How many years of life could be saved if Cardiovascular Disease was prevented in South Africa?

Abstract

BACKGROUND: Cardiovascular disease (CVD) account for about one-third of all deaths worldwide and more than half of these occur in developing countries. In South Africa, about 195 people died per day between 1997 and 2004 due to CVD and much attention has not been paid on the effect of the disease on life expectancy. We estimate the impact of CVD on life expectancy and the chances of survival in South Africa and we also estimate the percentage gains in life expectancy when CVD is eliminated.

METHODS: We collected the mortality data from the WHO statistical information system (WHOSIS) for South Africa in 2005. We used the data to estimate gains in life expectancy and chances of survival had CVD been eliminated from the population in 2005, given the age-and cause-specific mortality conditions of the period.

RESULTS: The results showed that CVD accounted for more than one-tenth of male and female deaths in this population. There was a probable of 5.2 years for males and 0.9 years for females when the impact of CVD was eliminated. Also, chances of survival also increased among males and females when CVD was eliminated in the population.

CONCLUSIONS: Effective intervention need to be put in place in South Africa so as to minimize the risk factors of the disease. This will eventually help to improve the health status in the country which has already been over-burdened with HIV/AIDS.

COMMENTS: We demonstrate the usefulness of multiple decrement tables in the elimination of disease in the population.

Introduction

Cardiovascular disease is the number one cause of death globally because more people die from the disease annually than from any other cause [1]. In 2008, an estimated 17.3 million people died of CVD, representing 30 percent of all global deaths and about 80% occurred in low-and middle- income countries. Of these, 7.3 million were due to coronary heart disease and 6.2 million were due to stroke. By 2020, studies indicate that mortality by CVD is expected to increase by 120% for women and 137% for men and by 2030, almost 23.6 million people will die from CVD, mainly from heart disease and stroke [2, 3, 4]. Cardiovascular disease contributes to disability, diminished quality of life and greatly increases health care cost [4]. Many people are dying of cardiovascular disease (CVD); yet, considerable attention has not been paid to these diseases.

In developed countries, studies have shown that the incidence of CVD is decreasing because of the various policies put in place to combat the risk factors but no study has shown similar trend in developing countries, rather, the incidence of the disease has been increasing overtime and men and women have equal chance of deaths from the disease [4]. In Africa, the World Health Organization (WHO) projects continuous increase in the burden of deaths from CVD due to urbanization, increase in life expectancy and decrease in mortality from infectious diseases [1, 5, 6]. In sub-Saharan Africa (SSA), CVD are anticipated to soon eclipse communicable and poverty-related diseases as the leading cause of mortality and disability [3, 5, 7]. For instance, the number of disability adjusted life years (DALYs) lost to CVD in sub-Saharan Africa rose from 5.3 million for men and 6.3 million for women in 1990 to 6.5 million and 6.9 million in 2000 for men and women respectively [1]. This implies that cardiovascular disease will not only be a considerable health burden which increases morbidity and mortality, it will also cause a significant health care cost and economic burden which will continue to grow as the population ages.

In South Africa, about 195 people died per day between 1997 and 2004 due to CVD. Despite the high rate of death caused by AIDS in the country, actuarial projections suggest that the rate of chronic disease, including CVD, is going to increase by 2010 [8]. More so, premature deaths caused by CVD in the working population (35-64 years) are expected to increase by 41% between 2000 and 2010. The most worrisome thing is that since more than half of the CVD mortality occurs before the age of 65 years, the impact on the economy will be very enormous. This indicates that the active population in the country will be seriously affected by this disease if serious measures are not put in place to address the disease. Although the burden of cardiovascular disease in terms of morbidity and mortality in South Africa is increasing, investigators have paid little attention to the measurement of the impact of the disease on the life expectancy of the population. Therefore, this study will fill this gap by examining the impact of CVD on the life expectancies of South African population at different age groups. Specifically, this study will also examine the chance of surviving from one age to another with and without the impact of cardiovascular disease. Finally, this study will estimate the percentage gains in life expectancy when the impact of cardiovascular disease was eliminated.

Methodology

We collected the mortality data from the WHO Statistical Information system (WHOSIS). The data provided the number of registered deaths by cause, sex and age with population and live birth data. The data presented by WHOSIS are those reported in a standardized format including the International Classification of Disease (ICD) codes. A total of 297,517 male deaths and 292,017 female deaths were reported in 2005, giving a total of 589,534 deaths [9]. Also, the ages of 1,679 deaths were not specified and they were not included in this analysis. The male and female population was 5, 094, 791 and 5, 038, 068 respectively.

Procedure

The age-specific mortality rates (${}_{n}m_{x}$), which is the basic information needed in constructing life table, was transformed into the probability of dying (${}_{n}q_{x}$) using the formula:

$$ {}_{n}q_{x} = \frac{2n * \text{nmx}}{2+(n* \text{nmx})} . $$

After this, the various life table functions like ${}_{n}P_{x}$, l_x, ${}_{n}d_{x}$, ${}_{n}L_{x}$, T_x and e_x were computed [10, 11]. A hypothetical population of 100,000 (radix) was assumed in the course of this study, in constructing the life tables. Furthermore, a multiple decrement table as developed by Makeham (1875) was used to eliminate the impact of cardiovascular disease. The assumption is that if deaths from cardiovascular disease were eliminated, there would be a greater exposure to other diseases and it would be expected that death rates (dependent death rates) for other causes of death will increase. The first step taken was that the dependent rates (Q_x) were used to calculate the independent rates (q_x) for the two categories of the causes of death (cardiovascular disease and other diseases), using the formulae below:

$$ \mathbf{q^{1}{}_{x}} = \frac{Qx'}{1-(1/2Qx'')} $$

$$ \mathbf{Q^{11}{}_{x}} = q^{1}{}_{x}\left(1-\frac{1}{2}q^{11}{}_{x}\right) $$

Secondly, the independent rates were adjusted as required and in this case, cardiovascular disease was eliminated and so $q^{1}{}_{x}$ becomes zero, but $q^{11}{}_{x}$ did not change because it was independent rate. Thirdly, the adjusted independent rates were used to calculate the new dependent rates using the formula above. Finally, the adjusted multiple-decrement table was then constructed and which gave the various life table functions without the impact of cardiovascular disease**.** The major limitation for this study is that it is impossible to completely eliminate the impact of CVD in a population. However, the results at least give an overview of what the life expectancy would be like if the impacts of cardiovascular disease are minimized in the country.

Results

This study was basically set out to estimate the chances of survival when all diseases are operating in South Africa and when cardiovascular disease are eliminated; observe the differences in life expectancies with or without the impact of cardiovascular disease and; examine the percentage differences in the life expectancies with and without the impact of cardiovascular disease.

Out of the 297,517 and 292,017 deaths recorded for males and female respectively in 2005, 35,427 males and 43,091 females died from cardiovascular disease. This indicates that the proportionate mortality ratio (PMR) of cardiovascular disease was about one- tenth (11.9%) of all male deaths and that of females was about fifteen percent (14.8%). The crude mortality rate for cardiovascular disease was about 150 deaths per 100,000 population for males and 170 deaths per 100,000 populations for females.

Also, the results showed that the corresponding probabilities of dying before age one (${}_1q_0$) and between ages one and four for those who survive to age one (${}_4q_1$) were 4.3% and 1.5% respectively for males and 4% and 1.4% respectively for females. These estimates translated to a life expectancy at birth of 50.6 years for males and 56.2 years for females (Tables 1 and 6)**.** This life expectancy for males and females showed a pattern that is a characteristic of a high mortality population.

Furthermore, the results showed that the probability that a new born baby in South Africa will survive to age 75 years was about 24% for males and 34% for females (Tables 1 and 6). The results further showed that the probability of surviving reduced at each age group from birth to ages 85 years. Also, without the impact of cardiovascular disease, the probability that a new born baby will survive to age 75 years was 31% for males and 40% for females (Tables 5 and 10). This indicates that the chance of survival increased when CVD was eliminated in the population. In other words, the results showed that the chance of survival from birth to 75 years for males increased by about twenty-nine percent (29.1%) and that of females increased by about seventeen percent (17.6%) when the impact of cardiovascular disease was eliminated.

Further, when the impact of CVD was eliminated, the life expectancies for males increased to 55.8 years and this indicates a probable gain of 5.2 years. For females, the life expectancies at birth increased to 57.1 years and it implies a probably gain of 0.9 years (about 10 months). This may in a way shows that cardiovascular disease mostly has greater impact on the males compared to the females in terms of life expectancy. The results further showed an increase in life expectancy at every age in the absence of cardiovascular disease for both males and the females. Although life expectancy is shown to have increased at every age in the absence of cardiovascular disease, the increase was more pronounced at early ages (0-4 years) than at other ages for both the males and the females (Figures 2 and 5). The results basically showed that when the impact of CVD was eliminated from the population, there was an increase in life expectancy and chances of survival.

Discussion

Understanding the impacts of CVD on life expectancies at different ages is very critical for policy purposes. This will basically help to direct appropriate intervention targeted to different age group in the population. There is no doubt that examining the impacts of CVD on life expectancy and chance of survival in South Africa is vital at this time, most especially because of the rate of urbanization in the country. This is because studies have shown that urbanization is usually followed by change in the burden of disease from infectious to chronic non-communicable diseases (NCDs) in developed countries or a double burden of infectious and chronic NCDs in developing countries [5]. This study basically demonstrated the usefulness of multiple decrement tables as a tool to examine potential gains in life expectancy by eliminating the impact of cardiovascular disease as causes of death in South Africa. The gains in life expectancy due to complete elimination of cardiovascular disease were based on the implicit assumption that the years lived at any age are of equal value. However, in terms of the economic costs and benefits, the years of life gained for the working population and among children may be more beneficial compared to the aged.

It has been observed that little attention has been paid to examining the impact of cardiovascular disease in developing countries most especially Africa, although the mortality from the diseases has been on the increase [13]. Coupled with the burden of HIV/AIDS in South Africa, cardiovascular disease has not been given much attention in the country. This is in spite of the projections that premature deaths caused by cardiovascular disease in the working population (35-64 years) are expected to increase by 41 percent between 2000 and 2030 [8].

The results showed a low life expectancy at birth in South Africa, which is a pattern seen in a developing countries with high mortality rates. The results also showed that the burden of cardiovascular disease affects males more than females because when the impact of the disease was eliminated, the males have more probable gain in in life expectancy and also higher chances of survival. This in a way supports the facts and projections on cardiovascular disease that men are more likely to bear more of the burden of the disease [2, 3, 4]

Also, the study showed that the chances of survival reduced from infancy through ages 75 years. Furthermore, this study has shown that increases in life expectancy when cardiovascular disease was eliminated were mostly pronounced at ages 0-4 years. This may indicates that the burden of congenital heart disease and rheumatic heart disease, which mostly affect children, are common in South Africa compared to the other categories of cardiovascular disease. Therefore, further studies need to be done in order to see the regional variations in terms of the impacts of cardiovascular disease in the country. This will eventually help in the proper monitoring of the disease and also allows a more focused interventions rather than assuming that the burden of the disease is the same in all the regions.

The study showed that there would be a probable gain in life expectancy at birth by 5.2 years for males and 0.9 years for females when the impact of CVD was eliminated. For instance, this implies that the life of new male-born baby in South Africa in 2005 could be increased by about 5 years if CVD was prevented. This may look small but it is important to start to think of the development that can be attained if the lives of average new born baby in South Africa could be prolonged if CVD is prevented in the population. Although the impact of the disease on life expectancy may not be huge now, if serious measures are not put in place, its effects on life expectancy and the economic growth of South Africa in the near future will be very enormous. In other words, although the South Africa Heart Foundation estimated the cost of CVD disability payment in South Africa to be US$ 70 million in 2000, this cost may continue to be on the increase if serious measures are not put in place to combat the risk factors of the disease. Also, effective primary, secondary and tertiary prevention strategies should be put in place in order to eventually prolong the life expectancy of people in South Africa.

Conclusion

This study was basically set out to show the impact of cardiovascular disease on life expectancies in South Africa. There was a probable gain in life expectancy and chances of survival when CVD was eliminated in the population. However, the small impact of cardiovascular disease on South Africa mortality may actually be due to the overshadowing effect of HIV/AIDS in the country. We therefore suggest that further studies be done to estimate the demographic impact of HIV/AIDS and CVD in South Africa. This will help to see the simultaneous impact of these two diseases on life expectancy and chances of survival in the country.

Limitations

The first limitation for this study is that it assumed that the impact of a disease can be completely eliminated and this may not be true in reality. Also, regional variations in terms of the impact of CVD could not be determined. There is the possibility that the impact of the disease may vary from one region to another and this implies that further studies need to focus on the impact of the disease at different regions in the country.

References

1. Kadiri S. (2005). *Tackling cardiovascular disease in Africa*. *BMJ 331: 711 doi: 10.1136/bmj.331.7519.711*.
2. Yach D, Hawkes C, Gould C, Hofman K (2004): *The global burden of chronic diseases: overcoming impediments to prevention and control*. *JAMA* 2004, 291(21):2616-2622.
3. BeLue R, Okoror T.A, Iwelunmor J, Taylor K.D, Degboe A.N, Agyemang C, Ogedegbe O. *An overview of cardiovascular risk factor burden in sub-Saharan African countries: a socio-cultural perspective*. Globalization and Health. 2009; 5:10. doi: 10.1186/1744-8603-5-10.
4. WHO (2011). *Global atlas on cardiovascular disease prevention and control.* http://www.who.int/cardiovascular_diseases/en/. Accessed on 23rd September, 2011.
5. Agyei-mensah S and de-Graft A A (2010): *Epidemiological Transition and the Double Burden of disease in Accra, Ghana*. Journal of Urban Health: Bulletin of the New York Academy of medicine, Vol. 87, No. 5.
6. Kengne A.P, Amoah A.G.B and Mbanya J.C (2005*). Cardiovascular Complications of Diabetes Mellitus in Sub-Saharan Africa*. Circulation 2005, 112(23):3592-3601
7. Bonow R, Smaha L, Smith SCJr, Mensah G.A, Lenfant C (2002): *World Heart Day 2002: the international burden of cardiovascular disease: responding to the emerging global epidemic*. Circulation 2002, 106(13):1602-1605.
8. The Heart and Stroke Foundation, South Africa. Heart Disease in South Africa: Media Data Document. Department of Medicine, University of Cape Town and Chronic Diseases of Lifestyles Unit, at the Medical Research Council: South Africa, 2007.
9. World Health Organisation Statistical Information System (2006). World Health Organisation.

10. Pollard A.H, Yusuf F, Pollard G.N (1990). Demographic Techniques. The Book Printer, Victoria.
11. Kpekpo G.M.K (1982). Essentials of Demographic Analysis for Africa. Heinemann Educational Books Inc.
12. Makem, W.M (1875). On an Application of the Theory of the Composition of Decremental Forces. Journal of the Institute of Actuaries, Vol. 18.
13. Gaziano TA, K Srinath R, Fred P, Sue H, Vivek C. Disease control priorities in developing countries 2005:645-662.

APPENDICES

LIST OF TABLES

Table 1 Life Table for Males in South Africa in 2005

Age	Population	Death	ASDR'000	${}_nm_x$	${}_nq_x$	P_x	l_x	d_x	${}_nL_x$	T_x	e_x
0	543,567	23823	43.83	0.04383	0.04253	0.95747	100000	4253	97023	5059218	50.6
1-4	2,112,411	8118	3.84	0.00384	0.01520	0.98480	95747	1455	39060	4962195	51.8
5-14	5,094,791	5434	1.07	0.00107	0.01064	0.98936	94292	1003	937905	4923135	52.2
15-24	4803438	15021	3.13	0.00313	0.03082	0.96918	93289	2875	918515	3985230	42.7
25-34	3995490	47527	11.90	0.01190	0.11232	0.88768	90414	10155	853365	3066715	33.9
35-44	2915564	56155	19.26	0.01926	0.17568	0.82432	80259	14100	732090	2213350	27.6
45-54	2058621	45375	22.04	0.02204	0.19852	0.80148	66159	13134	595920	1481260	22.4
55-64	1239743	36060	29.09	0.02909	0.25396	0.74604	53025	13466	462920	885340	16.7
65-74	589587	28985	49.16	0.04916	0.39461	0.60539	39559	15610	317540	422420	10.7
75+	195788	29081	148.53	0.14853	1.0000	0.0000	23949	23949	104880	104880	4.4

Source: Computed from WHO Statistical Information System, 2006

Table 2 Dependent rates (for males) from cardiovascular disease mortality and Other causes of mortality

Age	Q'_x	Q''_x
0	0.000044	0.043783
1-4	0.000062	0.003781
5-14	0.000032	0.001035
15-24	0.000085	0.003042
25-34	0.000356	0.011540
35-44	0.001128	0.018132
45-54	0.002743	0.019299
55-64	0.006155	0.022932
65-74	0.013474	0.035688
75+	0.044461	0.104072

Table 3 The Independent rates (for males) from cardiovascular disease mortality (q^{1}_{x}) and Other causes of mortality (q^{11}_{x})

Age	q^{1}_{x}	q^{11}_{x}
0	0.000045	0.043784
1-4	0.000062	0.003781
5-14	0.000032	0.001035
15-24	0.000085	0.003042
25-34	0.000358	0.011542
35-44	0.001138	0.018142
45-54	0.002770	0.019326
55-64	0.006226	0.023003
65-74	0.013719	0.035930
75+	0.046902	0.106438

Table 4 Eliminating the impact of cardiovascular disease: The new dependent rates for other causes of deaths

Age	Q^{1}_{x}	Q^{11}_{x}
0	0	0.043783
1-4	0	0.003781
5-14	0	0.001035
15-24	0	0.003042
25-34	0	0.011540
35-44	0	0.018132
45-54	0	0.019299
55-64	0	0.022931
65-74	0	0.035684
75+	0	0.103942

Table 5 Life table for males without the impact of cardiovascular disease

Age	Q''_x	$_nq_x$	P_x	l_x	d_x	$_nL_x$	T_x	e_x	Increase in ex	%increase in ex
0	0.043783	0.04248	0.95752	100000	4248	97026	5576967	55.8	5.2	10.3
1-4	0.003781	0.01497	0.98503	95752	986	380346	5479941	57.2	5.4	10.4
5-14	0.001035	0.01030	0.98970	94766	976	942780	5099595	53.8	1.6	3.1
15-24	0.003042	0.02996	0.97004	93790	2810	923850	4156815	44.3	1.6	3.7
25-34	0.011540	0.10910	0.89090	90980	9926	860170	3232965	35.5	1.6	4.7
35-44	0.018132	0.16625	0.83375	81054	13475	743165	2372795	29.3	1.7	6.2
45-54	0.019299	0.17601	0.82399	67579	11895	616315	1629630	24.1	1.7	7.6
55-64	0.022931	0.20572	0.79428	55684	11455	499565	1013315	18.2	1.5	9.0
65-74	0.035684	0.30281	0.69719	44229	13393	375325	513750	11.6	0.9	8.4
75+	0.103942	1.0000	0.0000	30836	30836	138425	138425	4.5	0.1	2.3

Source: Computed from WHO Statistical Information System, 2006

Table 6 Life Table for Females in South Africa in 2005

Age	Population	Death	$_nm_x$	$_nq_x$	P_x	l_x	d_x	$_nL_x$	T_x	e_x
0	532461	21739	0.040827	0.039693	0.960307	100000	3969	97222	5624185	56.2
1-4	2074550	7238	0.00349	0.013830	0.98617	96031	1328	380538	5526963	57.6
5-14	5038068	4595	0.000912	0.009079	0.990921	94703	860	942730	5146425	54.3
15-24	4766428	19096	0.004006	0.039273	0.960727	93843	3685	920005	4203695	44.8
25-34	3916352	57609	0.014710	0.137022	0.862978	90158	12354	839810	3283690	36.4
35-44	3031038	47050	0.015523	0.144050	0.85595	77804	11208	722000	2443880	31.4
45-54	2294692	31912	0.013907	0.130028	0.869972	66596	8659	622665	1721880	25.9
55-64	1486852	26248	0.017653	0.162212	0.837788	57937	9398	532380	1099215	19.0
65-74	850673	29951	0.035209	0.299385	0.700615	48539	14532	412730	566835	11.7
75+	398549	45513	0.114197	1.00000	0.00000	34007	34007	154105	154105	4.5

Source: Computed from WHO Statistical Information System, 2006

Table 7 Dependent rates (for females) from cardiovascular disease mortality and Other causes of mortality

Age	Q'_x	Q''_x
0	0.000039	0.040788
1-4	0.000059	0.003430
5-14	0.000039	0.000875
15-24	0.000147	0.003860
25-34	0.000541	0.014169
35-44	0.001022	0.017984
45-54	0.002039	0.011868
55-64	0.004250	0.013403
65-74	0.011178	0.024030
75+	0.040878	0.073318

Table 8 The Independent rates (for females) from cardiovascular disease mortality (q^1_x) and other causes of mortality (q^{11}_x)

Age	q'_x	q''_x
0	0.000040	0.040789
1-4	0.000059	0.003430
5-14	0.000039	0.000875
15-24	0.000147	0.003860
25-34	0.000545	0.014173
35-44	0.001031	0.017993
45-54	0.002051	0.01180
55-64	0.004279	0.013432
65-74	0.011314	0.024172
75+	0.042434	0.074848

Table 9 Eliminating the impact of cardiovascular disease: The new dependent rates for other causes of deaths (females)

Age	Q'_x	Q''_x
0	0	0.040788
1-4	0	0.003499
5-14	0	0.000875
15-24	0	0.003860
25-34	0	0.014169
35-44	0	0.017984
45-54	0	0.011868
55-64	0	0.013403
65-74	0	0.024035
75+	0	0.073260

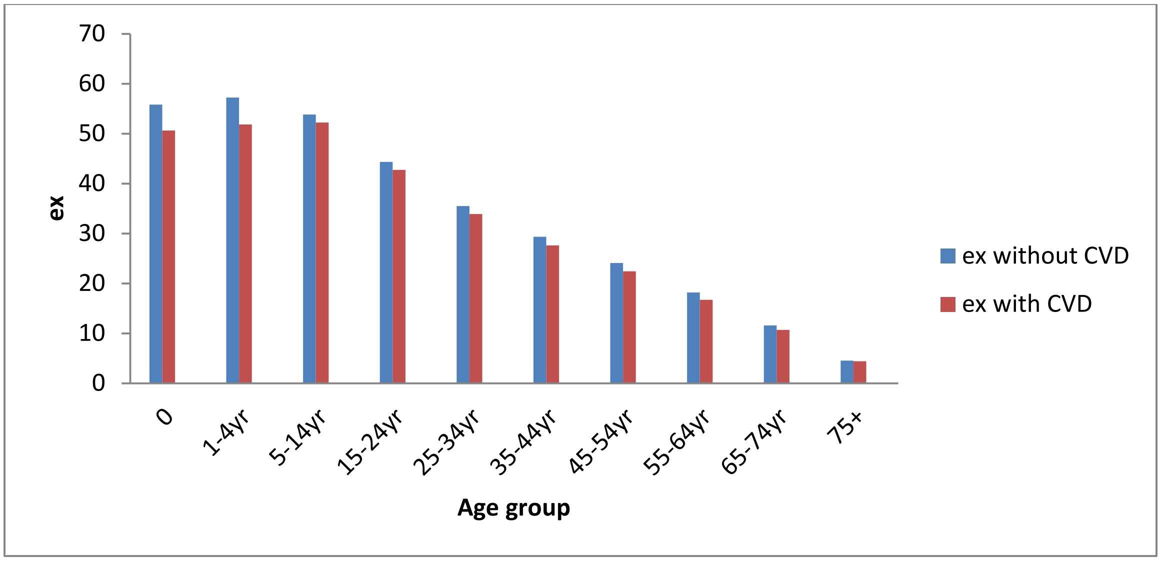
Table 10 Life table for females without the impact of cardiovascular disease

Age	Q''_x	$_nq_x$	P_x	l_x	d_x	$_nL_x$	T_x	e_x	Diff	% increase
0	0.040788	0.03966	0.96034	100000	3696	97413	5705712	57.1	0.9	1.6
1-4	0.003499	0.01387	0.98613	96034	1332	380540	5608299	58.4	0.8	1.4
5-14	0.000875	0.00871	0.99129	94702	825	942895	5227759	55.2	0.9	1.7
15-24	0.003860	0.03787	0.96213	93877	3555	920995	4284864	45.6	0.8	1.8
25-34	0.014169	0.13232	0.86768	90322	11951	843465	3363869	37.2	0.8	2.2
35-44	0.017984	0.16500	0.83500	78371	12931	720855	2520404	32.2	0.8	2.5
45-54	0.011868	0.11203	0.88797	65440	7331	617745	1799549	27.5	1.6	6.2
55-64	0.013403	0.12561	0.87439	58109	7299	544595	1181804	20.3	1.3	6.8
65-74	0.024035	0.21456	0.78544	50810	10902	453590	637209	12.5	0.8	6.8
75+	0.073260	1.00000	0.00000	39908	39908	183619	183619	4.6	0.1	2.2

Source: Computed from WHO Statistical Information System, 2006

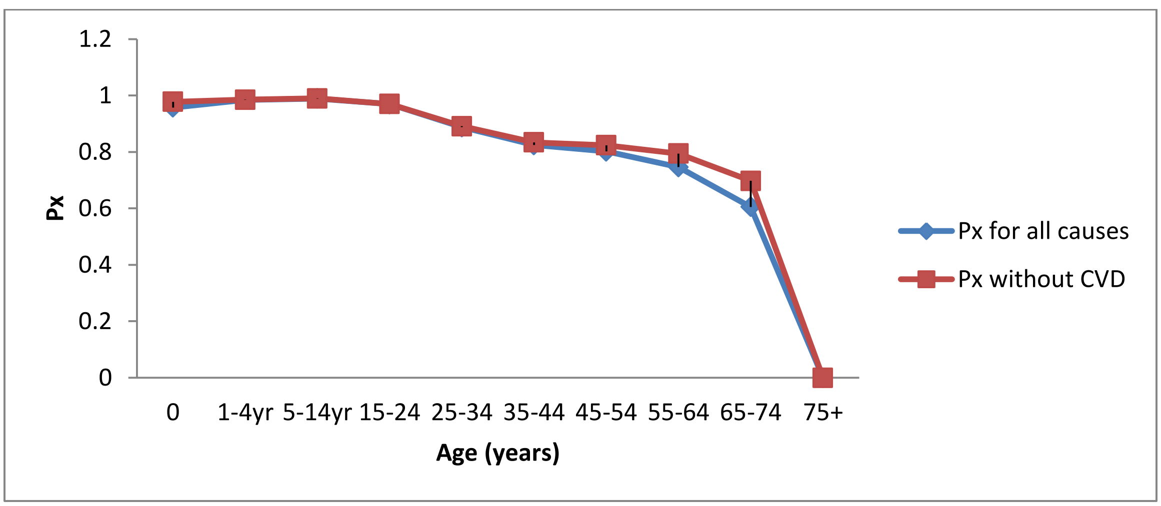
LISTS OF FIGURES

Figure 2 Life expectancy for males for all causes combined and without the impact of cardiovascular disease



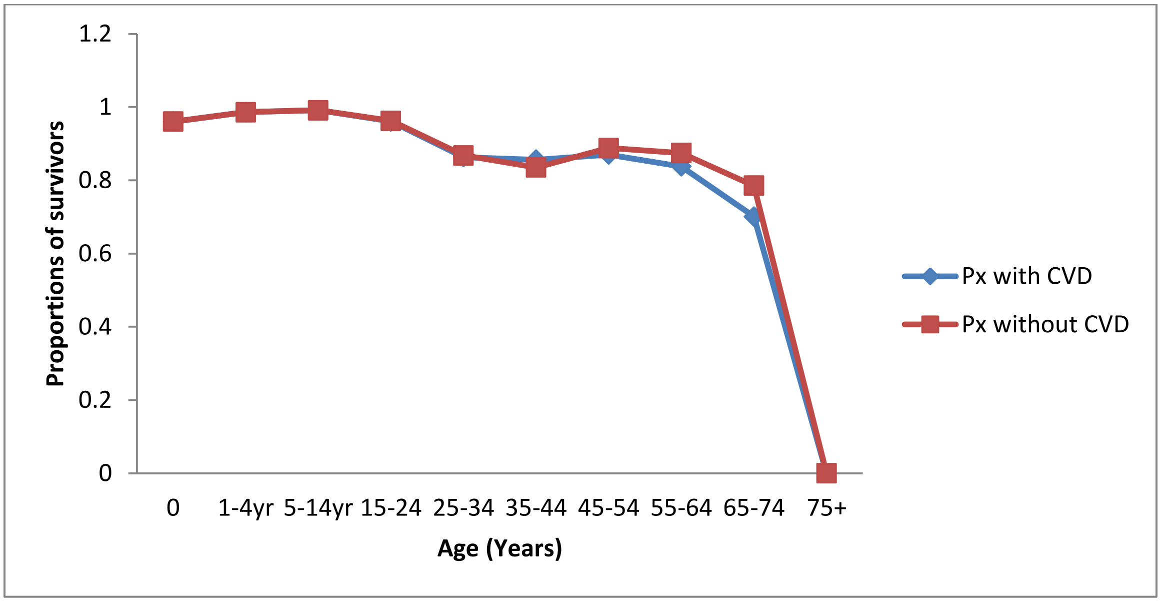
Source: Computed from WHO Statistical Information System, 2006

Figure 3 Estimated proportion of males surviving to exact age with and without in South Africa



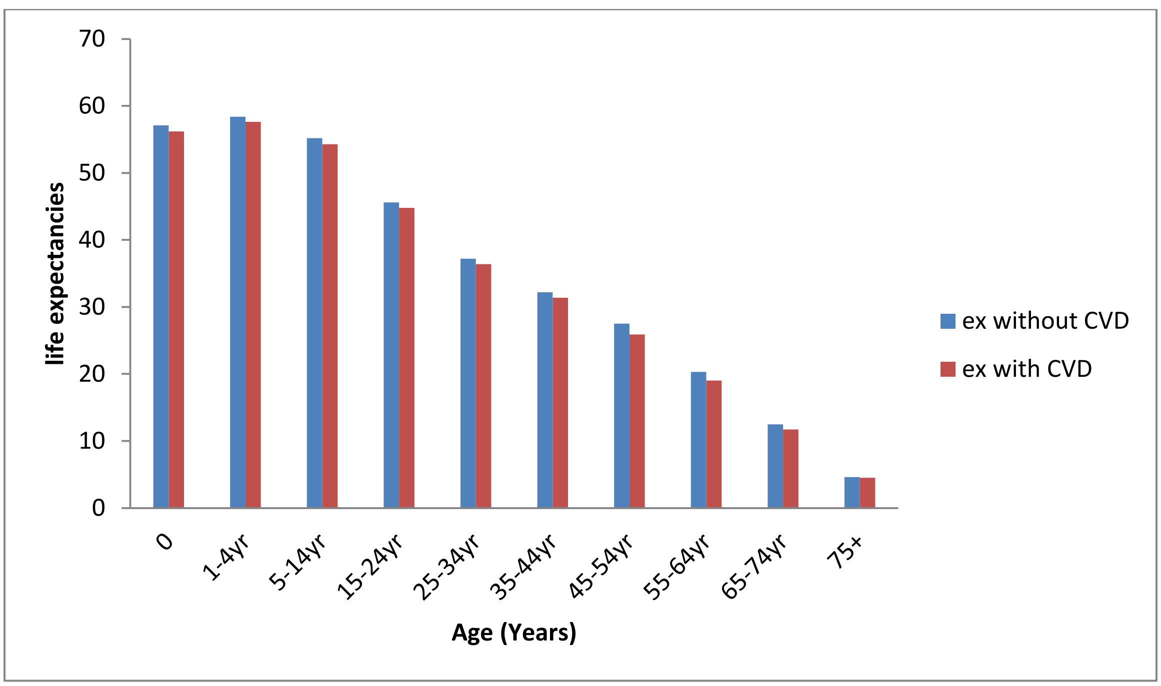
Source: Computed from WHO Statistical Information System, 2006

Figure 4 Estimated proportion of females surviving to exact age with and without in South Africa



Source: Computed from WHO Statistical Information System, 2006

Figure 5 Life expectancy for females for all causes combined and without the impact of cardiovascular disease



Source: Computed from WHO Statistical Information System, 2006