However, not all family history events are genetic and may be due to, or influenced by, both environmental and social factors. This paper will limit itself to the evidence that genetics plays an important part in determining life-span and will not comment on the issues surrounding genetic testing.

20.2 There is a strong relationship between family history and cardiovascular disease. In the 1983 Medical Impairments Study, the Standardised Mortality Ratio (SMR) for a family history of cardiovascular disease was 189%for men and 121% for women. The highest mortality ratios were observed in policyholders under age 40 who had an SMR of 237% and 131% for men and women respectively.

20.3 Whilst it is commonly accepted that a bad family history of cardiovascular disease, especially CHD, is an important risk factor for CHD, it is probably the result of the interaction between genetic factors, lifestyle and environmental influences. It is more difficult to determine, however, whether a positive family history is an independent risk factor.

20.4 In the Framingham Study *(49)* siblings with a brother with documented CHD had more than double the risk of a CHD event which was not accounted for by shared risk factors. The data was also used to determine whether a parental history of death from CHD before age 65 was an independent risk factor for CHD. This showed that the relative risk of an early CHD event was 1.5. This effect was not explained by other risk factors. The study also showed that parental history (of late CHD) was a strong predictor of CHD occurring beyond age 60.

20.5 Another impairment that shows the importance of family history is familial hypercholesterolaemia which is a genetic disorder which affects one in 500 lives. A study *(50)* between 1980 and 1989 of 526 patients aged 20 to 74 with heterozygous familial hypercholesterolaemia revealed that the SMR was the highest between ages 20 and 39 at 902. There was no significant difference between men and women. However, patients who survived through middle age seemed no longer to be at a substantially increased risk.

20.6 Table 31 attempts to analyse the number of lives in England where their parents died of a cardiovascular disease. The table is biased by the fact that some lives whose mother or father died of a cardiovascular disease at a young age will already have died.

Table 31 - Parental history and age at death from cardiovascular disease by age and sex of informant.

	Men	Women
	%	%
Informants Aged 45 - 54		
Mother		
Died from CVD Conditions:		
Before Aged 65	4	5
Aged 65-74	7	9
75 and Over	7	6
Died from Non-CVD Conditions	27	25
Cause of death not known	4	2
Father		
Died from CVD Conditions:		
Before Aged 65	10	12
Aged 65-74	13	12
75 and Over	10	7
Died from Non-CVD Conditions	39	38
Cause of Death Not Known	4	4
Informants Aged 55 - 64		
Mother		
Died from CVD Conditions:		
Before Aged 65	3	7
Aged 65-74	11	9
75 and Over	13	19
Died from Non-CVD Conditions	46	41
Cause of Death Not Known	7	4
Father		
Died from CVD Conditions:		
Before Aged 65	9	9
Aged 65-74	12	10
75 and Over	13	13
Died from Non-CVD Conditions	54	54
Cause of Death Not Known	5	8

Note: The remainder of mothers and fathers are still alive.

Source: Health Survey for England 1991 and 1992 combined

20.7 The table shows that 10% of fathers and 5% of mothers died from a cardiovascular disease before age 65.

20.8 A genetic link has also been identified for obesity. One study *(33)* found that two out of three obese patients had parents where one or both were also obese. Whilst this could have been environmental, another study reported a closer correlation between weights of adopted children and their natural parents, rather than their adoptive parents. This, therefore, supported a genetic explanation.

20.9 Environmental factors are also important. For example, children with parents who smoke are more prone to respiratory disorders and cancer in adulthood. This may explain a number of cancers. However, there are certain cancers which have a high incidence in one family, for example female breast cancer, and this has been associated with a mutant gene.

20.10 Mortality also varies by ethnic group, for example mortality from CHD is higher in people from the Indian subcontinent and stroke mortality is higher in people from the Caribbean and Africa. The reasons for these variations are not fully understood and could be environmental, however they cannot be fully explained by other risk factors. One report *(51)* concluded that "..ethnic differences in death rates from myocardial infarction appear to result more from genetic than, for example, from dietary factors".

20.11 One report *(52)* took a balanced view of the arguments. It stated that "geneticists increasingly emphasise the interplay between genetic pre-disposition and environment, as opposed to older notions of genetic determinism".

21. SOCIAL CLASS

21.1 There is a wide variation in mortality experience according to occupation. Whether occupation is an independent risk factor, or can be explained by the prevalence of other risk factors is an important issue and will be examined later in this section.

21.2 The use of occupational information, collected at census and death registration, provides valuable information about the relative mortality levels by occupation. However, the use of a large number of separate occupations can be unwieldy and ,therefore, it is common to group broadly similar occupations into social groups. This method is deemed to be simple and robust, although it loses information on occupational differences within social classes. The OPCS sub-divide occupations into six social classes:-

- I Professional
- II Lower Professional and Executive
- IIIN Skilled Non-manual
- IIIM Skilled Manual
- IV Semi-skilled
- V Unskilled

21.3 The use of the census data and death registrations to calculate social class mortality is open to criticism due to the fact that information given at the census and on death are not always consistent. In fact one study showed that only three-quarters of occupations classified at death matched their census (1971) social class record. These problems have been overcome by the use of the OPCS Longitudinal Study, which consists of a 1% sample of the 1971 population of England and Wales. The Longitudinal Study contains information on individuals from vital events since 1971, including deaths. As it follows individuals over time it provides a valuable source of information on trends in mortality by social class, with occupation details based on census data.

21.4 Table 32 shows the SMRs among men aged 16 to 64 using the Longitudinal Study data, based on the 1981 social class.

Table 32 - Mortality among men aged 16 to 64 between 1981 and 1985 by social class at the 1981 Census.

Social Class	Standardised Mortality Ratio
I	58
II	77
IIIN	93
IIIM	98
IV	107
V	130
Unclassified	204
All men	100

Note:

i) Within a social class individual occupation standardised mortality ratios will vary considerably.

ii) The unclassified group includes a large proportion of both those with pre-existing illnesses and those who were out of work.

Source: Mortality Statistics by Social Class, 1971-85 - OPCS Population Trends 56

21.5 The table clearly shows that there is a wide mortality differential between social classes. Based on the 1981 census and deaths between 1981 and 1985, the mortality ratio between Class V and Class I is over 2:1.

21.6 Making meaningful comparisons by social class is notoriously difficult and considerable caution should be exercised. In particular, the occupational structure and classifications were different for 1971 and 1981. In 1971 the social class classification was based on the general standing of the occupation in the community and in 1981 it was based on an assessment of skill.

21.7 The mortality in the years immediately following a census is also affected by the non-classification of many of those with pre-existing illnesses. This was a particular problem in 1971. As a result, mortality differentials are initially depressed after a census and subsequently widen.

21.8 Despite the data limitations, there is evidence of an increase in social class differences. This was confirmed by study of mortality differentials in Northern England between 1981 and 1991 *(53)*, which showed that mortality differentials had widened, primarily due to improvements in mortality in the most affluent areas and, at best, static mortality in the poorest areas.

21.9 The inverse relationship between mortality and social class and a widening of these differences is also a feature of the US population *(54)*.

21.10 The Whitehall Study of civil servants *(55)* provides additional information in trying to explain these differences. The study followed 17,530 male civil servants, classified according to their employment grade, between 1969 and 1979. The data was particularly useful, because all the men were in stable sedentary jobs and based in London. The results of the analysis are shown in table 33.

Table 33 - All cause mortality in 10 years by Civil Service grade and age.

Grade (In descending order)	Relative Risk
Administrators	0.6
Professional/Executive	1.0
Clerical	1.6
Other	2.1

Source: M R Marmot, M J Shipley, G Rose (1984)

21.11 The table shows that there was a strong inverse relationship between grade and mortality. The mortality ratio between men in the lowest grade (messengers) and men in the highest grade (administrators) was 3.5. This is larger than the mortality differences between the lowest and highest social classes. This may reflect more homogeneity within civil service grades than within social classes.

21.12 Whilst the study showed that smoking and other coronary risk factors are more common in the lowest grades, controlling for these factors reduced the risk associated with the grade by less than 25%. This would indicate that occupation may also be an independent risk factor. A follow-up report noted that whilst high and low ranking civil servants have higher blood pressures when at work than at home, the higher ranking civil servants have a significantly greater drop in blood pressure on going home. This may suggest that lower social classes are under more continuous pressure and this contributes to the mortality gradient *(56)*.

21.13 The previous paragraphs have focused on male social classes. The assessment of women is much more difficult because of the inadequate quantity of occupational data. In the studies prior to 1971 married women were classified by the occupations of their husbands. When social class is derived from women's own occupation, three substantial groups can be identified with differing levels of mortality. At ages 15 to 59 deaths between 1976 and 1981 led to SMRs of 78, 104 and 113 for non-manual, manual and unoccupied categories *(57)*. These ratios varied considerably by marital status.

21.14 However, it was felt that this method of classification understated social variation and, among married women with a job, husband's social class widened the differential. This can be seem from table 34.

Table 34 - The mortality of women according to different occupation definitions, based on the longitudinal study.

Standardised Mortality Ratio of Women aged 20-59			
Social Class	All Women by Own Occupation	Single Women by Own Occupation	Married Women by Husbands Occupation
I	101	72	76
II	79	69	84
III N	77	80	93
III M	97	110	110
IV	98	105	125
V	87	121	157
Unclassified	132	11	36
Unoccupied	116	208	49
All Women	100	100	100

Source: Occupational Mortality Decennial Supplement 1979-1980, 1982-1983, OPCS

21.15 Other studies show that, for women of working age, mortality differences by housing tenure and access to cars were similar to those for men.

22. GEOGRAPHY

22.1 Geography is another significant differentiator of mortality, this is shown in table 35.

Table 35 - Standardised mortality ratio (SMRs) for the period 1979-1983.

Area (ranked according to SMR values in 1979-83)	Males	Females
North	112	110
North West	111	110
Wales	107	105
Yorkshire and Humberside	106	105
West Midlands	104	104
East Midlands	99	101
South East	94	94
South West	90	93
East Anglia	88	92

Source: Mortality and Geography - OPCS, Population Trends 56

22.2 The data has been further analysed by social class and this showed that areas of relatively high mortality had a low proportion of class I and II households. However, the ranking of the regions remains within each social class grouping, although the mortality variation by region is lower for social class I than social class V.

22.3 The British Regional Heart Study *(58)* set out to examine whether differences in the distribution of risk factors could be responsible for the marked regional variation in CHD and stroke in Great Britain. The study examined 7,735 men aged 40 to 59 in 24 medium sized towns from 1978 to 1980. It also concluded that social class differences do not explain the variation in mortality between the South East of England and the North and Scotland.

22.4 On a town basis, CHD was strongly associated with blood pressure, cigarette smoking, heavy drinking, physical inactivity and percentage of manual workers. Blood cholesterol and BMI showed no association of statistical significance. These factors account to some extent for the regional variations in CHD mortality.

22.5 The BRHS went on to show that no matter where the men were born, those living in the South had the lowest risk and those living in Scotland had the highest risk. In other words, men born in the south who moved north experienced a higher risk of a major CHD event than men who remained in the south (the risks were 7.3 versus 4.4/1000/year). Equally those who moved south from the rest of Britain experienced a lower risk than those who remained (3.3 versus 7.9/1000/year) *(52)*.

22.6 These studies would suggest that geography plays some independent role as a mortality risk factor.

23. MARITAL STATUS

23.1 Marital status has been correlated (sometimes weakly) with other risk factors. For example married men had a higher mean BMI, did less exercise, but had lower blood pressure and drank less. It has already been stated that suicide is much lower amongst married groups. Table 36 shows the relative risk of death by marital status for 1991 and 1992.

Table 36 - Relative risk of death by age, sex and marital status compared with those married for 1992 and between 1980-1982 (England and Wales).

	Men						Women					
	Single		Widowed		Divorced		Single		Widowed		Divorced	
Age Band	1992	1980 -1982	1992	1980 -1982	1992	1980 -1982	1992	1980 -1982	1992	1980 -1982	1992	1980 -1982
25-29	2.00	2.29	-	-	1.65	-	1.95	2.22	6.83	-	1.71	-
30-34	2.85	2.95	7.14	-	1.72	2.25	2.26	3.07	5.03	-	1.71	1.72
35-39	3.40	2.74	4.86	-	1.89	2.68	2.29	2.48	3.38	-	1.40	1.61
40-44	3.07	2.32	3.36	2.60	1.88	2.18	2.31	2.20	2.29	1.56	1.53	1.58
45-49	2.61	2.01	2.16	2.12	1.82	2.03	2.11	1.70	1.85	1.52	1.40	1.44
50-54	2.27	1.73	2.18	1.85	1.75	1.86	1.71	1.54	1.55	1.41	1.37	1.42
55-59	2.05	1.58	1.90	1.72	1.70	1.70	1.71	1.40	1.53	1.30	1.38	1.40
60-64	1.74	1.45	1.77	1.56	1.69	1.55	1.33	1.28	1.44	1.32	1.33	1.28
65-69	1.60	1.29	1.63	1.44	1.62	1.39	1.28	1.18	1.34	1.25	1.34	1.16

Source: 1992 Mortality Statistics, OPCS Series DHI No. 27 and English Life Tables No. 14

23.2 The table shows that married men and women have much lower mortality than those who are single, divorced or widowed. Whilst marriage is a form of health selection, the peak relative mortality risk occurs at ages 35 to 39, although the proportions married do not peak until ages 45 to 54 *(59)*. For single males the peak relative risk is 3.4 and then it falls with advancing age, whilst for single females it is 2.3. For both sexes and all ages the mortality of single lives exceeds that of divorced lives.

23.3 Whilst part of the mortality difference can be attributed to the increased suicide rate of single lives, there is little factual evidence available which explains the total effect. However, it can be deduced that marriage is a selective process and, therefore, unhealthy lives are less likely to marry than healthy lives. In addition, each partner provides some control over the habits of the other and this helps to ensure the well being of both parties. One study *(60)* showed that men with substantially younger wives have longer life expectancies than men with older wives.

23.4 The 1988 and 1990 General Household Survey showed that widowed, divorced and separated men are more likely to be smokers than single men. Furthermore, single men were more likely to smoke than married men. This relationship was also seen for women, except that the single and married relationship reversed over age 50.

24. SUICIDES

24.1 A high proportion of deaths in the younger age groups is as a result of suicide. For men under age 45, successive birth cohorts have had higher age for age suicide mortality. Men now have four times the suicide rate of women *(61)*. The risk factors that have been analysed in the previous sections do not particularly identify the groups that are at more risk from suicide.

24.2 The likelihood of a person committing suicide depends on several factors, including:

- mental illness, alcohol or drug misuse, severe physical illness or disability;
- personal factors, including level of social support;
- loss of job, financial problems, widowhood, imprisonment;
- changes in the wider cultural environment;
- access to the means of committing suicide.

24.3 Certain occupations have a much higher suicide rate. The highest occupations for suicides are vets, pharmacists, dental practitioners, farmers and medical practitioners. Suicide rates are also much higher for those unemployed and seeking work.

24.4 Where the analysis is carried out by marital status, the figures show that the suicide rate is highest for widowed men followed by divorced men. Combined this group has almost three times the suicide rate of married men. In comparison single men experience about 30% more suicides than married men, although at certain ages their rate is similar to divorced and widowed men.

24.5 In section 18, alcohol misuse was mentioned as a cause of accidents and suicide. Where hospital patients had a diagnosis of alcoholism, suicide levels were over three times as high in men and over two times as high in women. It has been suggested that 15% of alcoholics may eventually commit suicide. Drug abuse is also a significant suicide risk factor.

24.6 Mental illness is also commonly related to suicide, in particular schizophrenia and depression.

24.7 Another condition that has been associated with increased rates of suicide is AIDS. This has been linked to the rise in all cause mortality for men aged 14 to 44. It has been estimated that only 30% of AIDS deaths are correctly recorded. Therefore, AIDS may be implicated in a proportion of the suicides.

25. WOMEN

25.1 Another fixed risk factor is gender. It has been discussed earlier that women are less at risk of CHD than men, until later in life. However, although men have three times the rate of heart disease, it is still the number one killer of women.

25.2 Studies conducted on men may not always hold true for women. It has been thought that oestrogen levels afford women protection against heart disease until the menopause. This may explain the fact that women have a higher level of protective HDL cholesterol and a lower level of dangerous LDL cholesterol than for men *(51)*. As a result, for women, total cholesterol may have a weaker predictive value of CHD mortality and the ratio of LDL to HDL may be a more effective tool *(12)*.

25.3 One study showed that HDL levels declined and LDL levels increased following menopause *(62)*. These results suggest that menopause has an unfavourable effect on the total cholesterol level and its elements and this may contribute to an increase in the risk of CHD. Shaper *(18)* reported that "Women in the fifth and sixth decades of life who are menopausal have 2-3 times the incidence of CHD when compared with women of the same age who continue to menstruate."

25.4 It was also reported that hormone-replacement therapy may protect against the rise in the LDL and the fall in the HDL cholesterol levels *(62)*. As a result hormone-replacement therapy (HRT) may decrease post-menopausal risk by as much as 50% *(63)*.

25.5 Another CHD factor is smoking. Women who smoke experience the menopause about two years earlier than those who do not smoke. In addition, older women who take oral contraceptives have a greatly increased risk of cardio-vascular related death if they also smoke.

25.6 Whilst HRT may protect against CHD, it has been recognised to increase the risk of breast cancer. Other risk factors linked to breast cancer include:-

- early onset of menstruation;
- late menopause;
- age at first full-term pregnancy (older mothers are at greater risk);
- not breast feeding;
- oral contraceptives (possible link);
- socio-economic factors (it is more common in social classes I and II).

25.7 These factors may suggest that women should be treated differently from men, when assessing the effect of known male risk factors on, in particular, CHD.

25.8 However, other specialists point out that women's lifestyles used to be healthier than men's, and may, therefore, have also protected them, but a higher proportion of women are now smoking and have a sedentary lifestyle compared with their mothers *(63)*.

26. POPULATION MORTALITY SUMMARY

26.1 This part of the paper has tried to provide evidence of the truly heterogeneous structure of the population and show that it could be sub-divided into smaller more homogeneous cells. The risk factors that would enable us to do this are both fixed (ie gender, age and family history) and modifiable (ie smoking, total cholesterol, blood pressure, weight, alcohol consumption, exercise). These risk factors do not explain all of the differences in mortality and other social and environmental characteristics also play a part (ie social class, geography and marital status). Each section has focused on a particular risk factor and analysed the results of various studies. In addition, each section has attempted to quantify the proportion of the population that would fall into the risk sub-groups.

In many cases the risk factors are multiplicative and their combined effect can magnify the risk by a factor of up 20. It is, therefore, necessary to consider the combined effect of all the risk factors, not just one (ie smoking) in isolation. This requires multi-variate analyses. The paper generally limited itself to univariate analyses.

26.3 Increasing the public awareness of the implication of these risk factors is one of the major goals of the Health of the Nation strategy in England.

26.4 This part of the paper has given an overview of the data available and has not attempted to reproduce any complex statistical analyses. A wealth of information is available and more comprehensive studies could be carried out.

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