Issue
No 8

Hannover Re's Perspectives –
Current Topics of
International Life Insurance

Cord-Roland Rinke

Life well spent is long

Leonardo da Vinci

The variability of life reflected in annuity products

hannover re®

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Contents

1. Introduction

Since the launch of Impaired Lives Annuities on the UK market in 1995 the enhanced annuity segment has been growing rapidly. New types of enhanced annuities have been introduced and new competitors have entered the market. The concept of enhanced annuities has become more familiar to people working in the life assurance industry. However, the details of enhanced annuities still appear obscure. On the basis of two examples, this paper attempts to provide some insight into issues relevant to the development of enhanced annuities.

Enhanced annuities can be described as a mirror of preferred lives in life assurance. Let us first consider a term life product. It is obvious that the health of an insured person has an effect on the risk assumed by the life assurer. The better the health of the insured, the more unlikely an early death; hence, for the same death benefit the premium for healthy insureds can be lower than for insureds with poor health. In a nutshell: "healthy is cheap".

In contrast let us now turn to an annuity contract. Annuities offer benefits that are payable as long as the annuitant is alive. The annuity provider has to make more annuity payments if the annuitant lives longer. Therefore, the better the health of the annuitant, the greater the benefit paid; thus, for the same annuity benefit the premium for healthy annuitants must be higher than for annuitants with poor health. In this case the motto is "healthy is dear".

The risk of insuring an unhealthy person seems to be more obvious. Life assurers have always required an assessment of an applicant's health for life assurance where a death benefit is payable. Persons in good health have always been accepted; persons with poorer health are rejected or only accepted for an additional premium. The idea of enhanced annuities is to perform an assessment of the applicant's health and offer better rates (i.e. lower premiums or higher benefits) for unhealthy persons.

In order to understand enhanced annuities it is important to know how the UK annuity market works; this issue will be addressed in the second section of the present paper. The third section will then seek to bring out similarities between the various types of enhanced annuities and classify them accordingly.

Diabetics constitute an almost ideal group for enhanced annuities. Annuities for unmarried persons could be another successful addition to the existing range of enhanced annuities. These two types of enhanced annuities will therefore be used as examples. Some of the issues that will be discussed are very similar for the two types of enhanced annuities, while other are not.

Since the launch of a new type of enhanced annuity always involves product development, this is a topic which must be addressed. Last but not least, the reassurance of enhanced annuities is important and will also be dealt with in this paper. The appendix includes a more detailed analysis of diabetic mortality and a list of references.

2. Annuity market in the UK

The annuity market in the UK is an excellent market for innovations. This is due to a number of reasons, including its size, dynamism, distribution system and last but not least the regulatory environment.

The UK is one of the largest markets for pensions and annuities. Moreover, the annuity market is likely to continue growing. As the elderly population increases in number, more and more of the retirees will have funds available for annuities. That means that the annuity market is growing in two dimensions: both in terms of the number of persons buying annuities and the funds available to purchase them.

Annuities are often sold through Independent Financial Advisers (IFA). The task of the IFAs is to provide the best advice. Of course, the best advice is not necessarily guided by price alone. The IFA will also take other important factors into account such as the financial strength of the annuity provider, the flexibility of the plan etc. Nevertheless, there can be little doubt that the premium for the annuity is the most significant factor.

The annuity market is very much shaped by the UK's pension system and the existence of the pension annuity or compulsory purchase annuity (CPA). This pension annuity is bought between retirement and attainment of the age of 75. Tax legislation demands that an annuity income be purchased from pension funds approved by the Inland Revenue. Consequently, almost everybody has to buy a CPA. Hence there is very little self-selection and the annuity provider experiences a mortality (on a lives basis) that is fairly close to the population mortality, albeit with some differences due to the class selection of annuitants.

All these aspects – legislation, distribution, volume and dynamism – combine to produce an annuity market which is an excellent platform for the introduction of inventive new solutions such as enhanced annuities. A number of different enhanced annuities are already available in the UK market, and the product has proven successful from the outset.

3. Classification of enhanced annuities

The first annuities marketed to individuals with impaired health were sold in 1995. Since then the market has seen various different sorts of enhanced annuities. Although the market is still very young it is already possible to classify the annuities into distinct types. It should, however, be pointed out that this classification is more fuzzy than strict.

The first type of classification uses the underwriting method to distinguish between enhanced annuities.

- Single-Class Underwriting
- Multiclass Underwriting
- Individual Underwriting

Single-class underwriting is certainly the simplest method. The underwriting process focuses on one (or just a few) parameters. If these parameters are within a certain range, the risk is accepted; otherwise the risk is rejected.

An example of this method would be smoker annuities: if an applicant has smoked a certain number of cigarettes for a certain number of years he is eligible for smoker annuities, if not he is rejected.

Multiclass underwriting increases the underwriter's choice by extending the single-class underwriting method to include more than one class that can be accepted for an enhanced annuity. In this case too, a few parameters are evaluated and the combination of parameters determines the class into which the applicant would fall; the class in turn determines the amount of enhancement. One possible class would also be rejection.

The different classes would result in a more accurate assessment of the risk. By defining different regions with different mortalities it would be possible to arrive at a multiclass product.

Finally, individual underwriting takes into account all the available information about the applicant; the risk is individually assessed and an underwriter assigns the expected mortality to the applicant. This is the most sophisticated, accurate and expensive approach. Impaired annuities are one such product.

The advantage of individual underwriting is that it uses all the available information and therefore provides the best estimate. Due to its greater degree of accuracy the margins can be smaller

than is the case with single and multiclass underwriting, and this can give the insurer a competitive advantage. On the other hand, the added cost of individual underwriting may negate the competitive advantage offered by its improved accuracy.

Multiclass underwriting would seem to be a good compromise. It can be performed at the same cost as single-class underwriting, yet it enables the insurance company to differentiate between risks according to life expectancy.

Under the second method of classification, a distinction can be made between enhanced annuities on the basis of the condition that leads to acceptance of the risk. In general, products are available in the following classes:

- Disease
- Lifestyle
- Environment

Enhanced annuities that fall into the disease category are those that focus on the influence of annuitants' health on mortality. Enhanced annuities for diabetics would be a typical example. This class of enhanced annuities was among the first and it is the most common.

The group of lifestyle annuities is characterised by the fact that the increased mortality is caused by the applicant's lifestyle. In other words, the person has chosen a way of life that causes increased mortality. Smoker annuities are typical lifestyle annuities. The problem with lifestyle annuities is usually twofold: firstly, the applicant may elect to change his lifestyle to a healthier one after applying for an enhanced annuity. However, this is usually more of a theoretical issue since retirees normally do not change their lifestyle even if this could increase their life expectancy. Moreover, mortality does not always improve immediately after a change in lifestyle (for example, it takes about ten years for the mortality of ex-smokers to reach the level of never-smokers). Secondly, it is often difficult to verify whether an applicant really has the required lifestyle.

Annuities that are enhanced because of environmental factors form a third group. Whereas people can choose a lifestyle they cannot choose the environment in which they live. Socio-geographic annuities belong to this type. Although people can theoretically choose an occupation, the choice is usually limited (most construction engineers would not be able to practise as dentists). Again, there is a problem with changing circumstances, but these rarely cause the mortality to decrease significantly.

It should be reiterated that classifications based on the underwriting method (single-class, multiclass and individual) or the cause of increased mortality (disease, lifestyle and environment) are not strictly defined; nevertheless, different enhanced annuities are offered for each class.

In this paper we shall consider two examples of enhanced annuities: diabetic annuities and unmarried annuities. Diabetic annuities belong to the disease class and would usually be underwritten either individually or on a multiclass basis. Unmarried annuities are lifestyle annuities that would be written using a single or multiclass method.

4. Diabetes mellitus

Diabetes mellitus is a very common chronic disease (prevalence of roughly 3 % in the UK). Diabetics have problems controlling their blood sugar level, which can result in various other illnesses. In general, there are two types of diabetes mellitus.

Diabetics suffer from a reduced or total lack of insulin production in the islet cells of the pancreas, or they may produce defective insulin that does not work properly. The insulin hormone is needed so that blood sugar may enter the cells; insulin acts as a "key to open the cell's door" for glucose.

Diabetes does not constitute a single disease entity, but rather it is a heterogeneous disorder. It has correlations to other diseases such as over-

weight and high blood pressure as well as all their injurious consequences, most notably macro- and microvascular complications. Kidney diseases, visual defects and the amputation of a foot or leg are common consequences for long-term diabetics.

The two types of diabetes mellitus are insulin-dependent diabetes mellitus (IDDM or type 1) and non-insulin-dependent diabetes mellitus (NIDDM or type 2).

Type 1 diabetes mellitus is usually acquired at an early age. Type 1 diabetics have totally lost the ability to produce insulin and they are dependent on their daily doses of insulin. This type is rather rare, with only 5% to 15% of all diabetics suffering from type 1 diabetes mellitus.

About 85% to 95% of all diabetics suffer from type 2 diabetes. The type 2 diabetics' pancreas still produces insulin, but the quantity or quality produced does not reduce the blood sugar level to the appropriate concentration. These patients usually have a higher age at onset and can often control their blood sugar level for decades by keeping a strict diet or taking drugs. In general they do not require a daily insulin injection.

Diabetes mellitus is a chronic disease resulting in a variety of defects. These defects engender a higher mortality. Although type 1 diabetes mellitus is more severe, the larger – and hence for enhanced annuities more interesting – group is composed of the type 2 diabetics.

5. Overview of the mortality of diabetes mellitus patients

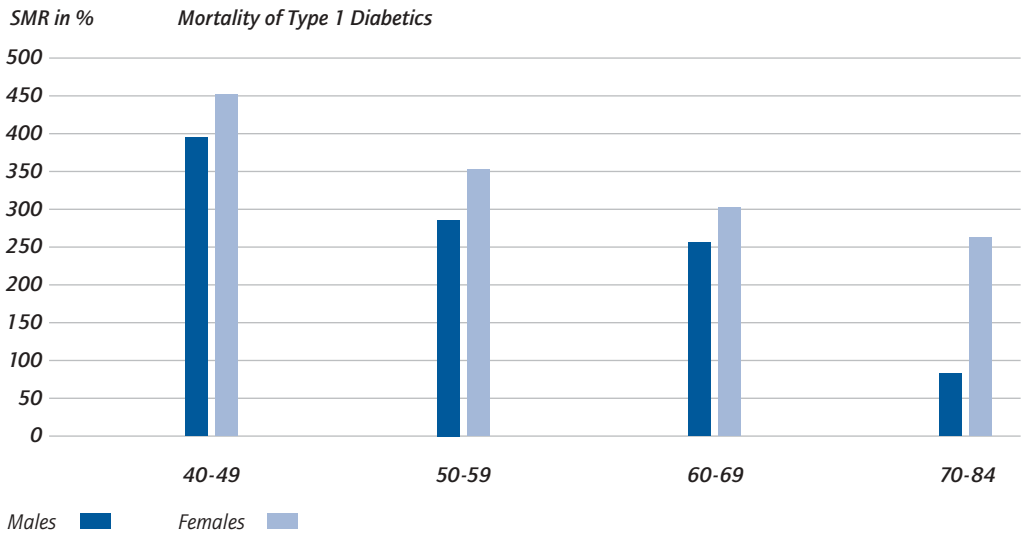
Almost all studies of mortality with respect to diabetes mellitus demonstrate excess mortality for diabetics compared to non-diabetic persons. The mortality of diabetics depends mainly on the attained age, duration, gender, type of diabetes mellitus, treatment and major related diseases such as overweight, high blood pressure, kidney disease or the amputation of a foot or leg.

Mortality in medical studies is often measured in comparison with the population mortality. A relative mortality ratio (or standardised mortality ratio, SMR) of one means that the mortality is exactly as expected for the population and a ratio greater than one means that the observed mortality is higher. The mortality of type 1 and 2 diabetes is usually observed separately.

Laing et al. [3] provide the relative mortality ratio of a cohort of insulin-treated diabetics in the UK for different age bands and both genders. These patients were essentially type 1 diabetics. The standardised mortality ratios were found to be 2.7 for males and 4.0 for females. Owing to the fact that male mortality is greater than female mortality for most ages, the mortality of the males was still higher than that of the females.

The relative mortality by attained age for males and females is shown in the following figure:

Figure 1: Mortality of type 1 diabetics in the UK



It can be seen from Figure 1 that the standardised mortality ratio decreases for both genders for ages above 40. It is important to note that although the relative mortality ratio decreases with increasing age, the absolute excess mortality continues to increase as the attained age rises.

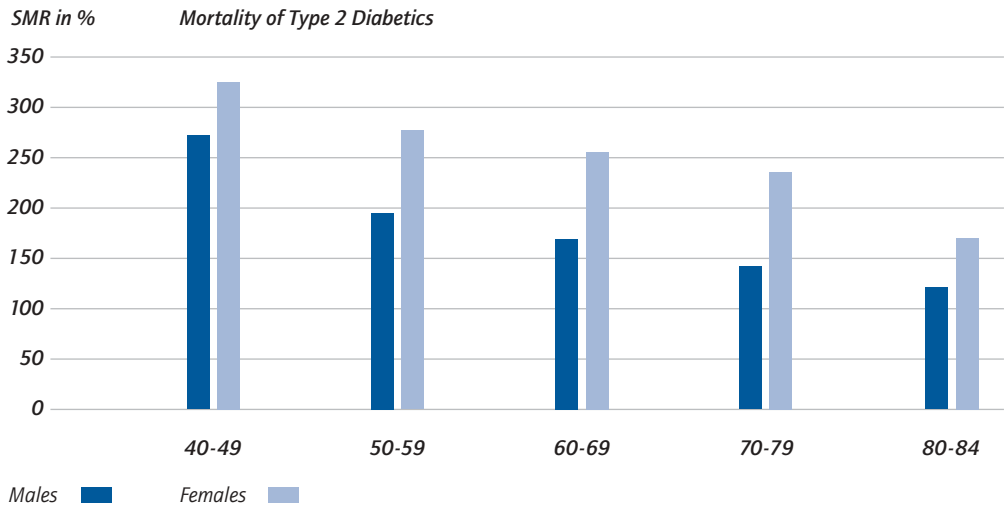
Unfortunately, the work of Laing et al. [3] does not indicate mortality by duration. Nevertheless, the attained age and duration since diagnosis are closely correlated for type 1 diabetes mellitus patients. On the basis of Figure 1, it would at least appear questionable whether a trend towards higher relative mortality ratios with increasing duration since diagnosis really exists.

The mortality of type 2 diabetes mellitus patients is less severe than that of type 1 diabetes mellitus. Yet there is certainly a difference in mortality compared with non-diabetic lives. Swerdlow and Jones [8] followed a cohort consisting of members of the British Diabetic Association for 25 years. The group comprised both type 1 and type 2 diabetics, but for ages above 40 the majority were type 2 diabetics.

The relative mortality ratio was 1.58 for males and 2.31 for females. Again, female diabetics have a relatively higher mortality than male diabetics. The relative mortality ratio for each age band has the same property with the exception of the stratum 30 to 39, where the females' ratio is slightly below that of the males; this difference is not significant. As expected, for both genders the excess mortality for type 2 diabetics is lower than for type 1 diabetics.

The details of the results are shown in Figure 2.

Figure 2: Mortality of type 2 diabetics



It can be seen that the structure of age-dependent relative mortality ratios is the same. For ages above 40 the relative mortality ratio decreases with increasing attained age.

The theory that diabetes mellitus has a greater effect on mortality with increasing duration is not supported by this study with respect to the relative mortality ratios, but it may be supported as regards the absolute excess mortality.

The gender- and age-related total mortality rates of type 2 diabetes mellitus patients are approximately double (for the relevant ages) those of non-diabetic individuals. All studies agree inasmuch as the total relative mortality ratios for female patients exceed those of males.

Up to this point the mortality has been examined in terms of gender, attained age and duration. There are also a number of medical factors which have a strong predictive effect on the mortality of diabetes mellitus patients. Studies are available describing the influence of the most important of these risk factors on mortality.

The major factors for the relative mortality risk of diabetics (attained age, duration, gender, type of diabetes mellitus) as well as other significant factors such as treatment and certain related diseases must now be used to derive the mortality of diabetics for Diabetic Lives Annuities.

The most important factor for the mortality of diabetics is the type of diabetes mellitus. Consequently, a set of four mortality tables (type 1 males, type 1 females, type 2 males, type 2 females) is produced, reflecting the key influences on the mortality of diabetes mellitus patients. All other factors are then used to adjust the mortality tables via a simple procedure of assigning an extra mortality risk to each of these factors.

This procedure has the advantage that it can easily be modified according to the number of questions on the application form and the other available medical information. In its simplest form, no additional information (apart from age, gender and type of diabetes mellitus) is obtained and the mortality tables are used without adjustments.

6. Product design for Diabetic Annuities

Annuity payments made to diabetes mellitus patients can be larger than for standard risks because they have a higher mortality. Depending on the type of diabetes and the important risk factors such as age, duration of diabetes mellitus, hypertension etc., the annuity could be as much as 25 percent higher than a standard annuity. This offers the annuity provider highly attractive business opportunities.

In order to successfully exploit such opportunities the product must be properly designed. Specifically, it has to be designed with the typical diabetic in mind, it needs to be simple and it must offer the standard options. There should be no ambiguity as to which patients may apply for a diabetic lives annuity. Important areas which need to be clarified are the application form and the accompanying procedure.

A number of standard options are usually available for annuities. These options should also be offered to diabetics. A guarantee period, a second life and escalating benefits could be included as with any other standard annuity. The inclusion of a second life or a guarantee period would obviously diminish the effect of the diabetic's higher mortality. The escalation of the annuity by a given percentage slightly increases the effect of the increased mortality because payments that have been inflated over many years are less likely to be incurred for diabetics.

The target group for diabetic lives annuities will be patients with any type of diabetes mellitus. Restricting diabetic lives annuities to either type 1 or type 2 patients would reduce the number of potential applicants or reduce the maximum possible additional annuity. Neither effect is desirable.

Since annuities are usually marketed through IFAs the product must be "sold" to the IFAs; the diabetic lives annuity should be sold to the IFAs as would any other annuity. It is important to keep the application process as simple as possible for the IFA and to provide the IFA with indicative terms for the annuity payments with respect to the four major classes, namely type 1 diabetes males and females and type 2 diabetes mellitus males and females.

Nevertheless, marketing activities can also target diabetics directly. The British Diabetic Association has approximately 200,000 members and publishes a magazine for its members. This magazine, entitled "Balance a Lifestyle", offers an optimal channel for reaching diabetics.

As has already been stated, the application procedure should be kept simple and it should not confront the applicant with questions that could normally only be answered by a general practitioner. As a rule, the IFA should be in a position to give the applicant preliminary terms for the diabetic lives annuity on the basis of age, gender and type of diabetes. After the application form is sent to the annuity provider, the exact premium is calculated and notified to the IFA or applicant. The applicant can than decide from which annuity provider he wishes to buy an annuity.

The application form should cover all relevant information about the patient's disease; in particular, all the important risk factors (type, duration, hypertension, treatment and overweight) must be identified in the application form. The application form could be designed as follows:

When did you begin to suffer from diabetes mellitus?			1980
What is your current height? weight?			6 ft 1 in 180 lb
From what type of diabetes do you suffer? Type 1, insulin-dependent diabetes Type 2, non-insulin-dependent diabetes	☐ ☒		
	Yes	No	
Do you take insulin? If yes, please indicate dosage.	☐	☒	
	Yes	No	
Do you take drugs? If yes, please indicate no. of different drugs.	☐	☒	
	Yes	No	
Do you suffer from hypertension or high blood pressure? If yes, please indicate your blood pressure reading.	☒	☐	170/90
	Yes	No	
Have you suffered from any of the following: Kidney disease Amputation of foot or leg	☐ ☐	☒ ☒	

The information given in the application form is then used to obtain the exact mortality of the applicant. This is done by assigning each risk factor an extra mortality percentage. The extra mortalities for each risk factor are combined in order to arrive at the total extra mortality, which is then applied to the pricing model of the risk carrier. Bands of total extra mortality can be defined so as to avoid using a huge number of different mortality tables, and it will be sufficient to calculate the premiums for just a few bands.

7. Mortality differentials and transition rates of unmarried and married persons

A prerequisite for determining annuity values for unmarried persons is knowledge of the mortality differentials according to marital status as well as the probability rates for a change of marital status, i.e. (re-)marrying, divorcing, becoming a widow or widower. Of course, it is also interesting to note the explanations that are offered for the mortality differentials.

The first study of the mortality differences between married and unmarried individuals seems to be [1], which appeared as early as 1858. Since that time many studies have been carried out on this subject. A good paper including an extensive and valuable discussion as well as a long list of references can be found in [9].

Despite these efforts, the mortality differences have still to be clearly explained. Many possible reasons have been suggested, and it is obvious that only a combination of these can account for all the observations in this field. The suggested explanations include:

- Selection, i.e. healthy people are much more likely to marry than sickly or weaker persons
- Responsibility, i.e. marriage leads to additional responsibility with respect to one's children and spouse and this in turn implies a more healthy lifestyle
- Mutual care-giving, i.e. living with a spouse is an important psychological advantage be-

cause a couple can share the vicissitudes of life

- Correlation, i.e. marriage may be correlated with certain other factors (education, income, etc.) that have an influence on mortality
- Social interaction, i.e. married persons may have a higher level of social interaction, which in turn is correlated with mortality

Whatever the reasons may be, it is a fact that unmarried mortality rates are higher than married mortality rates. It is also widely accepted that these differences have been increasing over time. There is no reason to believe that this will change in the future; however, there is also no way of proving this assumption. All we can do is wait and see.

In order to compare the mortality of the different unmarried statuses – single (i.e. never married), widowed and divorced – with the mortality of married persons, we shall use the quotient of these mortalities. Furthermore, the term "relative mortality" will be used for this quotient. A relative mortality of more than 1 (or 100 %) indicates a higher mortality than that of married persons.

These relative mortalities together with the distribution of marital statuses within the population are sufficient to derive mortality rates for each marital status. Since we are only interested in the ages that are important for annuities, we shall restrict our discussion to ages above 40.

The English Life Tables ([6]) show mortality rates according to marital status. The mortality rates for unmarried persons relative to the mortality rates for married persons are shown in the following Table 1 for selected ages:

Table 1:
Mortality rates of unmarried persons relative to married persons in England and Wales in 1980-1982

	Men			Women		
Age	*Single*	*Widowed*	*Divorced*	*Single*	*Widowed*	*Divorced*
47	203%	214%	181%	165%	150%	142%
57	159%	173%	162%	139%	130%	139%
67	129%	144%	143%	118%	125%	116%
77	105%	125%	130%	113%	116%	126%
87	77%	102%	129%	102%	102%	192%

It can be seen that the mortality of unmarried persons is higher than that of married persons for all combinations of age and gender except for single males of age 87. In the case of divorced or widowed individuals the effect is generally stronger for males than for females. For singles this holds true for ages between 35 and 75.

If we compare the different types of unmarried status, it is evident that in the case of males the relative mortality of singles aged older than 52 is always lower than the mortality of those divorced or widowed. At younger ages the relative mortality of divorced males is the lowest of the three types. At ages 72 and higher the divorced males show the highest relative mortality.

In the case of females, singles up to the age of 57 show the highest mortality. Between 62 and 72 widowed females have the highest mortality, while above this age divorced women experience the highest mortality rates among the unmarried. There seems to be no easily identifiable pattern for females as to where the mortality is lowest.

The mortality expressed as a percentage of the mortality of married persons decreases with age for most of the ages shown. This ratio increases among very elderly divorced persons.

Martin Werth presented slightly different data for England and Wales in [11]. Table 2 shows the mortality ratios.

Table 2:
Mortality rates of unmarried persons relative to married persons in England and Wales for 1991 and 1992

	Men			Women		
Age	*Single*	*Widowed*	*Divorced*	*Single*	*Widowed*	*Divorced*
37	340%	486%	189%	229%	338%	140%
47	261%	216%	182%	211%	185%	140%
57	205%	190%	170%	171%	153%	138%
67	160%	163%	162%	128%	134%	134%

These ratios are generally higher than the ratios in Table 1. However, they support the pattern of decreasing mortality ratios by age and higher ratios for males than for females.

It is interesting to look at the mortality relative to married persons over the course of time. Table 3 shows similar values to those in Table 1, but for the time period 1970-1972.

Table 3:
Mortality rates of unmarried persons relative to married persons in England and Wales in 1970-1972

	Men			Women		
Age	*Single*	*Widowed*	*Divorced*	*Single*	*Widowed*	*Divorced*
47	175%	197%	203%	150%	149%	153%
57	141%	158%	170%	127%	123%	123%
67	119%	141%	139%	108%	117%	120%
77	112%	123%	124%	106%	114%	130%

The ratio increases for single and widowed men and women with the exception of single males aged 77 and older. The pattern among divorced persons appears more complicated: among divorced females the ratio decreases for ages below 60 and increases for ages above 60; among males there does not seem to be an easily identifiable correlation.

The available data (together with the proportions of the different types of marital status within the population) is sufficient to calculate the mortality rates by marital status.

The calculation of annuity values for unmarried lives entails one additional problem. Unlike gender, the marital status of a person can change several times during his or her life. Hence the relative mortality of unmarried persons can change during their remaining lifetime. It is therefore necessary to take these transitions between different marital statuses into account.

The Office for National Statistics provides various data on divorce and (re-)marriage. Table 4, which was taken from [5], gives the transition rates for males and females with respect to the transitions from married to divorced, single to married, divorced to married and widowed to married.

It is obvious that the transition rates decrease with age. In general (except for widowed females), remarriage rates are much higher than the rates of divorce and first marriage for the age groups shown.

Table 4:
Transition rates in per mille in England and Wales in 1997

Age	*40-44*	*45-49*	*50-54*	*55-59*	*60 and over*
Divorce Male	18.5	14.0	8.1		1.7
Divorce Female	16.1	11.4	5.8		1.2
First Marriage Male	20.7	11.2	7.2	2.3	
First Marriage Female	18.5	10.3	6.7	1.2	
Remarriage Males Divorced	58.3	40.3		19.9	
Remarriage Males Widowed	48.2	40.6		7.6	
Remarriage Females Divorced	51.1	30.0		7.6	
Remarriage Females Widowed	39.8	17.3		1.3	

The transition rates for married to widowed are essentially mortality rates, which can be obtained by estimating the spouse's age. These transition rates are less important for the calculation than the transition rates from any unmarried status to the married status because they will only affect those few initially unmarried persons who marry later.

Finally, we can take a commonly used mortality table such as the PA 92 and adjust the mortality rates according to the relative mortalities and the transition rates.

The data presented in this section clearly shows that mortality rates for unmarried (single, divorced, widowed) persons are substantially higher than for married persons. It is also clear that the transition rates for higher ages decrease rapidly to a level such that these transitions can virtually be neglected for the purpose of calculating annuity values.

8. Product design for Unmarried Lives Annuities

Annuity payments for unmarried persons can be higher than for married persons since the unmarried have a higher mortality. As mentioned earlier, marital status – and hence mortality – can change during the course of a life. Annuitants would not accept a change in their annuity if they were to marry. The annuity must therefore be independent of the marital status at the time when it is paid; the annuity may only depend on the marital status of the annuitant upon inception of the policy.

It would, however, be possible to introduce an observation period during which the annuity would change if the insured were to marry. The longer this period, the lower the risk of someone buying an annuity shortly before getting married. It still seems open to question whether this approach would be acceptable and indeed whether it would have any significant effect.

Depending on marital status and age, the annuity could be up to 10 percent higher than a standard annuity. This offers the annuity provider highly attractive business opportunities.

Just as with Diabetic Lives Annuities, the product must be designed for the typical assured. It needs to be simple and must offer the standard options. It must be made clear who is eligible to apply for an Unmarried Lives Annuity (all unmarried persons, i.e. singles, divorced persons as well as widows and widowers). In contrast to the diabetic annuities, the application form and the procedure can be quite straightforward and need only include an additional question regarding marital status.

As far as available options are concerned, Unmarried Lives Annuities should be treated in the same way as any other annuity (including Dia-

betic Lives Annuities). It is evident that the inclusion of a second life is not compatible with an Unmarried Lives Annuity.

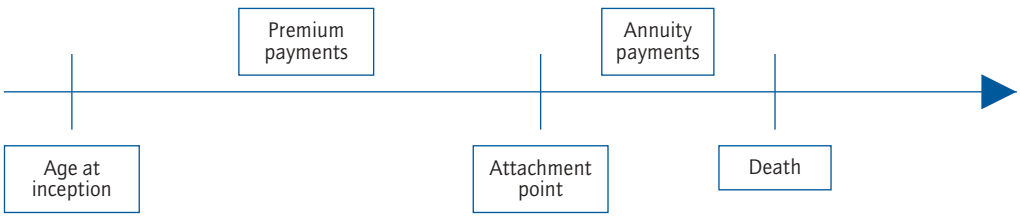
The target group for Unmarried Lives Annuities would be all unmarried persons, i.e. those who have never married or are widowed or divorced. For the same reasons as for Diabetic Lives Annuities, it would not be desirable to restrict Unmarried Lives Annuities. Nevertheless, if one believes that the relative mortality presented in Table 1 for male singles over the age of 77 is correct, the annuity values for single males aged above 65 can be higher than those of standard annuities.

It is important to keep the application process simple and to provide the IFA with terms for the annuity payments for all three classes (never married, divorced and widowed) for males and females. The application procedure can be straightforward and should not require the applicant to answer numerous or complex questions. The IFA will normally be able to give the applicant the final terms for the Unmarried Lives Annuity based on age, gender and marital status.

9. Reassurance

All new products involve considerable effort in the areas of product design, research and marketing; they also entail an additional risk and very often an initial financial strain. Furthermore, in the case of enhanced annuities medical expertise – whether in the design process or for the (medical) underwriting – is essential.

Annuities have traditionally been reassured using a quota share treaty, sometimes with a financing component. A highly innovative concept is time-specific excess of loss protection. As the name suggests, this is a non-proportional reassurance concept under which the "attachment point" is a time. Under a time-specific excess of loss agreement the reassurer (for an appropriate premium) pays all annuities after a specific time, e.g. all annuities for policyholders who are older than 85. The reassurance premium for this cover can be either a single premium or regular premiums that end at the attachment point.



In addition to covering the risks through a reassurance treaty, reassurers offer many services – especially in the area of product development. As new products, all enhanced annuities require advanced research. It is evident that the mortality basis of the enhanced annuity (e.g. Unmarried Lives Annuities and Diabetic Lives Annuities) needs to be obtained. In fact, the mortality basis is the key to enhanced annuities and can only be ascertained by examining all the available data. It is absolutely essential to investigate the effects of diseases and lifestyles on mortality. Hannover Life Re employs teams of actuaries and medical experts whose research is focused on mortality and its risk factors. This service is normally made available to our clients.

The results of relevant scientific papers are translated into mortality assumptions. Numerous medical papers are published, for example, on diabetes; however, experience in enhanced annuities is needed in order to apply such data to the expected annuitants. With its long-standing involvement in the enhanced annuity market, Hannover Life Re has an invaluable store of experience that it can share with a life office.

Different factors, such as diabetes and marital status, have a varying effect on the longevity risk, and this situation may produce a complicated risk description and insurance conditions. As far as possible it is important to use simplified underwriting that facilitates the performance of im-

portant underwriting steps directly at the point of sale. Consequently, the development of a simplified underwriting concept always figures prominently in Hannover Life Re's service when assisting a client with product design.

The medical and actuarial service provided by a reassurer could also be supplied by external consultants; however, the reassurer can stand behind its recommendations by assuming the risk of adverse deviations.

Identifying and addressing the right customers and the right sales partners is part of successful product design. Combining the insurer's and reassurer's knowledge of the (enhanced) annuity market in a partnership makes it easier to arrive at the appropriate product.

The acquisition of new business, especially in the case of annuity policies, produces a surplus strain because the valuation reserves are higher than the net single premiums. A quota share treaty with an initial financing component offers a solution to the annuity writer's problems. He can reduce his surplus strain, improve profitability and moreover reduce his risk. The reassurer could also tailor a financing reassurance treaty that addresses the needs for financing and increased solvency.

Last but not least, someone has to cover the longevity risk. The natural partner to cover the risk is the reassurer. Annuity providers are currently concerned about the risks that they have assumed. Apart from the risk that the annuity provider might experience a different mortality – stochastic risk: "betting" on correct odds, but losing – the insurer might have underestimated the future mortality improvement or the difference between population mortality and insured mortality – parameter risk: believing in incorrect odds.

The mortality risk can be addressed by using a quota share treaty or structuring a time-specific excess of loss treaty on the enhanced annuity portfolio. The time-specific excess of loss agreement is a comparatively cheap solution for handling the mortality risk.

Enhanced annuities create an additional risk for the annuity provider; since no reliable data is available in publications on which he can base the pricing mortality rates and given the fact that he is entering a new segment, the provider cannot be sure what business mix he will actually have to cover. Only a professional partner with high security can effectively cover large amounts of these risks.

Hannover Life Re is the leading reassurer of enhanced annuities in the United Kingdom. In partnership with professional insurers it has successfully launched the concept of enhanced annuities on the UK market. As a reassurer it has gained experience in product design and the marketing of enhanced annuities. It conducts extensive research and gathers medical and actuarial expertise on an ongoing basis. This know-how enables Hannover Life Re to reassure the longevity risk by taking account of various factors, including those relevant to Diabetic Lives Annuities. Hannover Life Re is committed to assisting innovative insurers in all areas in the process of introducing Diabetic Lives Annuities on the UK market.

Hannover Life Re has been a leading supporter of enhanced annuities since their initial development. Based on its many years of involvement with these products, we offer our clients a degree of expertise and service that is second to none.

10. Appendix

10.1 A closer look at the mortality of diabetes mellitus patients

Laing et al. give the relative mortality ratios for a cohort of insulin-treated diabetics in the UK for different age bands and both genders [3]. The patients in this study had diabetes mellitus diagnosed under the age of 30 and were treated with insulin; most of them were therefore type 1 diabetics. The observed mortality was almost three times (SMR 2.7) the normal mortality for males and four times (SMR 4.0) that expected for females.

The difference in relative mortality ratios indicates that the mortality for female type 1 diabetics is proportionately higher than for male type 1 diabetics. This result holds true for each observed age stratum. The relative mortality ratio for females is about 50% higher than for males. For ages above 40 it is 15 to 30% higher than for males. Since male mortality is greater than female mortality this result does not necessarily mean that for type 1 diabetics the opposite is true. In fact, for most ages (except the lowest and the highest age bands) the mortality of males was still higher than the mortality of females.

The relative mortality by attained age for males and females is given in Figure 1.

As annuities are usually bought at ages close to retirement it is sufficient to examine the mortality for ages above 40. It can be seen from Figure 1 that the standardised mortality ratio decreases for both genders for ages above 40. Although the relative mortality ratio decreases with increasing age, it is important to note that the absolute excess mortality continues to increase with attained age.

For males aged 70 to 84 the observed mortality was even better than normal. The 95% confidence interval for this age group is 0.5-1.3; this is not significant and may be due to random fluctuation or the selection of the observed group. Another explanation could be that those type 1 diabetics who survive up to the age of 70 form a select group which therefore has a lower mortality; the same effect cannot, however, be observed for females.

In the World Health Organization Multinational Study of Vascular Disease in Diabetes [10] similar relative mortality ratios were observed for type 1 diabetics. Although the ratios do not necessarily apply to the UK population, they support the observation that the relative mortality ratio decreases with increasing attained age above 40. The study observed the relative mortality ratio for three age bands and both genders; the results are as follows:

Table 5:
Standardised mortality ratios of type 1 diabetics by attained age

Attained Age	*35-44*	*45-54*	*55-64*
Male	~ 6.5	~ 4.5	~ 3.5
Female	~ 6.6	~ 6.2	~ 5.3

Having considered the effect of gender and attained age, it is interesting to examine the age at onset and duration parameters. The results must, however, be interpreted with care. Age at onset, attained age and duration are not independent variables – each pair of variables determines the third. An effect observed for one of the variables will usually also have a noticeable effect on the other two.

The study by Laing et al. [3] does not give mortality by duration, but an indication of this can be

obtained from the correlation between attained age and duration since diagnosis for type 1 diabetes mellitus patients. The age at diagnosis is mostly between 10 and 20 years. For age groups above 30 we can therefore assume that higher attained ages correspond to higher duration. This assumption, together with the findings shown in Figure 1, would suggest a decreasing relative mortality ratio with increasing duration; consequently, it does not support the argument that relative mortality increases with duration due to the chronic nature of the disease. It is important to bear in mind that this assertion is based on relative mortality ratios, whereas for absolute mortality the duration can still have an increasing effect.

Another German study of type 1 diabetics conducted by Lehsten et al. [4], which analysed the mortality using a multiple logistic regression, obtained a relative risk of 1.09 p.a. for the duration and 1.06 p.a. for the age at onset. This means that ceteris paribus the mortality increases by 9% for each additional year of the diabetes duration and by 6% for each additional year of age at onset of diabetes. The authors conclude that the difference of 3% p.a. means that the relative risk increases by 3% p.a. more due to duration than due to age at onset. It is not made clear whether this difference is significant.

Swerdlow and Jones [8] observed the relative risk by duration for diabetics in the UK whose age at onset was below 15. Again, this group was essentially composed of type 1 diabetics. No significant trend could be detected in the relative mortality ratio as a function of duration.

The WHO study by Wang et al. [10] shows a significant trend in the relative mortality ratio. Relative mortality ratios increase with increasing diabetes duration for both males and females. This trend is more pronounced among females than among males:

Table 6:
Standardised mortality ratios for type 1 diabetics by duration

Duration	*0-6*	*7-13*	*14-*
Male	~ 3.9	~ 4.2	~ 4.2
Female	~ 3.6	~ 5.4	~ 6.3

Nevertheless, it would appear that the existence of an increasing trend for relative mortality ratios depending on the duration since diagnosis has not been definitively established.

Undoubtedly, attained age has a significant impact on the relative mortality ratio. Relative mortality ratios decrease with increasing attained age. Some studies (e.g. Lehsten et al. [4]) suggest that the same is true of age at onset. Yet this observation could be caused by the increasing average attained age with increasing age at onset.

Swerdlow and Jones [8] studied a cohort of members of the British Diabetic Association. This cohort is a select group of diabetics, who probably pay more attention to their illness than the average patient. The group consisted of type 1 and type 2 diabetics, for the most part new members from the years 1966-1970. Although type 1 diabetics are over-represented in the British Diabetic Association for the relevant ages, the cohort consisted mainly of type 2 diabetics.

Female diabetics have a relatively higher mortality (SMR 2.31) than male diabetics (SMR 1.58). As expected, the excess mortality for type 2 diabetics is lower than for type 1 diabetics with respect to both sexes.

For age strata – with the exception of 30 to 39 where the difference is not significant – the relative mortality ratio of the female diabetics is higher than that of the males. Figure 2 shows details of the results for ages above 40.

In the case of ages above 40 the relative mortality ratio decreases with increasing attained age. Panzram [7] even states that "the difference in death rates in comparison to those of the general population narrows remarkably with advancing age".

The WHO study gives the following ratios, which also show a similar trend.

Table 7:
Standardised mortality ratios for type 2 diabetics by attained age

Attained Age	*35-44*	*45-54*	*55-64*
Male	~ 3.0	~ 2.6	~ 2.4
Female	~ 4.0	~ 3.6	~ 2.8

In Swerdlow and Jones' paper [8] the standardised mortality ratios were also considered in relation to both age at entry (to the British Diabetic Association) and attained age. In each stratum by age at entry a reduction in the relative mortality ratio was observed with increasing attained age. On the other hand, no significant independent effect of age at entry was noted when stratified by attained age.

Obviously, age at entry in this study is not always equivalent to age at onset of diabetes mellitus. Nevertheless, there is probably a strong correlation between the two variables and age at entry limits the age at first diagnosis. If we treat the difference between attained age and age at entry as the duration of diabetes this result can be interpreted further.

With increasing duration (difference between attained age and age at entry) the relative mortality ratio decreases. This observation could contradict the theory that diabetes mellitus has a greater effect on mortality with increasing duration. It is at least the case that the study does not support this theory as far as the relative mortality ratios are concerned, although it may be supported with respect to the absolute excess mortality.

In contrast to the findings of Swerdlow and Jones [8] the following data from Wang et al. [10] suggests that duration has a strong effect on the relative mortality ratio.

Table 8:
Standardised mortality ratios for type 2 diabetics by duration

Duration	*0-6*	*7-13*	*14-*
Male	~ 1.7	~ 2.2	~ 3.0
Female	~ 1.8	~ 3.5	~ 4.4

With respect to type 1 diabetes mellitus the trend is stronger for females than for males.

In general, the gender- and age-related total mortality rates of type 2 diabetes mellitus patients are approximately twice as high as the population mortality. All studies agree inasmuch as the total relative mortality ratios in female patients exceed those in males for almost all ages.

There are of course a number of medical factors that have a strong predictive effect on the mortality of diabetes mellitus patients. Two such factors are hypertension (high blood pressure) and proteinuria (the appearance of protein in urine, which indicates kidney damage). Wang et al. [10] give relative mortality ratios for type 1 and type 2 diabetics depending on the existence of hypertension and proteinuria. The results are shown in table 9 below:

Table 9:
Standardised mortality ratios for type 1 and type 2 diabetics depending on the existence of hypertension and proteinuria

Status of hypertension and proteinuria	*No hypertension, no proteinuria*	*Hypertension, but no proteinuria*	*No hypertension, but proteinuria*	*Hypertension and proteinuria*
Type 1 Males	~ 2.7	~ 3.5	~ 6.3	~ 11.0
Type 1 Females	~ 3.7	~ 5.3	~ 6.8	~ 18.0
Type 2 Males	~ 2.2	~ 2.9	~ 3.2	~ 5.5
Type 2 Females	~ 2.4	~ 2.4	~ 4.9	~ 8.0

It is evident that proteinuria is a very strong predictor of the future mortality of diabetes mellitus patients. Here, too, the effect is stronger for females than for males and for patients with type 1 diabetes mellitus than for type 2 diabetics.

There are certainly other medical factors that influence mortality. Treatment is usually a good indicator of the severity of a disease. For example, we may consider a patient with diabetes mellitus type 2. If the patient is treated only with diet, the disease can be expected to be less severe than if insulin has to be taken. On the other hand, intensive medical treatment can reduce the mortality. A number of papers discuss the influence of treatment on diabetes mortality.

This brochure describes in detail the most significant factors of age, gender and diabetes type; it would, however, be beyond the scope of this publication to examine all the major medical risk factors which can affect diabetes mortality.

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