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Components of Mortality Change by Cause in Developing Countries During 1980s

Introduction

IN this paper, we present and analyze information on mortality by cause in selected developing countries of the World for which detailed statistics of death by cause has been made available by the World Health Organization. Although cause of death information in most of the developing countries of the World continues to be poor because of problems related to registration of deaths and their medical certification, yet a few developing countries have been able to maintain fairly satisfactory cause of death reporting system that permits analysis of mortality change by cause. Though these countries may not be regarded as representative of the developing World, yet an analysis of mortality change by cause hi these countries may provide a fair indication of what is happening on the mortalilty front in this part of the World.

Information maintained by the World Health Organization on causes of death is the official national statistics in the sense that it has been transmitted to the Organization by respective countries. This information is based upon the underlying cause of death, defined as 'the disease or injury which initiates the train of morbid events leading directly to death, or circumstances of accident or violence which produced the fatal injury' (WHO, 1977).

Since the observed mortality is heavily influenced by the age and sex structure of the population, it is imperative in any comparative analysis of mortality that the age and sex structure effects on mortality level is removed. This is done, in the present study, by using age and sex standardized crude death rates in place of un-standardized crude death rates. World Health Organization uses the standard population suggested by Waterhouse and others (Waterhouse *etal.,* 1976) for the purpose of standardization. These age standardized death rates have been used in this analysis.

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This analysis covers fourteen developing countries of the World. One from Africa, three from Asia and ten from Latin America. Selection of countries for inclusion in the analysis was based entirely upon the availability of information on death by age, sex and cause at least at two points of time having an interval of at least five years.

Method

The analysis is based upon the decomposition of the change in the age standardized death rate into two components- change attributable to the sex differentials in mortality and the change attributable to the level of mortality. Details about the method adopted in this paper are given in the appendix. The basic equation used in the analysis is

$$\begin{aligned} ASDR &= (ASDRM\text{-}ASDRF) * p_m + ASDRF \\ &= SDM * + ASDRF \end{aligned} \quad (1)$$

where ASDR is the age standardized death rate for males and females combined, ASDRM and ASDRF are the male and female age standardized death rates and p_m is the proportion of males in the population. If the population is standardized to a sex ratio of 1, then equation (1) reduces to

$$ASSDR = 0.5 * SDM + ASSDRF \quad (2)$$

where ASSDR is the age and sex standardized death rate. If $\nabla ASDR$ denotes the change in the age standardized death rate over time, then it can be shown that

$$\nabla ASSDR = \nabla SDM + \nabla ASSDRF \quad (3)$$

Denoting by the subscript i, the cause of death i, it is easy to derive from (2) and (3) that

$$\begin{aligned} ASSDR_i &= 0.5 * SDM_i + ASSDRF_i, \\ \nabla ASSDRi &= 0.5 * \nabla SDM_i + \nabla ASSDRF_i \end{aligned} \quad (4)$$

and

$$\nabla ASSDR = 0.5 * \sum_i \nabla SDM_i + \sum_i \nabla ASSDRF_i$$

Findings

Table 1 summarizes the age and sex standardized death rates for fourteen countries included in this analysis for the latest year for which the information was available at the World Health Organization data bank. Countries included in the analysis vary widely in terms of the level of mortality. Lowest level of mortality has been observed in Costa Rica followed by Cuba. In Singapore also, current level of age standardized crude death rate is estimated to be 6 per 1000 population. On the other hand, Trinidad and Tobago with an age standardized crude death rate of more than 8 per 1000 population has the highest mortality level among the countries included in the analysis.Other countries where the age standardized

crude death rate has been estimated to be more than 8 per 1000 population are Mauritius and Sri Lanka, although information about Sri Lanka dates back to the year 1986.

TABLE 1 : CURRENT LEVELS AND COMPONENTS OF MORTALITY IN DEVELOPING COUNTRIES

Country	*Year*	*Rate*	*Components of mortality*			
				Absolute	*Proportional*	
			SDM	*ASDRF*	*SDM*	*ASDRF*
Argentina	1990	677.2	166.5	510.7	24.6	75.4
Bahamas	1987	717.9	155.0	562.9	21.6	78.4
Chile	1989	658.0	166.9	491.1	25.4	74.6
Costa Rica	1991	545.8	100.8	445.0	18.5	81.5
Cuba	1990	561.6	79.4	482.2	14.1	85.9
Kuwait	1987	600.6	74.3	526.3	12.4	87.6
Mauritius	1992	815.8	220.4	595.4	27.0	73.0
Mexico	1991	666.7	127.6	539.1	19.1	80.9
Puerto Rico	1991	632.5	190.5	442.0	30.1	69.9
Singapore	1990	592.5	125.4	467.1	21.2	78.8
Sri Lanka	1986	815.3	157.3	658.0	19.3	80.7
Trinidad and Tobago	1991	820.1	161.7	658.4	19.7	80.3
Uruguay	1990	667.5	187.7	479.8	28.1	71.9
Venezuela	1990	668.8	127.8	541.0	16.6	83.3

Remarks: Rates are given per 100 000 population, standardized by age and sex.

Table 1 also gives the absolute as well as relative magnitude of the two components of mortality— one attributed to the sex difference in mortality levels and the other attributed to its level. Interestingly, in most of the countries included in the analysis, sex difference in mortality account for 20-30 per cent of the mortality at the aggregate level. This implies that elimination of sex difference in mortalilty alone will result approximately 20-30 per cent decline in mortality even under prevailing social, economic and environmental conditions and current state of medical advancement.

Table 2 summarizes the trend in age and sex standardized death rates and in its two component for the fourteen countries. All countries included in this analysis, except Puerto Rico, has shown decline in mortality levels of varying degree during the past decade. This decline has been most rapid in Mauritius where age and sex standardized death rate decreased by more than 4 deaths for every 1000 population between 1981 and 1992 resulting in an average annual rate of decline of 0.38 per year for every 1000 population. In Kuwait also, the decline in mortality has been almost equally rapid. By contrast, in Argentine, Cuba and Sri Lanka, there appears to be little mortality transition during the 1980s. In all these countries,

TABLE 2 : TRENDS IN LEVEL AND COMPONENT OF MORTALITY IN DEVELOPING COUNTRIES

Country	*Level and component*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*
Aargentina	ASDR			691.2			698.1	704.1	721.3		678.5	677.2		
	SDM			147.9			156.3	157.8	165.1		165.8	166.5		
	ASDRF			543.3			541.8	546.3	556.2		512.7	510.7		
Bahamas	ASDR		767.5				700.9		717.9					
	SDM		185.9				138.2		155.0					
	ASDRF		581.6				562.7		562.9					
Chile	ASDR			733.4		758.5		702.6	663.9		658.0			
	SDM			174.4		193.7		164.6	138.4		166.9			
	ASDRF			559.0		564.8		538.0	525.5		461.1			
Costa Rica	ASDR	618.3			495.9			614.1		618.9	596.0	533.1	545.8	
	SDM	104.9			70.6			119.6		131.7	128.2	104.7	100.8	
	ASDRF	513.4			425.3			494.5		487.2	467.8	428.4	445.0	
Cuba	ASDR		588.9		608.0		593.1	567.7	559.4	614.2		561.6		
	SDM		77.7		66.4		67.4	70.4	72.1	74.1		79.4		
	ASDRF		511.2		541.6		525.7	506.3	487.3	540.1		482.0		
Kuwait	ASDR			765.1			714.4	655.0	600.6					
	SDM			127.0			97.7	72.3	74.3					
	ASDRF			638.1			616.7	582.7	526.3					
Mauritius	ASDR		1236.2	1221.9			984.2	927.5	904.0				831.5	815.8
	SDM		442.4	432.4			271.1	209.7	224.3				225.7	220.4
	ASDRF		793.8	789.5			713.1	717.8	697.7				605.8	595.4
Mexico	ASDR			800.7				719.6				699.5	666.7	
	SDM			150.5				126.3				131.3	127.6	
	ASDRF			650.2				593.3				568.2	539.1	

Puerto Rico	ASDR		591.1	507.6	566.9		617.3	598.5	612.6		643.5	644.9	632.5
	SDM		140.1	114.6	132.8		149.2	158.7	163.4		171.4	193.9	190.5
	ASDRF		451.0	393.0	434.1		468.1	439.8	449.2		472.1	451.0	442.0
Singapore	ASDR		745.7				699.9	657.2	649.0		650.8	592.5	
	SDM		150.4				150.0	145.8	140.1		147.7	125.4	
	ASDRF		595.3				549.9	511.4	508.9		503.1	467.1	
Sri Lanka	ASDR	843.4		798.5	806.2		819.3	815.3					
	SDM	93.6		123.3	119.0		119.6	157.3					
	ASDRF	749.8		675.2	687.2		699.7	658.0					
Trinidad	ASDR				912.6			818.5		840.5	864.1	816.0	820.1
and Tobago	SDM				136.5			113.8		102.7	179.6	150.1	161.7
	ASDRF				776.1			704.7		737.9	684.5	665.9	658.4
Uruguay	ASDR					730.4	690.2	689.2	706.3			667.5	
	SDM					180.9	168.6	159.3	165.7			187.7	
	ASDRF					549.5	521.6	529.9	540.6			479.8	
Venezuela	ASDR	833.9			717.4				696.0			668.8	
	SDM	134.1			119.8				115.6			127.8	
	ASDRF	699.8			597.6				580.4			541.0	

Remarks: Rates are per 100 000 population.

TABLE 3: PROPORTIONAL CONTRIBUTION OF SDM AND ASDRF TO ASDR

Country	*Component*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*
Argentina	SDM			21.4			22.7	22.4	22.9		24.4	24.6		
	ASDRF			78.6			77.5	77.6	77.1		75.6	75.4		
Bahamas	SDM		24.2				19.7		21.6					
	ASDRF		75.8				80.3		78.4					
Chile	SDM			23.8		25.5		23.4	20.8		25.4			
	ASDRF			74.5		74.5		76.6	79.2		74.6			
Costa Rica	SDM	17.0						19.5		21.3	21.5	19.6	18.5	
	ASDRF	83.0						80.5		78.7	78.5	80.4	81.5	
Cuba	SDM		13.2		10.9		11.4	12.2	12.9	12.1		14.1		
	ASDRF		86.8		89.1		88.6	87.8	87.1	87.9		85.9		
Kuwait	SDM			16.6			13.7	11.0						
	ASDRF			83.4			86.3	89.0						
Mauritius	SDM		35.8	35.4			27.6	20.5	24.8				27.1	27.0
	ASDRF		64.2	64.6			72.4	79.5	75.2				72.9	73.0
Mexico	SDM			18.8				17.6				18.8	19.1	
	ASDRF			81.2				82.4				81.2	80.9	
Puerto Rico	SDM		23.7	22.6	23.4		24.2	25.5	26.7		26.6	30.0	30.1	
	ASDRF		76.3	77.4	76.6		75.8	73.5	73.3		73.4	70.0	69.9	
Singapore	SDM		20.2				21.4	22.2	21.6		22.7	21.2		
	ASDRF		79.8				78.6	77.8	78.4		77.3	78.8		
Sri Lanka	SDM	11.1		15.4	14.8		14.6	19.3						
	ASDRF	88.9		84.6	85.2		85.4	80.7						

Trinidad & Tobago	SDM		15.0			13.9		12.2	20.8	18.4	19.7
	ASDRF		85.0			86.1		87.8	79.2	81.6	80.3
Uruguay	SDM			24.8	24.4	23.1	23.5		28.1		
	ASDRF			75.2	75.6	76.9	76.5		71.9		
Venezuela	SDM	16.1	16.7				16.6			19.1	
	ASDRF	83.9	83.3				83.4			80.9	

Remarks: Figures given in table are percentages.

average annual rate of decline in age and sex standardized death rate has been less than 0.5 death per 1000 population. In Argentine, for example, the age and sex standardized death rate decreased by only 0.14 deaths per 1000 population in between 1982 and 1990.,This implies an average annual rate of decline of just 0.0175 deaths per year for every 1000 population.

In Puerto Rico, mortality, instead of decreasing, has increased during the 1980s. The age and sex standardized death rate, in this country, increased by an absolute amount of 0.41 deaths for every 1000 population in between 1981 and 1991. This implies an average annual rate of increase of 0.04 death per year for every 1000 population.

In Table 3, the relative contribution of the two components of mortality— the component attributed to female mortality and the component attributed to sex difference in mortality— to aggregate mortality level has been presented. In general, the relative contribution of sex difference in mortality appears to have increased over time in all countries except Kuwait. However, recent information on mortality in Kuwait is not available, hi Bahamas and Mauritius, on the other hand, current contribution of sex difference in mortality to overall mortality is less than that prevailed ten years ago. But this contribution has shown an increasing trend in recent years.

The increase in the contribution of sex difference in mortality to overall mortality levels implies that either the gap between male and female mortality has increased over time or the rate of decrease in the sex difference in mortality has been slower than the rate of decrease in female mortality. In fact, sex difference in mortality has increased over time in Argentine, Cuba, Puerto Rico, Sri Lanka, Trinidad and Tobago and Uruguay. In the remaining countries, except Kuwait, Bahamas and Mauritius, the rate of decrease in the sex difference in mortality has been found to be slower than the rate of decrease hi the female age and sex standardized death rate.

It is possible to measure the proportion of total change hi mortality as measured by the age and sex standardized death rate attributed to the change hi sex difference hi mortality and the change in the female age and sex standardized death rate. It may be seen from table 4 that hi only eight of the 14 countries, change hi the female age and sex standardized death rate and sex difference hi mortality are hi the same direction. In rest of the countries, female age and sex standardized death rate has declined but the sex difference hi mortality has increased. This implies that the decrease in male age and sex standardized death rate has not been able to keep pace with the female age and sex standardized death rate in these countries, hi Puerto Rico, it is this increase in sex difference hi mortality which has been found to be responsible for the increase hi overall mortality levels. It is also clear from Table 4 that if a decrease hi die sex difference hi mortality could be achieved, a much more rapid decline hi overall mortality levels could have been possible.

Even hi those countries where sex difference hi mortality has declined over tune, the contribution of reduction hi sex difference in mortality hi comparison to the contribution of female age and sex standardized death rate has been much smaller. In Venezuela, for example, reduction hi sex difference in mortality accounted for only 3.8 per cent of the reduction hi overall mortality. Similar, hi Costa Rica, reduction hi sex difference in mortality accounted for only about 5.7 per cent of the reduction hi overall mortality levels.

By contrast, in Bahamas and Mauritius, most of the reduction in age and sex standardized death rate has been due to a reduction in sex difference in mortality, hi Bahamas, for example, decrease in the sex difference in mortality accounted for more than 62 per cent of the reduction in age and sex standardized death rate during the period 1981 -87. hi Mauritius, this proportion is more than 52 per cent while in Kuwait, reduction in sex difference in mortality accounted for nearly one third of the reduction in age standardized death rate.

TABLE 4 : CONTRIBUTION OF CHANGE IN SDM AND ASDRF TO CHANGE IN ASDR

Country	*Period*	*Change in ASDR*			*Level of ASDR at the end of the period*
		Total	*Due to SDM*	*Due to ASDRF*	
Argentina	1982-90	14.0	-18.6	32.6	677.2
Bahamas	1981-87	49.6	30.9	18.7	717.9
Chile	1982-89	75.4	7.8	67.6	658.0
Costa Rica	1980-91	72.5	4.1	68.4	545.8
Cuba	1981-90	27.3	-1.7	29.0	561.6
Kuwait	1982-87	164.5	52.7	111.8	600.6
Mauritius	1981-92	420.4	220.0	198.4	815.0
Mexico	1982-91	134.0	22.9	111.1	666.7
PuertoRico	1981-91	-41.4	-50.4	9.0	632.5
Signapore	1981-90	153.2	25.0	128.2	592.5
Sri Lanka	1980-86	27.8	-63.4	91.2	815.3
Trinidad and Tobago	1983-91	92.5	-25.2	117.7	820.1
Uruguay	1984-90	62.9	-6.8	69.7	667.5
Venezuela	1980-90	165.1	6.3	158.8	668.8

Clearly, mortality transition has followed different path in different countries.

It is also possible to decompose total change in mortality according to the change in mortality by cause. For this purpose, causes of death have been grouped into the following seven categories according to the IX Revision of International Classification of Diseases, Injuries and Death.

I Infectious and Parasitic Diseases
II Malignant Neoplasms
III Diseases of Circulatory System
IV Diseases of Respiratory System
V Diseases of Digestive System

VI Accidents and Injuries
VII All other categories

The proportional contribution of change cause specific mortality to all cause mortality is given in Table 5. Similarly, the proportional contribution of change in cause specific female mortality to all cause mortality is given in Table 6 while the proportional contribution of change in cause specific sex difference in mortality to all cause sex difference in mortality is given in Table 7. In all the three tables, a negative sign indicates that the differentials have increased. On the other hand, the positive sign indicates that they have decreased over time.

It may be observed from Table 5 that hi Costa Rica, Kuwait, Mauritius, Singapore and Venezuela, mortality has declined in all cause of death categories whereas in rest of the countries, it has declined in some categories and increased in other cause of death categories. As already stated, this pattern of mortality change is due to the interaction of change hi the female mortality and the change in sex difference in mortality. A comparison of Table 5 and Table 6 suggests that this change in cause specific mortality is largely guided by the change in female mortality as out of 98 observations, in only 12 observations direction of change hi overall mortality is different from the change hi female mortality.

It may also be seen from Table 5 that primary contributor to the change hi overall mortality during the period under review are the diseases of circulatory system. This cause of death category was number one contributor to change hi overall mortality in seven countries and number two contributor hi two countries. Next important contributor to the change in overall mortality are the diseases of respiratory system. This cause of death category was number one contributor hi one country and number two contributor in three countries.

In case of female mortality, contribution of both diseases of circulatory system and diseases of respiratory system hi determining the change hi all the cause mortality becomes even more prominent. The diseases of circulatory system have been found to be number one contributor hi eight countries and number two contributor hi three countries. Similarly, diseases of respiratory system has been found to be number one contributor in one country and number two contributor hi two countries.

Contrary to both sex and female mortality, main contributor to the change hi sex difference in mortality has been found to be accidents and injuries. This cause of death category was number one contributor hi five countries and number two contributor hi two countries. Next main contributor to the change in sex difference in mortality is the diseases of circulatory system. This cause of death category was number one contributor in four countries and number two contributor hi two countries.

hi general, sex difference hi mortality by specific cause of death categories has increased over time. It may be seen from Table 7 that out of 98 observations, exactly half have negative sign indicating an increase hi the sex difference hi mortality by specific cause. This is in quite contrast to the change hi female mortality by cause where only 13 observations, out of 98, have been found to be negative. Otherwise also, sex difference in mortality has increased hi six of the fourteen countries but female mortality has not increased in any of these countries during the period under review.

TABLE 5 : CONTRIBUTION OF SPECIFIC CAUSES OF DEATH TO CHANGE IN ASDR (PER CENT)

Country	*Infectious and parasitic diseases*	*Malignant neoplasms*	*Diseases of circulatory system*	*Diseases of respiratory system*	*Diseases of digestive system*	*Injuries and accidents*	*All other causes*
Argentina	-5.4	-21.8	111.8	' -27. 1	41.8	7.9	-7.1
Bahamas	-10 6	-81.2	139.3	107.8	-4.1	-22.4	-28.8
Chile	4.4	5.4	42.4	-12.4	14.0	1.6	44.7
Costa Rica	6.2	1.0	11.5	8.1	1.7	25.7	45.8
Cuba	21.4	-11.0	58.6	44.9	-5.3	-13.4	4.8
Kuwait	6.4	17.0	14.7	7.7	5.0	10.8	38.4
Mauritius	7.4	4.8	46.2	11.1	0.0	1.8	28.6
Mexico	24.8	-5.6	9.0	16.6	10.7	26.0	18.6
Puerto Rico	-14.3	-18.8	81.9	1.0	18.1	-15.9	-152.2
Singapore	6.3	7.2	25.6	29.5	4.3	3.0	24.1
Sri Lanka	65.1	6.7	-4.7	32.7	-6.3	-25.5	32.0
Trinidad and Tobago	5.2	-5.4	87.0	10.9	6.3	9.1	-12.9
Uruguay	15.3	-3.7	67.0	-3.2	2.4	-12.8	34.9
Venezuela	8.5	9.9	30.1	3.5	1.9	17.7	28.4

TABLE 6 : CONTRIBUTION OF SPECIFIC CAUSES OF DEATH TO CHANGE IN ASDRF (PER CENT)

Country	*Infectious and parasitic diseases*	*Malignant neoplasms*	*Diseases of circulatory* system	*Diseases of respiratory* system	*Diseases of digestive* system	*Injuries and accidents*	*All other causes*
Argentina	2.1	1.2	68.7	-1.5	18.7	1.5	9.2
Bahamas	-12.3	-107.5	59.4	239.0	21.4	-13.9	-86.1
Chile	3.8	4.9	41.3	-7.8	12.0	2.8	43.0
Costa Rica	6.4	-1.9	25.0	15.9	0.6	12.0	42.0
Cuba	22.3	-14.1	55.9	41.7	-2.4	3.4	-7.2
Kuwait	3.7	24.9	5.5	4.9	2.9	7.2	51.1
Mauritius	12.3	0.3	43.0	13.4	3.5	0.7	26.8
Mexico	28.0	-3.1	13.2	19.4	9.2	9.3	24.0
Puerto Rico	-44.4	-11.1	464.4	0.0	61.1	-18.9	-351.1
Singapore	2.5	9.7	29.6	26.5	3.7	1.7	26.3
Sri Lanka	20.9	6.3	9.6	14.7	2.0	4.9	41.6
Trinidad and Tobago	5.4	-0.2	64.2	9.3	2.7	4.9	13.5
Uruguay	12.1	0.7	58.4	-3.0	5.0	-5.3	32.1
Venezuela	7.3	12.9	34.6	5.0	2.4	5.5	32.2

TABLE 7 : CONTRIBUTION OF SPECIFIC CAUSES OF DEATH TO CHANGE IN SDM (PER CENT)

Country	*Infectious and parasitic diseases*	*Malignant neoplasms*	*Diseases of circulatory* system	*Diseases of respiratory* system	*Diseases of digestive* system	*Injuries and accidents*	*All other causes*
Argentina	-7.8	-18.5	-36.3	-17.7	-1.3	3.2	-21.5
Bahamas	-9.5	-65.3	187.6	28.4	-19.5	-27.5	5.8
Chile	8.8	9.4	52.2	-51.6	30.8	-8.8	56.1
Costa Rica	2.5	50.6	-216.0	-123.5	19.8	256.8	109.9
Cuba	-44.1	64.7	-11.8	8.8	-44.1	-273.5	200.0
Kuwait	12.2	0.4	34.3	13.5	9.7	18.4	11.6
Mauritius	3.1	8.9	49.0	9.1	-3.2	2.8	30.2
Mexico	9.2	-17.9	-11.5	3.1	17.9	107.0	-7.6
Puerto Rico	-3.8	-13.4	-15.8	0.8	4.0	-9.6	-62.2
Singapore	25.5	-5.4	5.0	44.7	7.4	9.8	13.0
Sri Lanka	-1.6	-6.1	-15.9	-6.8	-5.6	-18.3	-45.7
Trinidad and Tobago	-6.5	-19.0	19.4	-4.2	10.3	10.3	-110.3
Uruguay	18.5	-41.5	22.2	1.5	-29.6	-64.4	-14.1
Venezuela	39.4	-65.4	-84.3	-33.9	-11.0	321.3	-66.1

Conclusions

The analysis presented here reveals that in all but one of the countries included in this analysis, mortality has declined during the 1980s although the rate of decline has varied from country to country. Puerto Rico is the only country of the sample under study where mortality, instead of declining, has increased during the period under review. The analysis also reveals that in a number of countries of the sample, sex difference in mortality has widened over time as a result of which, the pace of decline in both sexes has been slower than the pace of decline in female mortality alone. In fact, female mortality has declined even in Puerto Rico but because of the increase in sex difference in mortality, the both sex mortality hi the country has shown an increasing trend. In Argentina also, increase in sex difference in mortality has contributed substantially in slowing down the pace of mortality decline.

A decomposition of mortality change into specific causes of death suggests that the observed decline in mortality levels in most of the countries in the sample has been largely due to the decline in mortality from diseases of circulatory system and diseases of respiratory system. Decline in mortality from these diseases has been particularly rapid in case of female population in all the countries of the sample. But, in half of these countries, sex difference in mortality from diseases of circulatory system has increased with time. This shows that, hi these countries, female mortalilty from diseases of circulatory system has declined more repidly than the male mortality. Besides the diseases of circulatory system and diseases of respiratory system, role of other cause of death categories in mortality change, either in all cause mortality of in cause specific mortality, has been, at best, marginal.

Causes of relatively slower decline in male mortalilty hi the countries included hi this analysis are not known at present. However, the analysis suggests that relatively slower decline in male mortality due to diseases of circulatory system, especially cardiovascular diseases may be one of the important cause, hi any case, it is clear from the analysis that this relatively slower decline in male mortality in a number of developing countries is largely responsible for a relatively slower decline in both sex mortality.

References

Waterhouse *et al.,* 1976, *Cancer Mortality in the World.* Geneva, World Health Organisation.

World Health Organization, 1977, *International Statistical Classification of Diseases and Causes of Death,* IX Revision. Geneva, World Health Organization.

Appendix

Methodology

It is well-known that in any population, male and female death rates are not same and, in general, female death rate is less than the male death rate. In any case, the two death rates, in combination determine the death rate for the whole population. In other words, if p_f denotes the proportion of females in the population and p_m is the proportion of males, then

$$\text{ASDR} = \text{ASDRF}^*p_f + \text{ASDRM}^*p_m.$$

But $p_f + p_m = 1$. Hence

$$\text{ASDR} = (\text{ASDRM} - \text{ASDRF}) * p_m + \text{ASDRF}$$

This means that the death rate in any population can be decomposed into two components- the level component which is reflected in terms of female death rate and the sex difference component which is reflected in terms of the difference between male and female death rates. Here it is implicitly assumed that female death rate is less than the male death rate. This assumptions holds for most of the countries of the World. However, if male death rate is less than the female death rate as is the case with India, it is easy to observe that

$$\text{ASDR} = (\text{ASDRF} - \text{ASDRM}) * p_f + \text{ASDRF}.$$

The above relation shows that death rate in any population is dependent upon three factors. 1) the sex structure of the population as reflected by the sex ratio; 2) the level of female (male) death rate; and 3) excess of male (female) death rate over female (male) death rate. If the population is standardized in terms of sex structure also by taking $p_m = p_f = 0.5$ then the above basic relation reduces to

$$\begin{aligned}\text{ASSDR} &= 0.5 * (\text{ASSDRM-ASSDRF}) + \text{ASSDRF} \\ &= 0.5 * (\text{ASSDRF-ASSDRM}) + \text{ASSDRM}.\end{aligned}$$

Where ASSDR is the age and sex standardized death rate. If ASSDR_i denotes the age and sex standardized death rate due to cause of death i, then it is simple to show that

$$\begin{aligned}\text{ASSDR}_i &= 0.5^* (\text{ASSDRM}_i - \text{ASSDRF}_i) + \text{ASSDRF}_i \\ &= 0.5^* (\text{ASSDRF}_i - \text{ASSDRM}_i) + \text{ASSDRM}_i\end{aligned}$$

and

$$\begin{aligned}\text{ASSDR} = \textstyle\sum_i \text{ASSDR}_i &= 0.5 * \textstyle\sum_i (\text{ASSDRM}_i - \text{ASSDRF}_i) + \text{ASSDRF}_i \\ &= 0.5 * \textstyle\sum_i (\text{ASSDRF}_i - \text{ASSDRM}_i) + \text{ASSDRM}_i\end{aligned}$$

If ∇ASSDR denotes the change in the age and sex standardized death rate over time, then it can be shown that

$$\begin{aligned}\nabla\text{ASSDR} &= 0.5 * \textstyle\sum_i \nabla(\text{ASSDRM}_i - \text{ASSDRF}_i) + \nabla\text{ASSDRF}_i \\ &= 0.5 * \textstyle\sum_i \nabla(\text{ASSDRF}_i - \text{ASSDRM}_i) + \nabla\text{ASSDRM}_i\end{aligned}$$